Western Australian School of Mines: Minerals, Energy & Chemical Engineering

An Evaluation of Tertiary Educators' Perception of Online Teaching Related Ergonomic Factors

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics. The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number

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ABSTRACT

In this digital communication age, universities are using online communication as a pedagogical method of teaching and student learning. As a result, there was a need to evaluate the ergonomic factors that affected educators who provide online education. The Aim of this research was to identify and assess ergonomic factors that affected educators in minerals, mining engineering and other educators' experience with online teaching.

To obtain a clearer idea of the issues, and to construct a questionnaire for a broader population of academics, four mini–Focus Group meetings were held with two focus groups having educators with more than 3 years' experience in online teaching, and the other two focus groups with academics with less than 3 years' online teaching experience. The focus group data and questionnaire data were analysed qualitatively following thematic analysis methodology using NVivo 12 software. The questionnaire for the main study was developed using findings from the focus group results and the literature review findings. Data for the questionnaire part of the study was collected through the Qualtrics survey tool. A mixed method approach was used to analyse the data. Qualitative data was analysed using NVivo 12. Quantitative analysis used descriptive and analytical statistics with analysis conducted through SPSS (v29) software.

Descriptive statistics used for quantitative data analysis identified that 121 online educators answered the research questionnaire and provided the number and percent for participants' demographic details. Logistic regression analysis was used to identify if there was a relationship between the year of online teaching experience, subjects taught and five ergonomic factors' effects on online educators. A thematic analysis was performed with the qualitative data collected from the comments provided for the five ergonomic factors related questions and with the answers provided for the questionnaire open-ended questions. Studying the detailed comments provided by the participants and comparing them with their yes or no answer provided an understanding of how the 5 ergonomic factors affected the educators who conducted online teaching and why these factors affected them.

Results reveal that most participants had better physical ergonomic conditions when working from campus, in comparison to working from home. Noise was the main environmental problem. The main organisational ergonomic concern was not having

enough time to be able to provide a high standard of teaching and student feedback. Cognitive ergonomic problems were identified as needing to learn new technologies which sometimes did not work well. Educators were affected by social ergonomic factors that include lack of interaction with students. The ergonomic factor educators teaching online reported that most affected their work was social ergonomic factors.

Logistic regression analysis identified that teaching engineering subjects online had similar ergonomic problems as teaching other subjects. The relationship with years of online teaching experience and other ergonomic factors identified that educators with more than 3 years of online teaching experience were less affected by physical, environmental, organisational, and social ergonomic factors, but were more affected by cognitive ergonomic factors. Educators new to online teaching reported that the organisational ergonomic factor of not having enough time to prepare online teaching materials was their biggest challenge. As time passed by social ergonomic factors were described by research participants as became a more prominent concern.

The following factors were identified as the online teaching work wellbeing and effectiveness enhancing factors. The physical and environmental ergonomic facilitating factors were identified as having sit-to-stand desk with matt finished surface to help reduce glare and desk with adequate width and storage space for the resources. Environmental ergonomic factors included having a teaching room with good acoustic features including noise reducing features, comfortable temperature control methods and having good air quality. The organisational ergonomic factors were having enough paid hours to complete all online teaching related duties including teaching preparation, developing new or updating existing course and unit of study materials, providing feedback, and answering students' queries.

In contrast, lack of technology related training provided by the university, inadequate technological infrastructure, difficulty in locating online teaching related information and the complex language of technical documents were identified as barriers. Concentrating on screen-based work for more than 60 minutes without break, lack of information on decision making and problem solving in online teaching platform were the other factors that participants felt were a barrier to their online teaching work. Feelings of isolation, receiving inadequate support and guidance from the university, language barriers, cultural

differences were the other issues related to social ergonomic factors that were identified as online teaching work barriers by the participants.

The results related to the research objective, the differences in the perceived factors between engineering and other academics, concluded that the educators teaching engineering subjects had better lighting control device and a fewer number of educators teaching engineering complained about inadequate allotted time for online teaching related work than educators teaching other subjects, while a greater number of educators teaching other subjects were affected by lack of audio-visual contact with students through internet.

It was concluded that the organisational ergonomic factor of having allocated paid hours for training would encourage the educators to participate in training for technology use as well as education on policies and procedures use, and that gaining this cognitive knowledge will help to facilitate their work. More interaction between students and educators was identified as social ergonomic facilitating factors to enhance the effectiveness and motivation for online teaching.

This research identified that there was a lack of knowledge about ergonomic factors and their effects on health and productivity within the participant educators. Thus, a fact sheet, and a narrated power point presentation were prepared for the online educators to provide academics who conduct online teaching with a basic understanding of ergonomic factors, how the 5 ergonomic factors affect productivity, physical and mental health, and recommendations on risk management for educators that teach online. A checklist for academics who teach online to assess ergonomic factors related to their work was also developed for their use. This research has provided a valuable insight into the perceptions of educators of how the five ergonomic factors impact their online teaching work. Research findings have assisted with identifying factors that facilitate, and factors that are barriers, to online teaching in minerals and mining engineering and have contributed to ergonomic theoretical knowledge.

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ABREVIATIONS

AI	Academic Integrity
ANU	Australian National University
AUTOCAD	Automatic Computer aided designing / Drafting / Drawing
BBC	British Broadcasting Corporation
CDE	Crisis distance education
CEF	Cognitive Ergonomic Factor
CNBC	Consumer News and Business Channel
COVID-19	Coronavirus Disease 2019
DESE	Department of Education & Skills & Employment
DETY	Department of Education, Training and Youth Affairs, 2001
EEF	Environmental Ergonomic Factor
ELCWA	Employment Law Centre WA
ESOS	Education Services for Overseas Students Act
EU-OSHA	European Agency for Safety and Health at Work
FGP	Focus Group Participants
FTE	Full-time equivalent staff
GMAT	Graduate Management Admission Test
GRE	Graduate Record Examination
HBMSU	Hamdan Bin Mohammed Smart University
HECS	Higher Education Contribution Scheme
HEFF	Higher Education Facts and Figures
ICAI	The International Centre for Academic Integrity
ICEF	International College of Economics and Finance
ICT	Information and Communication Technologies
IEA	International Ergonomics Association
IELTS	International English Language Testing System
IEQ	Indoor environmental quality
IPA	Interpretative phenomenological analysis
KHDA	Knowledge and Human Development Authority
MCQ	Multiple Choice Questions
MIT	Massachusetts Institute of Technology

MOE	Ministry of Education
MOOCs	Massive Open Online Course
MRIIRS	Manav Rachna International Institute of Research and Studies
MSD	Musculoskeletal Disorder
NTEU	National Tertiary Education Union
NUC	National Universities Commission
OECD	Organization for Economic Cooperation and Development
OEF	Organisational Ergonomic Factor
PCK	Pedagogical Content Knowledge
PEF	Physical Ergonomic Factor
SEF	Social Ergonomic Factor
STEM	Science, technology, engineering, and mathematics
TAFE	Technical and Further Education
TESQA	Tertiary Education Quality and Standards Agency Act
TOEFL	Test of English as a Foreign Language
UAE	United Arab Emirates
UAEU	United Arab Emirates University
UQ	University of Queensland
USA	United States of America
UTS	University Technology Sydney
UWA	University of Western Australia
WFH	Work From Home
WHO	World Health Organisation
WRMSD	Work Related Musculoskeletal Disorder

1. INTRODUCTION

1.1. Background

In the 21st century, there has been a paradigm shift in attitudes towards having an online education system, and online learning is no longer peripheral or auxiliary, but a vital part of today's conventional education system (Al-Samarraie et al., 2018). There are continual advances in mining technology (Bellanca et al., 2019). To be competitive in the work force, mining industry professionals with a Diploma are enrolling in Associate Undergraduate Degrees and undergraduate degree mining students are continuing with postgraduate tertiary education studies (TAFE Directors Australia, 2016). Many Australian mining tertiary education students work in remote locations, so they enrol to study online (Stone et al., 2019). The trend of online learning and of blended learning is increasing and becoming more personalised (Boelens et al., 2017). The learners are supposed to be central to the online learning experiences and it is expected that online learning will be personalised by the students with the students engaged in the learning processes (Maseleno et al., 2018). A personalised learning process consists of three parts.
1) Deeper student learning with instructional planning.
2) Understanding each student's learning capability, pace, and interests.
3) Provisioning appropriate learning experience to match each student's exclusive learning profile (Maseleno et al., 2018).

Educators are not always provided with enough time to do the above (Paudel et al., 2018). In 2010, the U.S. Department of Education published the definition in the National Educational Technology Plan, in which personalisation refers to the instruction that is paced to learning needs, tailored to learning preference and designed to meet the specific subject interests of different learners (Maseleno et al., 2018). In a fully personalised learning environment all the components, like the learning objectives, content, pace, as well as the method may all vary (US Department of Education, 2010).

At the end of 2019 with the outbreak of the COVID-19 pandemic student learning was shifted to digitalisation to minimise the spread of the virus by introducing social-distancing. This resulted in many university courses having fully online university teaching. E-

Learning, online learning and distance education can be referred as the digital method of academic content delivery and rapid learning by using information technology applications and Internet technology. The term ‘e’ of e-Learning can refer to electronic/ exploratory/ enhanced/ expanded / experimental/ efficient/ easy-to-use learning (Zhou et al., 2020). There are continuous changes in society, technologies and expectations of students that have motivated the educators and institutions to improve and invent new pedagogy and teaching methods. Some of the key features contributing to the development of new pedagogy are blended learning, combined approaches to the construction of knowledge, use of multimedia and open educational resources. For adult learning there is an increasing choice and learning freedom with anytime, anywhere, and any size learning, new methods of assessment, self-directed and self-paced non-formal teaching, and learning (McPherson & Nunes, 2004).

1.2. Ergonomic Factors

1.2.1. Introduction

The role of online educators is different from traditional classroom educators, and this potentially affects the educators ergonomically. Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance (definition adopted by the International Ergonomics Association in 2000, IEA, 2023, p.1).

Ergonomics is also defined as a scientific discipline which utilises applied sciences to identify relationships between work and human capability and includes “the design and evaluation of tasks, jobs, products, environments, and systems in order to make them compatible with the needs, abilities, and limitations of people” (Dennerlein, 2017, p. 577). Ergonomics provides a theoretical understanding “of human behaviour and performance” (Wilson, 2000, p. 557), fits the task to the person, the product to the user and improves both comfort and productivity (Kroemer, 2017). For this reason, ergonomic factors should be considered for educators who teach online. Ergonomists encourages a universal, human-centred approach to work systems design considering physical, environment, organisational, cognitive, social, and other relevant factors (Grandjean, 1986; Haslegrave et al., 1990; Jansz, 2011; Jansz et al., 2018; Karwowski, 2001; Stanton et al., 2004).

1.2.2. Physical Ergonomic Factors

Online education conducted through the internet requires a computer, smartphone, or other electronic devices with access to the internet to teach online. Physical ergonomics is concerned with the educator's human anatomical and anthropometric measurements that would influence desk design, seating, and computer height while teaching online. Online teaching can involve continuous 3 hours sitting on a chair without changing posture vs 3 hours classroom teaching with flexibility. Inadequate ergonomic designed workplace may lead to certain musculoskeletal disorders (MSDs) such as back pain, neck, and shoulder discomfort and other (Harrington & Walker, 2004). Due to prolonged sitting in association of computer-use for teaching online many researchers reported that the e-educators were developing MSDs (Bergqvist et al., 1995a, 1995b; Demure et al., 2000; Faucett & Rempel, 1994; Ferreira et al., 1997; Goode et al., 2019; Hales et al., 1994; James et al., 2018; Marcus & Gerr, 1996; Ong, 1994; Yu & Wong, 1996).

1.2.3. Environmental Ergonomic Factors

The lighting, ventilation, temperature, and noise of the room where the online educators spend most of their time are the examples of environmental ergonomic factors (Harrington & Walker, 2004). In qualitative study conducted by Jansz et al. (2016) one of the online educators reported that spending prolonged time working with looking at a computer screen in a poorly lit room caused headaches and that this educator needed to purchase stronger reading glasses to continue with online teaching. Arif and Alam (2015) reported that three quarters (75%) of people who work for 6-9 hours in front of a computer screen complained of having problems with their vision. Abdelaziz et al. (2009); Eksioglu, (2017); Helland et al. (2008); Robertson et al. (2016); Sen and Richardson, (2007) all identified that working for long hours in front of a computer screen caused visual problems for some users due to the need to continually focus on the screen. Abdel-Hamid et al. (2013) reported that similar environmental conditions using a computer screen caused fatigue (76.9% of the population) and headaches (74%) in the population of their cross-sectional study of 826 office workers.

1.2.4. Organisational Ergonomic Factors

The organisational ergonomic factor that impacted online teaching the most was that the educators not having enough time to do all the updates required for their teaching materials,

not able to complete all other work, including marking student assignments and complete all university required paperwork within their workload allocation time (Jansz et al., 2016). Van de Vord and Pogue (2012) stated that providing assessment feedback was very time consuming for online instructors. Sessional staff who were specially employed to mark student assignments reported that they had to work unpaid overtime to be able complete marking and the time allowed did not include the required to provide adequate feedback on the marked work for individual student. The time required for downloading assignments, checking them through Turnitin, uploading assignments and for doing marking moderation were also not allocated. (Jansz et al., 2016). Gous and Roberts (2015, p.268) reported "academic staff work long hours, even weekends."

1.2.5. Cognitive Ergonomic Factors

Cognitive ergonomics focuses on the psychological characteristics of work (Choppin et al., 2018; Hollnagel, 1997) involving identifying, interpreting, and processing information by an individual (Attwood et al., 2004) includes perception, learning ability, memorising power, problem solving and motivation (Jansz, 2011). Insufficient knowledge of the university policies, procedures, the usage of modern technologies and online educational tools were the cognitive ergonomic factors affecting educators teaching online (Jansz et al., 2016). Even experienced university educators found it difficult to complete online documents, particularly when links or formatting did not work properly (Jansz et al., 2016). Helping students enrolled in fully online courses with how the online educational system works, especially for the assignments, was time consuming as some educators had to repeatedly clarify information so that students understood. Students misunderstanding created extra work for the educators as they had to clarify and resolve the misunderstandings that students shared with each other (Jansz et al., 2016). The cognitive resources required to complete a task, from competing means, can impact the cognitive workload which can undermine performance (Engström et al., 2017). Online educators may experience difficulty in dealing with the information flow in dynamic environments (Leaver & Reader, 2016).

1.2.6. Social Ergonomic Factors

The development in communication technologies allows working from home and this is becoming a more common practice for workers, educators, and students (Ciccarelli et al., 2011). For online learning social ergonomics includes the communication and interaction between students, educator, and the relationship with co-workers in the online environment. Answering emails from students and other related personnel consumed a considerable amount of educators' time in the online teaching platform as in online platform students generally had very minimum interaction between fellow students preferring to directly communicate with their teachers rather than their peers (Jansz et al., 2016). A variety of research studies have identified that online teachers have the most effect on student learning and have a responsibility to assist with, and enable, student learning through effective communication (Chen et al., 2010; Coates, 2007; Laird & Kuh, 2005; Ma et al., 2015; Smith et al., 2005; Sun & Rueda, 2012).

This research was conducted to identify how these five ergonomic factors affect, both positively and negatively, educators who teach online.

1.3. Research Aim and Objectives

This study aimed to identify and assess ergonomic factors that affect educators' experience with online teaching. Based on the research aim the objectives were to identify the following:

1. Ergonomic factors that were perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering academics.
2. Ergonomic factors that were perceived by university educators to be a barrier to providing online teaching.
3. Differences in the perceived effects of ergonomic factors between engineering and other academics who conducted online teaching.
4. Relationship of the five ergonomic factors towards experience in online teaching.

1.4. What was known about this Topic

There were published information about how ergonomic factors affect humans at work. (Heidarimoghadam et al., 2022). There were published information about how ergonomic

factors affect students studying online (Gumasing & Castro, 2023), but there were few publications identified focusing on the effect of ergonomic factors on the educators teaching online and these publications were mainly focused on physical or environmental ergonomic factors.

1.5. Gaps in knowledge

There were no publications found on how all five ergonomic factors affected the educators who provided online teaching at universities in mining and mineral engineering, on whether the five ergonomic factors differently affect educators teaching engineering than the educators teaching other subjects. No publications were found identifying the relationship between the five ergonomic factors, years of online teaching experience and having casual, fixed term, or ongoing employment. There was also a gap in knowledge related to identifying any difference in all 5 ergonomic factors effects on online educators for developed countries and developing countries.

This study commenced in the era of the COVID-19 outbreak when the education system was required to adopt the emergency online educational platform due to government requirements for isolation of people at home to prevent the spread of the virus. At the start of this pandemic there were no published articles related to how the educators were affected by ergonomic factors due to the government required emergency shift to online teaching by university educators. The data for this research was collected from March 2021 till November 2021. People in some of the countries included in this research were in lockdown either continuously or discretely, so new knowledge was generated about how social ergonomic factors affected online educators at universities.

1.6. New Knowledge Generated

The research results have added to ergonomic and online minerals and mining engineering ergonomic theoretical knowledge. This research generated new knowledge by identifying online educators work facilitating ergonomic factors as well as ergonomic factors which act as a barrier to the effectiveness of their online teaching work. There were 9 physical, 11 organisational, 11 social, 7 cognitive and 9 environmental ergonomic factors identified that facilitated online learning for mining and mineral engineering educators. See figure

64 on page 332. There were 8 physical, 8 environmental, 10 organisational, 7 cognitive and 8 social ergonomic factors that were identified as barriers. See figure 65 on page 334.

Other new knowledge generated was that educators with more than 3 years of online teaching experience were more likely to experience the following barriers to their work than educators with less than 3 years online teaching experience.

- Facing difficulty with the understandability of related documents (cognitive ergonomic factor)
- Receive less training for technology and other areas (organisational ergonomic factor)
- Affected by language barrier (social ergonomic barrier)
- Lack of support and guidance received (social ergonomic factor)
- Inadequate technical infrastructure (organisational ergonomic factor)

Further new knowledge generated by the findings of this research were that there was not a significant difference in perceived physical and cognitive ergonomic factors between educators teaching engineering and non-engineering subjects which was confirmed by the results of the Chi-square analysis performed between the ergonomic factors and the subjects taught by the educators (engineering or non-engineering) as shown in the following table 1. There was however a significant positive difference for educators teaching mining and minerals engineering in the environmental ergonomic factor of having good lighting control, being provided with more time for marking student work and providing feedback (organisational ergonomic factor) and with having better audiovisual contact with students when teaching online (social ergonomic factor).

Table 1
Relationship between five ergonomic factors and subjects taught.

Ergonomic Factors	***Significance***
Physical Ergonomic Factors-	➢ None of the physical ergonomic factors had any significance differences between educators teaching engineering subjects or non-engineering subjects.
Environmental Ergonomic Factors-	➢ A greater number of educators teaching engineering online had access to lighting control device which had been confirmed by an odds ratio of (0.24) at $p \leq 0.01$.
Organisational Ergonomic Factors-	➢ A fewer number of educators teaching engineering online indicated that the time allotted for marking and providing feedback were inadequate with an odds ratio of (0.21) at $p \leq 0.01$ than educators teaching non-engineering subjects. ➢ A greater number of educators teaching engineering online identified that they received enough time for teaching preparation with an odds ratio of (0.2) at $p \leq 0.01$ than the educators teaching other subjects.
Cognitive Ergonomic Factors-	➢ None of the cognitive ergonomic factors had any significance difference between educators teaching engineering subjects or non-engineering subjects
Social Ergonomic Factors-	➢ A greater number of educators teaching engineering subjects online identified that they had audio-visual contact through the internet with students while teaching online with an odds ratio of (0.11) at $p \leq 0.01$ than the educators teaching other subjects.

1.7. Research Significance

To date and knowledge, there had been no known previous research published that identified the influence of all 5 ergonomic factors on university educators teaching online for minerals and mining engineering. This research provides a valuable insight into the perceptions of educators on how physical, cognitive, social, organisational, and environmental ergonomic factors affect their online teaching. It has identified the factors that facilitate, and factors that act as a barrier, to the educators teaching online. This research has identified the ergonomic factors affect educators with fixed-term employment, ongoing employment, and casual employment and the relationship between the years of online teaching experience of the educators and the ergonomic factors. The findings of this research can be used to improve the ergonomic factors that affect the educators who conduct online teaching.

As an intervention strategy to facilitate effective work for online educators a fact sheet, checklist, Case study 1 & 2, case study QA and power point presentation have been developed (see Appendixes 14, 15,16, 17 and 18) for orientation use for educators who conduct online teaching to assist them with understanding the ergonomic factors that can affect them and to provide information on factors to consider making their online teaching safe, healthy, and productive. This knowledge can be used to improve the cognitive, social, organisational, environmental, and physical ergonomic factors for academic staff who teach minerals and mining engineering and other subjects online to prevent ill health due to ergonomic work-related factors health and to improve work productivity.

Discovering the ergonomic factors that positively and that negatively affect academic staff who teach minerals and mining engineering, and other subjects online has provided opportunities for policy makers, designers, hardware, and software developers to improve the work systems and equipment as outlined in the research report recommendations.

1.8. Research Limitations

The main limitation of this research was the diversity of the participants as most of the participants were from Australia and India. The number of participants from other countries were less, so the research results mainly indicate how the ergonomic factors affect tertiary education online educators in Australia and India.

1.9. Outline of the Research Report

Chapter 1 Introduction

This chapter provides the research background, aim, objectives, describes what was known about this topic, new knowledge generated through this study, research significance, research limitation, and provides an outline of the research report.

Chapter 2 Literature Review

The literature review chapter is divided into five main theme sections. Section 1 of the literature review describes the effects of COVID-19 on traditional and online teaching. An

article from this section titled ‘Effect of COVID-19 Pandemic on Traditional Teaching’ has been published and cited 7 times. Section 2 describes how the global tertiary education system dealt with the COVID-19 Pandemic. Section 3 reviews employment types (casual, fixed term and ongoing employment) for educators who teach online. Section 4 focuses on online teaching in mining and metallurgical engineering. The last section documents the 5 ergonomic factors related to online teaching.

Chapter 3 Methodology

This chapter provides detailed information on the research methodology, including a description of the study design, research setting, and scope, target population, sampling techniques, study participants and ethical issues. It also describes the research tools, the data collection methods, and details of data analysis methods. It includes the focus group methodology, focus group questionnaire development, focus group data collection, focus group data analysis method and the online study questionnaire development. It continues with providing information related to the online questionnaire pilot and main study methodology including the data analysis methods used.

Chapter 4 Focus Group Results and Discussion

This chapter provides detailed information on focus group data collection, analysis, results, and a discussion of the findings. It describes how the questionnaire was developed based on the focus group results.

Chapter 5 Questionnaire Results and Discussion

A detailed description of the participants’ questionnaire results and analysis of the data received is described and discussed.

Chapter 6 Conclusions and Recommendations

In this chapter the conclusions derived from the quantitative and qualitative analysis to achieve research aim and each research objectives are described with the revised models for both the facilitating factors and barriers to online teaching including the conclusions.

Recommendations are included to improve the ergonomic factors related to the work and working conditions of tertiary educators who conduct online teaching.

1.10. Introduction Summary

This chapter has recorded the research background, research aim and objectives, gaps in knowledge that this research was conducted to fill, what was known about the topic, new knowledge generated, research significance, and limitations.

The next chapter is a review of published literature related to the research topic of ergonomic factors that affect educators who conduct online teaching. Please note that the terms online learning, e-learning, distance learning is used interchangeably throughout this and following chapters.

2. LITERATURE REVIEW

2.1. Literature Review Methodology

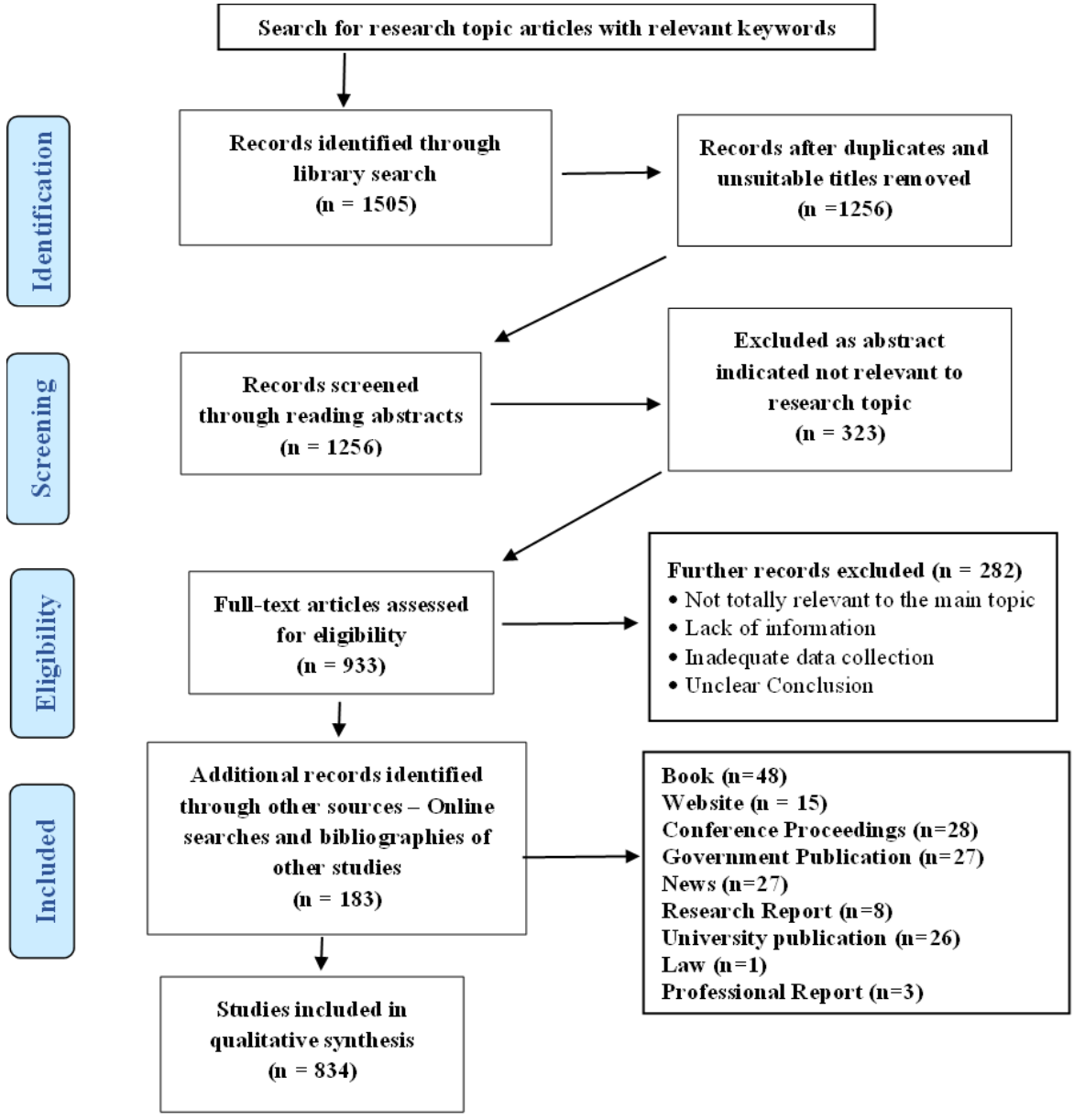
2.1.1. Introduction

The purpose of this literature review was to provide a theoretical foundation for the research by reviewing previously published literature about online teaching. This review focused on the roles, responsibilities, advantages, barriers, and effectiveness of online educators. It also focused on assessing the differences in the perceived factors between engineering and other academics, including ergonomic factors which influence the effectiveness in facilitating online teaching. The chapter begins with an introduction to the literature review methodology.

2.1.2. Literature Review Methodology

The literature review for this thesis was conducted using an initial search of the databases Science Direct, ProQuest, PubMed, SAGE, Wiley Online Library, and Web of Science. Other searches were conducted through Google Scholar, a Curtin University library catalogue search. The literature search was limited to the English language and included published literature from 1942 up to and including 2023. A total of (834) relevant references were identified using the relevant keywords. Relevant key words used in the literature search were ‘Online teaching’, ‘Online teaching and learning’, ‘COVID-19 Pandemic’ , ‘influence of COVID 19 pandemic on academics’, ‘demand of online higher education among working professionals’, ‘online teaching in mining and metallurgy’ , ‘Effective online teaching’, ‘benefits of online teaching’, ‘barriers of online teaching’, ‘online teaching and traditional teaching’, ‘traditional face to face teaching and online teaching’, ‘online teaching and ergonomics’, ‘online teaching and physical ergonomics’, ‘online teaching and environmental ergonomics’, ‘online teaching and social ergonomics’, ‘online teaching and organisational ergonomics’, ‘online teaching and cognitive ergonomics’, ‘ergonomics’, ‘ergonomic factors’, ‘physical ergonomics’, ‘environmental ergonomics’, ‘social ergonomics’, ‘organisational ergonomics’, ‘cognitive ergonomics’, ‘educator experience in online teaching’, ‘employment type’, ‘employment type for educators’. The method used for the literature search and screen process is summarised with the Figure 1 flow chart depicting the article search and selection procedure.

Figure 1
Flow chart depicting the article search and selection procedure



The next section of the literature review describes the history and gradual transformation of education to modern day online education, method of education and role of educators in ancient times and includes the definition of interchangeable terminology of online distance education.

2.2. How Global Tertiary Education Systems Dealt with COVID-19 Pandemic

2.2.1. Effects of COVID-19 Pandemic on Traditional Teaching.

The first section of the literature review traces the history of education from the beginning when the educators were parents to the development of online education in tertiary education institutions. It includes the effects of the COVID-19 pandemic on traditional teaching and has been published as an article.

Effect of COVID-19 Pandemic on Traditional Teaching

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This article can be found in Appendix 11. The article provides the background information to how global tertiary education system dealt with COVID-19 Pandemic.

2.2.2. The Pandemic

In Australia, the first Covid-19 cases were reported at the end of January 2020 (WHO, 2020) and were related to people traveling for tourism, work, or study. Most of the universities first adopted a wait and watch approach, though it quickly became very clear that a global pandemic was occurring and isolation measures to prevent the spread of infection were required (Babbar & Gupta, 2022). Social distancing and months-long quarantine forced many academics working in higher education to change from classroom to online teaching.

Due to the coronavirus pandemic, changes in higher education which would have typically taken several years due to administrative regulations were introduced promptly within days (Strielkowski, 2020). This was a clear example of the Schumpeterian "creative destruction" in making that will forever change the status quo in academia and higher education (Schumpeter, 1942; Strielkowski, 2020).

Online teaching and learning became the compulsory component of all educational institutions including schools, colleges, tertiary educational institutions, and universities globally. The outbreak of this virus forced the shut down all educational institutes globally to limit the spread of the virus (Radha et al., 2020). Many university educators had to upskill their digital proficiencies and develop new educational materials to change from traditional face-to-face teaching and blended programs to a distance learning and online education delivery (Pather et al., 2020). University educators had to develop alternative method of teaching during this lockdown period where the teaching academics and students connect virtually. Many of the online educator globally thought that it might increase the inequality and the digital divide, as a substantial number of students did not have access to the required resources as well as opportunities to participate in online education (Bakker & Wagner, 2020).

The COVID-19 pandemic caused traditional classes to "move online" in a high-priority manner (WHO, n.d.), which resulted in extra stresses and workload for university staff who were already struggling to balance teaching, research, and administrative responsibilities, as well as work-life balance (Houlden & Veletsianos, 2020; Houston et al., 2006). Educators from all backgrounds and age groups were required to develop and implement

their scheduled classes from home, sometimes without proper technical support from the institution (Hodges et al., 2020).

Some university educators did not have a good pedagogical content knowledge (PCK) required for online teaching (Angeli & Valanides, 2005; Ching et al., 2018; Kali et al., 2011; Shulman, 1987) which included technical and administrative features of online teaching like, establishing workflows, using technical platform and tool, etc. Studies by Ching et al. (2018) and Ocak (2011) revealed the complex nature of the instructional situation and inadequacies in planning and organisation were difficult to describe by university teachers with respect to transforming to teaching web-based courses. The COVID-19 pandemic contributed to a profusion of advice for teachers related to the tools and materials which a teacher could use while replacing their face-to-face classes to online classes (Bates, 2020; Rapanta et al., 2020).

2.2.3. Effects of COVID-19

In 2020, due to the travel restrictions to limit the spread of COVID-19 universities faced economic uncertainties as they lost income from the international students (BBC News, 2020a; Collini, 2020). Universities made staff redundant to reduce wage costs (The Guardian, 2020), halted all new hiring (Kirsop et al., 2020), and were reluctant to recommence contracts of fixed-term academics (Matchett, 2020), thus increasing the workload of existing academics (McKie, 2020; Kınıkoğlu & Can, 2021).

Within universities gender segmentation was predominant as the number of women was higher in the lower academic ranks, and female students and academics were concentrated in the humanities, education, social sciences, arts, and health (HASS) (Blackmore, 2020; Mavin & Yusupova, 2020). In other areas like policy and funding centres, university restructuring and priorities, and departments such as science, technology, engineering, mathematics, and medicine (STEMM) remain male-dominated. The new remote working/work-from-home arrangement became more difficult for female academics during the COVID-19 pandemic because they were required to take care of their children at home while schools and childcare centres were not open during the lockdowns (Blackmore, 2020; The Guardian, 2020). During pandemic doubts over working conditions and job market were also increased.

Once all courses shifted to the online platform from traditional face-to-face platform the educators were required to work above and beyond their normal work duties and hours to address requirements of individual students, maintain and reconfigure course delivery, assessment etc. as the ratio of student to academic became higher resulting from staff redundancies and contracts not being renewed (Matchett, 2020). Thus, academics started feeling overworked, devalued, underfunded in research, and tired of ongoing restructuring and conflicting guidelines and priorities (Blackmore, 2020).

2.2.4. How COVID-19 Impacted universities globally.

2.2.4.1. Introduction

This section explores 'how the universities globally responded to the first wave of the pandemic?'

Table 2
Described the summaries reviewed

Region	Country/Countries
Western Pacific Region	Australia, China
Eastern Mediterranean Region	United Arab Emirates
European Region	United Kingdom
Southeast Asia Region	India
Region of America	United States of America
African Region	Nigeria

Note: Adapted from "COVID-19: 20 Countries' Higher Education Intra-Period Digital Pedagogy Responses", by Crawford et al., 2020, *Journal of Applied Teaching and Learning (JALT), 3 (1), 1-20:* (https://doi.org/10.37074/jalt.2020.3.1.7.) Copyright Murdoch University.

2.2.4.2. Australia

Australian higher education responded to COVID-19 by first responding to international students concerned with flight restrictions, then to domestic student concerns and the requirement for social isolation. Some universities had a temporary halt to classes for staff to learn how to design online learning (Monash University, 2020; Victoria University, 2020) and others were intending to continue face-to-face learning with social distancing protocol supplemented by online recordings (University of Queensland, 2020; University

of Technologies Sydney, 2020). Other universities made rapid progressions toward online learning without suspending classes (Australian National University, 2020; University of Tasmania, 2020). There were a few universities that did not apply substantial restrictions for domestic students as they did not require self-isolation (University of Western Australia, 2020). From the 24th of March 2020 the Australian government prohibited all public gatherings of more than two non-family/household members (Bagshaw, 2020). This situation considerably affected the universities that did not digitalise their courses at the beginning of the pandemic.

2.2.4.3. China

China's higher education sector had more time to prepare as it was the country where the pandemic began. On 26th January 2020, Beijing declared postponing the start of the spring semester classes (Berlinger et al., 2020). On 28th January 2020, the Ministry of Education of China extended this delay across the country to all levels of colleges and universities (Khaliq, 2020). Most of the standardised tests were cancelled on 28 January, including the Graduate Record Examination (GRE), the Graduate Management Admission Test (GMAT), the International English Language Testing System (IELTS), and the Test of English as a Foreign Language (TOEFL) (ICEF, 2020). The Shanghai campus of New York University (2020) declared that all classes would be digitalised and will be taught online from February 17th, 2020. All other universities followed the path of transferring all their classes to online, though not every university had the resources and academic abilities to transform traditional classes into online classes so quickly (Leung & Sharma, 2020). The academic staff reported feeling isolated due to ongoing social distancing (Cappelletti, 2020).

2.2.4.4. India

India shares a border with neighbouring country China, and as of 29th March 2020 the number of cases was very low in comparison with the population. It concerned many individuals that the figures were lower than actual due to under-reporting (Mansoor, 2020). The health system of India was not prepared to handle the huge numbers of cases if India hit the level where the rate of active cases was proportionately similar to Italy or the USA (The Economist, 2020). On 24th February 2020, students from the Manav Rachna

International Institute of Research and Studies (MRIIRS), University at Faridabad gathered to show unity with victims of COVID-19 (Hui, 2020) as there were no restrictions imposed on public gathering. No national decision was made to shut down schools (Mansoor, 2020). It was the regional governments who announced schools will be closed in their respective areas (The Economist, 2020). Till the end of March 2020, most of the universities postponed their implementing strategy for a shutdown.

2.2.4.5. Nigeria

Africa's most populated country, Nigeria, announced the closure of its airports to international flights for one month from 21 March 2020 to respond to the COVID-19 outbreak (Adigun et al., 2020). Large gatherings and unnecessary travel were restricted in a bid to avoid the community spread of the COVID-19 virus (Alshammari et al., 2020). All public and private school closures were ordered in 10 of the 26 states (Adnan, 2020). The National Universities Commission (NUC) implemented closure of all universities in Nigeria in March 2020 (Erezri, 2020).

2.2.4.6. United Kingdom

There were 17,093 confirmed positive cases, with 1,019 deaths, by 29th March 2020 (WHO, 2020a), resulting in a rising risk level for England. It was believed that the first infected person diagnosed with this virus in the UK was a Chinese national student from the university of York, in early February (BBC News, 2020a). The university continued operating as normal, but some extra precautionary measures were imposed to limit the spread of COVID-19. The British government declared a nationwide lockdown of public houses, restaurants, and other institutions with an assurance of a series of funding packages for the employees and employers who would be affected by the lock down and social isolation requirements, on March 20th (BBC News, 2020b). The British Government announced that from March 20th, 2020, universities were required to shift their traditional teaching and learning to online measures as much as possible, encouraging working from home, deferring graduation ceremonies, withdrawing open days, as well as changing the examination arrangements and procedures (BBC News, 2020c; 2020d; 2020e). Universities were required to introduce more flexible admission processes, including delaying the start dates and reduce some entrance requirements (Bothwell, 2020).

2.2.4.7. United Arab Emirates

Four hundred and sixty-eight COVID-19 cases, including two deaths, were reported by the 29th of March, in the United Arab Emirates (UAE) (WHO, 2020a). The UAE had been successful in containing the virus spread by implementing various safety measures including schools and university closure, cancelling all public events and gatherings, put a hold on entering the country, imposing precautionary measures in food outlets, disinfecting objects in the country, adopting work from home culture, etc. which resulted in low infection rates, and a low death rate (CNBC, 2020). All universities in UAE shifted to online teaching mode. Zayed University adopted Adobe Connect, the University of Sharjah and United Arab Emirates University adopted the Blackboard systems, and Heriot Watt University Dubai went with a virtual learning tool, named Vision (The National, 2020). UAE's first e-university Hamdan Bin Mohammed Smart University (HBMSU) commenced in February 2009 and had a wide-ranging understanding of delivering content in online mode (HBMSU, 2020), so, HBMSU helped all UAE educational institutions to implement online classes by offering training for effective online delivery for all university educators (HBMSU, 2020). Universities moved to emergency online delivery mode. To able to support students affected directly or indirectly by COVID-19 restrictions, UAE educational institutions positioned themselves to continue to engage their students in collaborative communications either in synchronous method using web meeting tools or in the asynchronous method using discussion boards and other tools.

2.2.4.8. United States of America

The first on-campus COVID-19 case was reported in the week of 17th February 2020. Self-protection and prevention related recourses were published by many organisations to help all staff and students. Due to underestimating the severity of COVID-19 by the country's head of state combined with the spring break, the higher educational institutions didn't start moving into online teaching and student learning mode until March 2020. Some renowned institutions announced to shift to the online delivery mode in early in March, and many others accompanied them by mid-March. With the sudden dramatic increase in infection rate, the USA had surpassed China by late March with the number of confirmed cases (WHO, 2020a). By March 23rd, Harvard and MIT Universities moved to fully online

education (Crawford et al., 2020). Yale, Princeton, Stanford, the University of California, and Southern Oregon University joined them (Crawford et al., 2020). Many universities extended Spring Break by one week to get enough time for a smoother transition to online. Higher education in Texas's analysis revealed that some institutions were yet to decide on shifting to online delivery mode as of 22nd March (Bawab, 2020).

2.2.5. Differences between Emergency Online Education as a response to Pandemic and Typical Online Education

Almost all countries globally had replaced the traditional face-to-face educational delivery system with an online distance education delivery model as a defensive tool to fight against the spread of the COVID-19 virus by the end of March 2020. Though many countries had been encountered a number of natural and man-made disasters prior to this pandemic, online distanced learning was not implemented as a solution to those particular crises. Crisis distance education (CDE) is exceptional both in its philosophies as well as in its procedure. The main differences can be described as

i) The unexpectedness of shifting traditional education mode to online distance education mode. CDE was introduced in schools and other institutions without any previous regulations or procedures. It was "pushed" into society without providing the necessary skills and knowledge (Rangiwai & Simati-Kumar, 2020).
ii) Internationalisation was another difference where CDE has been imposed globally as a non-pharmaceutical intervention. It was an international concern rather than an institutional concern.
iii) Its popularity increased as it became of public importance in society, limiting the community circle.
iv) The expansion of online distance education was huge as it reached out to all schools and other educational institutions beyond its normal zone. In this pandemic, online distance education became mandatory for students of all age groups, from kindergarten to doctoral level.
v) The fifth difference was an imposition. CDE was enforced in many countries as a national, top-down 'draconian measure' (Taylor et al., 2020). Distance education was previously treated as a luxury, but it was changed to a necessity to fight against the spread of coronavirus (Al Lily et al., 2020). Distance learning was enforced as a primary means for individuals' education.

vi) The medical emergencies were the sixth difference. Generally, the main reasons for distance education were geographical isolation, flexibility, disability, etc. but with the COVID-19 pandemic it was used as a tool to create isolation to deal with medical emergencies and tragedy.

More differences between Emergency and Typical Online Education are demonstrated in table 3,4, & 5, documenting disruptive incidences where traditional distance education had been changed (Adnan & Anwar, 2020; Bick, 2020; Lall & Singh, 2020; Luyben et al., 2020; Mayo, 2020; Taylor et al., 2020; Tran et al., 2020).

Table 3
Differences in teaching.

Participations				
Topic	**Benchmark**	**Traditional Online Education**	**Emergency Online Education**	**Reference**
Compliance	It is approved by all parties involved (the institution, educator, and student)	Yes	No	Müller & Goldenber, 2020
Method	It can be consisting of both online and face to face communication, not entirely online	Yes	No	Rusdiana et al., 2020
Option	Students have an option, to enrol either for face-to-face or distance education	Yes	No	Yulia, 2020
Substitute	Replaces and removes face-to-face education	No	Yes	Bokde et al., 2020
Time frame	Must be full-time at the school level	No	Yes	Sa & Serpa, 2020
Major	Involves all science, social science, and engineering degrees	No	Yes	Bezerra, 2020
Course	Includes different types of courses: theoretical, practical, etc.	No	Yes	Yaman & Muhlis, 2020
Necessities	Includes students with special needs	Yes	No	Bozkurt et al., 2020
Psychology	Psychologically groomed prior to commencing	Yes	No	Pragholapati, 2020
Magnitude	Globally, an exceptional number of students enrolled	Yes	Yes	Ramya & Variyar, 2020
The mass media	A great media exposure	No	Yes	Arshad, 2020
Technicians	Technicians have an exceptional societal value; they are being considered as 'enterprise rescuers'	No	Yes	Arshad, 2020

Participations				
Topic	**Benchmark**	**Traditional Online Education**	**Emergency Online Education**	**Reference**
Charge	The same fee required for offline and online course	No	Yes	Al Lily et al., 2020
Readiness	Institutions implement it, regardless of readiness	No	Yes	Wodon, 2020
Care	More serious and interested learners join	Yes	No	Nabukeera, 2020

Table 4

Differences in age and background

Age				
Topic	**Benchmark**	**Traditional Online Education**	**Emergency Online Education**	**Reference**
Age Cohort	Mainly higher degree university-level students can enrol, so there is a specific age range	Yes	No	Setiawan, 2020
Parents/ Guardians	Students get help from, or depend on, their parents or guardians	No	Yes	Wajdi et al., 2020
Scarcity	Temporary solution and will be there only for a short period of time	No	Yes	Bozkurt et al., 2020
Background				
Family	Family members are involved where their children are enrolled	No	Yes	Tanveer et al., 2020
Administration	An individual becomes aware and agreed on all pros and cons before enrolling	Yes	No	Sa & Serpa, 2020
In advance	Learners have good knowledge of how assessment and examination will take place	Yes	No	Luyben et al., 2020
Preparation	Learners, Educators, and administrators are (e.g., pedagogically) well organised	Yes	No	Alam, 2020
Social Class	Open to the various social groups	No	Yes	Sezgin & Fırat, 2020

Table 5
Differences in educational quality

Educational Quality				
Topic	**Benchmark**	**Traditional Online Education**	**Emergency Online Education**	**Reference**
Plan	It is pre-planned	Yes	No	Tzifopoulos, 2020
System	It is a comprehensive system, from objectives to examination methods	Yes	No	Tanveer et al., 2020
Infrastructure	Entails an administrative and technical infrastructure	Yes	No	Dubey & Pandey, 2020
Research	It is well studied	Yes	No	Selvan & Hussain, 2020
Examination	Exams can take place face-to-face	Yes	No	Ferdig et al., 2020
Curriculum	Curriculums are primarily designed for online teaching delivery	Yes	No	Luyben et al., 2020
Priority	It has higher priority over face-to-face education	No	Yes	Lim, 2020
Methods	Teaching methods and approaches are limited	No	Yes	Langford & Damșa, 2020
Pressure	All decisions are made under stress including administrative and organisational.	No	Yes	Rusdiana et al., 2020
Face-to-Face Meeting	Can meet teacher physically if desired/required	Yes	No	Langford & Damșa, 2020

Note: Adapted from "Distance Education as a Response to Pandemics: Coronavirus and Arab Culture", by A. Lily, A. Ismailz, A. Abunasser, F. Alhajhoj and R. Alqahtani, 2020, *Technology in Society*, 63(11), p. 2-3, (https://doi.org/10.1016/j.techsoc.2020.101317). Copyright 2020 by Elsevier Ltd.

2.2.6. Section Summary

This section of the literature review has summarised the information related to the effect of the COVID-19 pandemic on the overall education system, how COVID-19 affected universities in different parts of the world.

2.3. Educator Employment Types in Online Teaching

2.3.1. Introduction

Over the last 15 years, a significant growth in more experienced senior and junior academic educators had been observed. Between 2008 and 2019, academic staff with Level D and above increased by 49% – from 10,148 to 15,106, Level A academic staff grew by 43% – from 13,790 to 19,651 and Level B and Level C academic staff grew by around 20% (U Australia, 2022). There was an increase of 54% from 15,553 in 2008 to 24,043 in 2019 in the casual academic, whereas FTE staff grew by 29% from 90,049 in 2008 to 116,300 in 2019. The percentage of casual staff increased from 15% in 2008 to 17.1% in 2019, before declining to 15% per cent in 2020. In 2020, the majority of Australian university teaching-only staff were casual staff (71%). In contrast most of the research -only staff (78%) were on fixed-term contracts. Eighty percent of teaching and research staff and 64% of professional staff were tenured or permanent ongoing staff (U Australia, 2022).

Australian universities had substantially changed and expanded as there had been a growth in the number of university students, which had increased from 441,000 in 1989 to 1.5 million in 2017 (Department of Education, Training and Youth Affairs, 2001; Department of Education and Training , 2014; Norton et al., 2018), along with a progressive drop in direct government funding provided for an individual student and significant increase in the amount and percentage of secured short-term funding provided by national research granting bodies (Andrews et al., 2016). Overall, 1,470,865 students studied at 39 comprehensive Australian universities in 2020. Seventy two percent (or 1,057,777) of university students were domestic students and the remaining 28% (or 413,088) were international students (U Australia, 2022).

The introduction of Higher Education Contribution Scheme (HECS) for domestic students' costs of the courses by Hawke Labour government resulted the ending of free education in 1989. HECS, is an interest-free state loan in which students' fee payments were postponed until their income exceeds a minimum threshold; it was then paid automatically through the tax system. Initially student payments were restricted to 20% of costs, but by 2020 it was 49% (on average) (Doidge & Doyle, 2020).

Universities in Australia were forced by the COVID-19 outbreak to re-evaluate their business models and projections. Between 1994 and 2018, the enrolment of full fee-paying international students increased ten times, and were a quarter of total university students, which made Australian higher education, pre-pandemic, a $30 billion industry (Cawood et al., 2018; Department of Education & Skills & Employment, 2018). The "massification" of higher education of Australia had been convoyed by a gradual shifts in its conceptualisation from being "public" to "private" giving more importance on training students with relevant skills and flexibility required by the labour market, since late 1980s. One fifth of recent school leavers were enrolled at university by 1992; which became a quarter in 2002 (Norton, 2014); 32% by 2009; and by 2017, 42% of school leavers were enrolled in higher education course under Australia's short-lived demand-driven policy (Norton, 2019).

A loss of $4.8 billion was forecasted in the higher education sector of Australia due to the decrease in the numbers of international students in the year of 2020 (Jackson, 2020). Academics with insecure employment, which was about 40% who were responsible for around 70% of undergraduate teaching, were discarded (Connell, 2019).

Universities in Australia employ academics under any of the following five broad categories of employment: Permanent, Fixed-term, Ongoing, Sessional, or Casual where permanent, fixed-term, and Ongoing staff were either full-time or part-time employees (Andrews et al., 2016).

2.3.2. Permanent Employment

Permanent employment was the most common employment type in Australia. "A permanent employee is an employee engaged on a permanent basis and maybe 'full-time' or 'part-time'. Continuity of employment and access to entitlements are the main advantages of permanent employment." (ELCWA, 2020, p.1). "Part-time employees have access to the same entitlements as a full-time permanent employee, but on a pro-rata basis according to the hours worked" (ELCWA, 2020, p.1).

Jenson et al. (2009) found in a study performed on the academic workload at the University of Western Sydney that full-time academic employees believe that the workload for them

was intensified by adding more responsibilities such as hiring and supporting casual employees, where the commitment to the higher standards of the casual employees was not always same as ongoing or fixed-term academics. Coates et al. (2009) argued that casualisation has added an extra burden on tenured academics, as they were responsible to manage the army of sessional staff on top of their existing work. The tenure or permanent academics were likely to experience more administrative workload.

2.3.3. Fixed-term Employment

Andrews et al. (2016, p. 3) define Fixed-term employment for academics as "employment for a specified term or ascertainable period, for which the instrument of engagement will specify the starting and finishing dates of that employment, or instead of a finishing date, will specify the circumstance(s) or contingency relating to a specific task or project, upon the occurrence of which the term of the employment will expire." Therefore, a fixed-term employment contract ensures a definite period of employment, which ordinarily cannot be shortened, except on unusual grounds which are generally mentioned in the contract such as poor performance, serious misconduct, etc. (Andrews et al., 2016). Norton et al. (2018) reported that 46% of non-casual academic staff in 2017 had a fixed-term contract of employment.

2.3.4. Casual Employment

A substantial portion of undergraduate teaching in most of the universities of Australia is facilitated by educators employed on a 'casual', non-fixed term or course-by-course basis (Australian Government Office for Learning and Teaching, 2015; May et al., 2013). Various terms are assigned to define casual teaching academics such as 'sessional academic', 'adjunct' and of course 'casual teaching staff'. This position eliminates them from some of the rights and benefits which are generally associated with standard ongoing university employment (Burgess & Campbell, 1998). Over the decades, universities have become encouraged by policies of being "flexible" which has resulted in 65% of academics working on contract or casual terms (McDonald, 2021). The main reasoning behind casual appointment appears to save cost and having greater flexibility in managing teaching staff (Lama & Joullié, 2015).

“Casual employment is not always short-term employment as some of the casual academic staff continue their employment over multiple semesters as permanent casuals” (Baik et al., 2018, p. 375). A case control study with 29 casual tutors performed by Flavell et al. (2019), identified that even when casual academics were provided with education on the use of on-line teaching tools, they had minimal opportunity to include these online learning innovations in their online teaching due to not having ongoing employment. In the year 2017, 31% of Australian university teaching staff were casual with 55% being female academics (Baré et al., 2020). FTE casual staff grew 54.6% from 15,553 in 2008 to 24,043 in 2019. In 2020 Australian FTE casual staff decreased by 18.1% to 19,696 (U Australia, 2022).

2.3.5. Section Summary

All the educators, irrespective of their employment type, had been reported as struggling between the allocated time and the real-time spent providing online education that can increase stress (Jansz et al., 2016). University educators who conduct online education could be teaching focussed and/or teaching and research academics with ongoing, fixed term, or casual employment. In the published literature reviewed no published studies were identified related to how all five ergonomic factors impact the educators who were teaching online.

2.4. Online Teaching in Mining and Metallurgical Engineering

2.4.1. Introduction

Studies have been conducted to determine the trends in engineering education and how to prepare future engineering students in the 21st century (Anaya, 2013). Thom 1998 stated that a new paradigm for future engineering curriculum should emphasize environmentally sustainable technology, methods, and processes; global issues: system-oriented approaches; and higher importance on engineering principles (Anaya, 2013; Mehrabian et al., 2008).

2.4.2. Online Engineering Education

In 2020 with the global spread of the COVID-19 pandemic, more online education was introduced (Qadir et al., 2020). Conventionally, an engineering study is content and design-oriented, and highly focused on developing problem-solving skills (Steiner et al., 2011; Valentinea et al., 2017). The growing acceptance of online learning environments offered awareness into a prospective solution for teaching problem-solving skills. Setting all the required tools and related resources online and minimising the class time might help to teach the students to develop their problem-solving methodologies to solve problems by themselves (Blom & Saeki, 2012; Male et al., 2010; Nair et al., 2009; Ramadi et al., 2016; Wickramasinghe & Perera, 2010). These tools may be introduced to students as a part of their engineering units, rather than a specific unit dedicated to teaching problem-solving skills, which represents cognitive ergonomic factors.

It had been identified that, educators were subjected to high levels of stress linked with intense job demands, even under best working conditions (Ansley et al., 2016). Stress factors included administrative support, availability of instructional resources, and general policies (Bettini et al., 2017; Richards, 2012; Owens, 2015). The engineering educators' capacity to perform efficiently as well as build positive relationship with students and co-worker may be compromised due to their unmanaged stress (Berkowitz et al., 2017; Cancio et al., 2018).

2.4.3. The relation between the new Industrial Revolution and Engineering Education.

A report published by the World Economic Forum in 2015, emphasised issues regarding the gaps in skills in the 21st-century and recommendation on how to solve the problem with the use of technology (World Economic Forum, 2015). The author of this report (table 6) defined a set of 16 critical competencies required in a 21-century educational platform, which is further divided into three categories, such as foundational literacies, competencies, and character qualities (Das et al., 2020).

Table 6

Competencies needed in the future engineering workforce

Reports on Skills Required for Future of Jobs	New Concept for Education Report		ASEE-TUEE
Complicated problem Solving	Foundational Knowledge	Knowledge	Good Communication skills
Critical Thinking		Numerical proficiency	Fundamental knowledge of Physical and Engineering Sciences
Creative ability		Scientific knowledge	Ability to Recognize formulate and solve engineering problems
People management		Knowledge of Information and Communication	Systems Assimilation
Coordinating with others		Financial knowledge	Inquisitiveness and Continued Aspiration for Constant Learning
Emotional intelligence		Cultural and Civic knowledge	Self-drive and inspiration
Judgment and decision-making skill	Competencies	Knowledge of consideration	Cultural awareness in the general perception (nationality, ethnicity, linguistic, gender, sexual orientation)
Service orientation		Creativity	Economics and Business Expertise
Negotiation		Communication	Having a high-level sense of ethical standards, integrity. Able to take global, social, intellectual, and technological responsibility
Cognitive flexibility		Collaboration	Reasoning ability
Critical Thinking	Character Qualities	Inquisitiveness	Willingness to take a calculated risk
		Initiative	Ability to prioritise efficiently

Reports on Skills Required for Future of Jobs	New Concept for Education Report	ASEE-TUEE
Organisational skills	Perseverance/tenacity	Project management (supervising, planning, scheduling, budgeting, etc.)
	Adaptability	Teamwork skills and ability to function on multidisciplinary teams
	Leadership	Entrepreneurship and intrapreneurship

Note: Adapted from "Reimagining Engineering Education: Does Industry 4.0 need Education 4.0?" by S. Das, D. Kleinke and D. Pistrui, 2020, *2020 ASEE Virtual Annual Conference.* (https://www.researchgate.net/publication/339983822). Copyright 2020 by American Society for Engineering Education.

2.4.4. Remote and Virtual Laboratories.

2.4.4.1. Laboratories

Educators of engineering educational institutions experience continuous challenges in the process of transition from a traditional classroom setting to an online teaching and learning environment with one of the main challenges being to include access to laboratory equipment that is typically available in a traditional classroom setting (Kane, 2018; Kuchirka et al., 2016). Science, technology, engineering, and mathematics (STEM) courses require hands-on laboratory elements, which generally were hard to transfer into an online environment (Aliane et al., 2010; Bourne et al., 2005; Hsiung & Deal, 2013; Pintong et al., 2012).

The amount of knowledge and clarity on any subject a student could get from "doing things" were much higher than just listening or viewing the same thing. Simply listening during online class did not engage students as it does in laboratory classes (Mackay & Fisher, 2014). Laboratory classes encouraged students to think harder like synthesise and analyse the subject matter by themselves (Dalgarno et al., 2003). Using laboratories were vital part of an engineering education as laboratories helped to verify any theory, improve understanding, offers improved hands-on skills, motivate, and increase the eagerness of learning deeply about the engineering profession and its practical application (Mackay & Fisher, 2014). The majority of the educators in engineering studies emphasise the

importance of practical laboratory work in the learning process (Cho & Kuyath, 2010). Conventional skills gained by the students in practical laboratory classes were from observational to calculating and interpretive (O'Connor et al., 2003). The apparent difficulties faced while converting and implementing hands-on lab works as a virtual laboratory were the widespread doubts within academic community regarding online engineering courses (Jordan, 2009).

In the case of virtual or online laboratory courses more laboratory stations and hours are available (Dalgarno et al., 2003). The scarcity of available training courses to train the educators and technicians to effectively train students in online laboratory platform was an issue (Benson & Mealy, 2014; Mawn et al., 2011; US Department of Education, 2010b). Availability of interaction and hands-on practical classes in any engineering course symbolises a good course by engineering professionals. For online engineering courses, the practical classes were designed in a different way, where the practical class experiments could be performed with the use of simulation software in virtual laboratories (Anon, 2002).

Online laboratory work can be made possible to the students by following two possible way (Cho & Kuyath, 2010):

Virtual labs- This uses simulation software on a host machine to run the laboratory experiment. The main problem lies in setting up the most realistic simulations compared to the real-world situation. Due to the excessively theoretical nature of this process sometimes students struggle to acquire essential skills and sufficient practice.

Remote labs- This type of online laboratory work includes real equipment situated at a remote location. In this case, the absence of real equipment in proximity becomes a possible hurdle for the students. Even with unavoidable critics, remote and virtual labs were broadly believed to be an excellent way to share specialised skills and resources over a wide geographical area as they reduce overall costs while improving educational experience (Mackay & Fisher, 2014).

Due to the virtual nature of the laboratory work, absence of sincerity, precision and sense of accountability can be noticed with some students, which also affects the educators, e.g. the experience of virtually observing a simulation of a machine is entirely different with watching by physically standing in front of a two-meter-high machine working in motion.

Thus, the basic skill of handling machine habitually comes from hands on experience (Potkonjak et al., 2016).

Engineering students and educators face multiple challenges such as level of competency with operating computer and internet needed to perform online laboratory classes (Balakrishnan & Woods, 2013). The work ethic and cognitive effort required to complete laboratory work are very different for traditional hands-on laboratory work versus an online laboratory work as a higher level of motivation, dedication, and discipline are required to succeed in completion of online laboratory work (Schmitt et al., 2017). These above-mentioned features of online laboratory classes may influence cognitive ergonomic factors of educators and technicians.

2.4.4.2. The advantages of virtual/remote laboratories.

The advantages of virtual/remote laboratories are listed below (Potkonjak et al., 2016).

Cost effectiveness- – Institutions could organise high-quality laboratory facility virtually with a lower cost than traditional laboratory as educators can supervise more students at any time in virtual laboratory work.

Flexibility – Several different virtual simulations which involved unique virtual components could be created easily by the educators or technicians for the students.

Multiple access – Educators can use virtual laboratories for more than one student at a particular time.

Change in the system configuration – Modification or amendments in the parameters of any virtual laboratory work was very easy to implement in contrast with traditional laboratory system.

Opportunity for leaning from mistakes – In virtual environment it is possible to fix any mistake without much effort, as for example, in a virtual robotic experiment, collision with the settings or overloading is permissible, as replacing the motors with more powerful one can be done without much hassle in case the arm of or other part of a robot got damaged due to using excess load or other. Thus, ‘damage’ was acceptable in virtual laboratory world, and gives opportunity to learn from mistakes.

2.4.4.3. Assessment Technique and developing Examination questions in online engineering courses.

One of the main challenges engineering academics faced were to develop and prepare online exams without sacrificing the educational quality and exam security. Educators may feel challenged if they did not have much/any prior experiences with teaching online as well as with setting and evaluating online student exams (Mehrabian et al., 2008). Some accreditation boards require an end-of-course comprehensive examination and/or simplified economically sustainable assessment options to validate the knowledge gained in tertiary educational platform (Dayananda et al., 2020). The introduction of online examinations, e-examinations, and bring-your-own-device standards are recommended as an alternative scenario to the large, invigilated examination rooms with paper-and-pencil (Shraim, 2019). Assessment quality includes the quality of all aspects of assessment practices, for instance test elements, assignments, assessments, examinations, the process used for assessing, or a course and the policies, procedures, and administration of the assessment process. Substandard assessment quality pose to significant consequences at all levels of education (Gerritsen-van Leeuwenkamp et al., 2017). It effects on the appropriateness, precision, and reliability of information collected to identify the level of the students' performance and progress prior to selection, issue certification, and accountability (Gerritsen-van Leeuwenkamp et al., 2017).

To be able to successfully create and follow good assessment techniques the educators are required to be very knowledgeable in the use of different relevant technologies (Albrahim, 2020). Receiving continuous update and training of existing and new technologies helps to improve the cognitive ergonomic factor of educators teaching online. In the methodologies of developing examination questions for the online education system, academics use various types of questions containing but not limited to multiple-choice, true/false, matching, short question, paragraph, and calculations (Shraim, 2019). Graphic-based questions are very common for engineering and technology courses (Mehrabian et al., 2009). The available learning resource system in some cases was not yet fully capable to support and allow the educators to design and implement the desired graphics-based online examination, but other platforms like Autodesk, AutoCAD allows collaborative features to create graphics-based questions (Mehrabian et al., 2009). According to Khan and Jawaid, (2020) different assessment techniques should be used for different teaching modes i.e.,

synchronous, or asynchronous including assignments, evaluation folders, MCQs, Open Book Examinations, and for assessing laboratory examination outcomes Quantitatively Structured Practical/Clinical Examination and Viva Voces were used (Gamage et al., 2020; Khan & Jawaid, 2020).

A good internet connection for both the online educator and students were very important to conduct the previously mentioned assessment techniques. Mainly for two reasons the online evaluation became one of the most concerning features during COVID-19 pandemic. Firstly, the on-site evaluation process needed to be redesigned by the educators to comply with the requirements of online learning and assessments, secondly, it was very difficult to ensure that the students followed the instructions provided by the educators' despite of having their direct supervision and not using any inappropriate additional material (Gamage et al., 2020). The following areas of concerns were faced by the educators while assessing the students.

Academic Integrity: The academic integrity defined by the International Centre for Academic Integrity (ICAI) as "a commitment, even in the face of adversity, to six fundamental values: honesty, trust, fairness, respect, responsibility, and courage" (ICAI, 2021, p.4). In Australia, academic integrity refers to "acting with the values of honesty, trust, fairness, respect and responsibility in learning, teaching and research" (U Australia, 2017, p.4). Australian universities are required to follow 3 Acts, supporting Regulations and a Code of Practice to sustain academic integrity to maintain educational standards:
(1) The Tertiary Education Quality and Standards Agency Act 2011 (TESQA, 2011),
(2) The Higher Education Standards Framework 2015 (Threshold Standards), (Birmingham, 2015),
(3) The Education Services for Overseas Students Act 2000 (ESOS Act, 2000) and
(4) The Australian Code for Responsible Conduct of Research, 2018 (National Health and Medical Research Council, 2018).
"Much like the USA, Australia also considers primacy of institutional autonomy as the topmost priority concerning academic integrity" (U Australia, 2017, p.5).

Cheating: Another main theme identified was cheating in online examinations. In an online assessment platform sometime cheating can be reach at unacceptable level (Sullivan, 2016). One survey showed that, 73.6% of students think cheating was easier in online

examination platform in compared with traditional regular examination platform (Aisyah et al., 2018). To minimise the peer-to-peer cheating potential some educators use randomised examination sequences (Butler-Henderson & Crawford, 2020). Various methods were identified by the educators to alleviate cheating such as, facial recognition of the test participant (multiple distinct biometric mechanisms including fingerprint scanning system or face geometry recognising technology could be utilised to authenticate users prior to taking an online examination, unapproved use of textbook/notes, organising a set-up for online examination, restrict student access to a test bank and blocking the use of unauthorised devices (e.g. phone, Bluetooth, and calculators) (Levy & Ramim, 2009). During the examination the access to other people should be restricted, detecting computer failures, identify any discrepancy in the method for invigilating (Hearn Moore et al., 2017). Recently, webcams gained popularity to solve both potential authentications and cheating issues in case of online examination monitoring by using the companies offering both verification technology and webcam proctoring as a package, also these technologies are compatible with some MOOCs (New, 2013a, 2013b; James, 2016). Generally, the online exams are "open book" exam. In online exams, students were tested more on the concept to avoid above mentioned problems.

Interface design: The interface of any system influence on the feeling about the environment of the online examination platform like if it's posed as a barrier or not (Butler-Henderson & Crawford, 2020).

Technology issues: There are not many studies found which mentioned any issues related to technological problems (Bohmer et al., 2018; Matthíasdottir ´ & Arnalds, 2016; Schmidt et al., 2009). In one study it was reported that 5% of students complained about technological problems ranging from experiencing a slow system through to the system not working properly incorporated with the computer operating system, though, the researchers stated that none of the students in this study reported of incapability to complete their examination due to the technical issues (Matthíasdottir ´ & Arnalds, 2016).

Developing concept-based examination questions is not always easy for engineering subjects which are mainly based on engineering designs and calculations. The following problems were identified by Mehrabian et al. (2009).

i) *Interactivity:* According to some academics their presence during examination is useful as this provides the students extra comfort by knowing that if required, they can clear their doubts either for content or material. In the case of online exams, educators may make themselves available through email, telephones, and texts at the time of examination if the student really needs them.

ii) *Equity***:** In the online examinations, the method of developing questions can be "guided grouping of the questions", where questions are stored in a question bank, divided, and grouped according to their level of difficulty, then the questions appear randomly. Online course management systems are used to generate random questions in the examination. This requires a lot of testing and practice to become the master of this process which consumes a lot of time and dedication as there are not enough resources available for this.

iii) *Hands-on' Demonstration of Concept***:** It is not easy for the educators to know the level of understanding of the concepts of their online students. Screen capturing software can capture all the movements of the cursor and can be able to trace back. Using this might help but it is still in an experimental stage.

iv) *Team-workability Assessment:* For the engineering and technology students' ability to perform in a group and work in a team is essential. In an online platform, there must be techniques available to assess these skills.

v) *Ethics***:** The Engineering Criteria 2000 of the Accreditation Board for Engineering and Technology (ABET) promised to improve considerably and meticulously the setting of engineering education in the United States. Increased attention was focused on the ethical responsibilities of engineers. This is becoming an extra concern for educators especially those who teach online.

All the above factors needed to be taken care by the educators. These factors may impact the environmental/physical, technological, and psychosocial aspects of educators who teach online.

Online educators are required to interact with their computer, mouse, chair, table/desk, electrical outlets, and the designated office space provided by the university, and this can result in discomfort in body parts if the educator adopts an awkward posture (Shirzaei et al., 2015; Wickremasinghe & Kumuduni, 2022). Educators may experience physical soreness and pain (in back, neck, legs, hands, fingers, wrists), with the possibility of

developing muscular skeletal diseases (Realyvásquez-Vargas et al., 2020). Exposure to varied levels and types of noise (Lee et al., 2016; Wickremasinghe & Kumuduni, 2022), temperature (Califano et al., 2017; Wickremasinghe & Kumuduni, 2022), and lighting (Omidiandost et al., 2015; Wickremasinghe & Kumuduni, 2022), may cause distraction and discomfort for online educators when working.

Cognitive ergonomic factor can affect the educators when developing, executing, and assessing online examinations, due to increase of mental workload or intellectual fatigue (da Silva, 2014).The use of new and unfamiliar technological applications (such as Classroom, Google Meet, Teams, Zoom, and Drive, among others) in order to complete all the responsibilities of an educator, be mentally demanding (Realyvásquez-Vargas et al., 2020).

2.4.5. Criterion for best practices in e-assessments.

Currently, a combination of both qualitative and quantitative approaches is used while designing online assessment tasks. The following observations were made from reviewing published literature (Joshi et al., 2020)

- *Variety*: Both quantitative and qualitative methods of assessment were used to support all types of learning styles. Ensuring that the methods used should encourage more than superficial learning, via collaboration, teamwork, feedback methods, problem-based learning, etc.
- *Authenticity*: Used to model a precise assessment which replicates the real-time circumstances/responsibilities a students will encounter after graduation.
- *Collaboration*: This permits the communication among students and educators, other academics, experts, members of the local or global community, and experts.
- *Feedback*: Ensuring appropriate and timely feedback mechanisms are incorporated throughout the online assessment process.
- *Online resources*: Ensuring that the students should use and take advantage of all available online resources.
- *Student responsibility*: Providing more options of pathways within the course and assessment should be encouraged. Stipulation of such responsibility of the learning process can empower large numbers of diverse students by using similar assessment tasks with integral options to account for individual student interests.

‘Variety’, ‘collaboration’ and ‘feedback’ are good ways of maintaining physical/visual interaction which improves the social interactions of the educators as well as the students.

2.4.6. Misapprehensions.

Online education is a lonely, non-teacher-led, self-managed activity that is among some of the popular misapprehensions (Bourne et al., 2005). However, the recent advanced online education is completely opposite to that as recent online education is very much dynamic and student-oriented, having a higher rate of communication between teacher and student compared with face-to-face on-campus engineering courses (Bourne et al., 2005). Another common misapprehension is that online education is exclusively about the application of technology to teaching and learning (Bourne et al., 2005). It is true in some aspect that online education is facilitated by technology, but it is not exclusively about technology (Richardson et al., 2016).

2.4.7. Limitations of Online Engineering Teaching.

i. It is difficult to provide direct operation experience of the instruments in the online engineering educational platform (Grose, 2003).
ii. Explaining mathematics-based material is very hard in on an online platform (Peterson & Feisel, 2002).
iii. Occasionally the design tools and graphics required for computing power are hard to avail (Bourne et al., 2005).
iv. It is very hard to teach engineering subjects online as these are primarily science and mathematics based and generally requires laboratories and equation manipulation. These problems have been resolved to some extent by implementing current advanced technological tools (Bourne et al., 2005; Potkonjak et al., 2016).
v. Laboratory-related education is tough in an online platform due to the unavailability of having hands-on experience from a distance. Implementing remotely manipulated virtual hands-on laboratories in online engineering studies can minimise the problem of laboratory education (Bourne et al., 2005; Potkonjak et al., 2016).

Successful delivery of online engineering courses requires the availability and expertise of using complicated computer resources. The majority of the 3D CAD modelling and

dynamic modelling software is very convoluted and time consuming to configure and use successfully for solving specific problem, as most of the available software models were created on simplified systematic abstract theories (Potkonjak et. al., 2016; Vukobratovic et al., 2003). The educators and the students required to have in depth knowledge in technology to be able to control all the virtual equipment and software.

2.4.8. How technology helps to achieve desired quality, scale, and scope in online engineering education.

A combination of several technologies from high-speed connectivity to course management systems, are used to facilitate online engineering courses that would not be possible otherwise. The following table 7 summarises the examples to illustrate how technology helps to implement online teaching by improving quality, scale, and scope in online engineering studies.

Table 7

Technology-enhanced learning in Online Environment

The use of technology helped to improve the activity	Method of Technology implementation	Latent Effects: Quality, Scale, Scope
The collaboration of student teams within numerous institutions	Internet and multiple TCP/IP empowered technologies, both synchronous and asynchronous	Quality, scale, and scope
Tough game-playing simulations through institutions	Simulation software	Quality
Accessing remote laboratories and instruments	Remote control through the Web	Quality, and scale
Following student work progress	Course management systems used to track student work progress	Quality
Displaying student work, portfolios	Web-based portfolios	Quality
Remote experts	Using synchronous tools for conveying experts live to a class	Quality
Intercollege Courses delivery	Web-based	Scale
Providing courses to distant and distributed learner populations	Web via the Internet	Scale
Self-paced modules, including shared modules (e.g., Merlot)	Various technology tools are available to package self-paced courses	Scale, and scope
Capturing lectures for asynchronous delivery Streaming video, audio Scale	Streaming video, audio	Scale

Note: Adapted from “Online engineering education: learning anywhere, anytime,” by J. Bourne, D. Harris, and F. Mayadas, 2005, *JALN 9*(1), p142, (https://onlinelibrary.wiley.com/doi/pdf/10.1002/j.2168-9830.2005.tb00834.x). https://creativecommons.org/licenses/by/4.0/. Not copyright.

Overall tertiary education, and particularly engineering education, have experienced substantial fundamental transformation globally due to outbreak of COVID-19 pandemic (Ali et al., 2022). Educators have been forced to re-evaluate the current content of engineering programs in the perspective of developing fields (information technology, biotechnology, nanotechnology) and with a multidisciplinary effort (systems engineering, mechatronics). A continuous need to develop, execute, and assess innovative pedagogical approaches for incorporating these novel subjects into educational programs has been identified (Esche, 2002).

Table 8

Effect of ergonomic factors on educators teaching engineering and other subjects.

Task	Engineering	Science	Others	Ergonomic Factors	Literature
Course delivery	WebCT	WebCT	WebCT		Strickland & Butler, 2005
Online laboratory teaching	Remote/ virtual laboratory			Time consuming and technological difficult (Cognitive Ergonomic Factor)	Bhute et al., 2021; Vukobratovic & Potkonjak, 1985; Vukobratovic, Potkonjak, & Matijevic, 2003
Examinations	Security	Security	Security		Burke, 2009; Hollister & Berenson, 2009; Penteado & Marana 2009; Ramim & Levy, 2007; Stone, 2021
Teaching problem solving skills	Hard to explain mathematics-based material	Hard to explain mathematics-based material	N/A	Stress (Cognitive Ergonomic Factor)	Peterson, & Feisel, 2002; Steiner et al., 2011; Valentine et al., 2017
Teaching team building skills	Goalsetting and task performance theory	N/A	N/A		Campion et al., 1993
Student behavioural problems	No shows or non-participation	No shows or non-participation	No shows or non-participation	Isolation (Social Ergonomic Factor)	Cook, 2007; Lyke & Frank, 2012; Rochester & Pradel, 2008; Summers et al., 2005
Psychological hindrances and obstacles	Intense job demands			Stress (Cognitive Ergonomic Factor)	Ansley et al., 2016; Berkowitz et al., 2017; Cancio et al., 2018
Virtual Laboratory	Hard	Hard	N/A		Dalgarno et al., 2003; Mackay & Fisher, 2014 Potkonjak et al., 2016
Developing online exams					Califano et al., 2017; Wickremasinghe & Kumuduni, 2022
Use of new and unfamiliar technological applications	Classroom, Google Meet, Teams, Zoom, and Drive				Realyvásquez-Vargas et al., 2020

2.4.9. Section Summary.

This section has described the demands in online engineering education, including the practical use of acquired theoretical expertise. While discussing the main challenges faced by the educators in online engineering studies the main obstacle identified are that the educators mainly struggle with developing assessment tasks for online tests. How a traditional hands-on laboratory work is converted to accommodate the online platform was

described. No published studies were identified related to how all 5 ergonomic factors affected academics teaching minerals and mining engineering online. This research was conducted to address this gap in knowledge.

The existence of considerable amount of stress factors were associated with using Information and Communication Technologies (ICT) and specific organisational dynamic related to virtual teaching. Frequently reported risk factor with online university teaching were the isolation resulting from a lack of face-to-face contact within teachers and students (Dolan, 2011; Fouche, 2006; Mintz-Binder & Allen, 2019; Schulte, 2015; Yick et al., 2005). The difficulties of formal and informal communication within the organisation and the teachers were the main reason for experiencing disappointment, distress, and alienation (Eib & Miller, 2006). Increased workload and the indistinct boundaries between work and family space were other attributes which were negatively perceived by educators teaching online.

2.5. Ergonomic Factors Related to Online Teaching

2.5.1. Introduction to online teaching ergonomic factors

The role of online educators is different from traditional classroom educators that potentially affect the educators ergonomically. “Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design to optimise human well-being and overall system performance” (IEA, 2024, p.1). Ergonomics is also defined as a scientific discipline which utilises applied sciences to conclude relationships between work and human capability and includes “the design and evaluation of tasks, jobs, products, environments, and systems to make them compatible with the needs, abilities, and limitations of people” (Dennerlein, 2017, p. 577). Ergonomics provides a theoretical understanding “of human behaviour and performance” (Wilson, 2000, p. 557), fits the task to the person, the product to the user, and improves both comfort and productivity (Kroemer, 2017) which is a reason that ergonomic factors should be considered for educators who conduct online teaching.

Studies showed that ergonomic factors such as the physical ergonomic factors (PEF) (workspace, computer, and furniture) (Earthman, 2004); environmental ergonomic factors (EEF) (noise, lighting, and ventilation) (Zandvliet & Fraser, 2005); organisational ergonomic factors (OEF) (course structure, workload, and tutor support) (Ginns & Ellis, 2007; Woolner et al., 2007); cognitive ergonomic factors (CEF) (how teaching efficiency affected by the design of study material) (Benjamin, 2014; Ginns & Ellis, 2007; Jansz, 2011; Lavrov et al., 2013); and social ergonomic factors (SEF) (opportunities for interaction with peers and tutor) (Zandvliet & Fraser, 2005) impacts significantly on the well-being and satisfaction of online educators along with the learners. However, currently, very little knowledge is known about how these five ergonomic factors interact individually and/or in combination to impact upon the educators in teaching online.

2.5.2. Physical Ergonomic Factors

Physical ergonomics involves human anatomical, anthropometric, physiological, and biomechanical physical characteristics on physical activity. The anthropometric measurements influence desk design, seating, and computer height while teaching online.

Academics teaching online were spending a higher percentage of their working hours in sitting positions working with computers which potentially poses detrimental health effects (Gerr et al., 2004; James et al., 2018). Online teaching could involve continuous 3 or more hours teaching in a sitting position without changing posture vs 3 or more hours of classroom teaching with flexibility. Poor ergonomic set workplace might lead to certain musculoskeletal disorders (MSDs) such as back pain (Harrington & Walker, 2004). Many researchers reported that the e-educators were developing musculoskeletal disorders due to prolonged sitting in association with computer-use for teaching online (MSDs) (Bergqvist et al., 1995a, 1995b; Demure et al., 2000; Ferreira et al., 1997; Faucett & Rempel, 1994; Goode et al., 2019; Hales et al., 1994; James et al., 2018; Marcus & Gerr, 1996; Ong, 1994; Straker & Mathiassen, 2009; Yu & Wong, 1996). Additionally, the accumulated hour of prolonged sitting is a more important factor than the one-off prolonged sitting scenario, which was linked with less healthy metabolic rates in comparison with interrupted sitting (Healy et al., 2008).

The correlation between musculoskeletal symptoms and use of computers for long hours, including the use of mouse had been studied previously in the general office environment (IJmker et al., 2007; Klussmann et al., 2008). The operational working environment of academics were more diverse than a standard computerised office environment, hence the relationship between hours spending in working with computers and the development of musculoskeletal symptoms for academics might be different (Gornall & Salisbury, 2012). Online educators teach online using computer, smartphone, or other electronic devices with internet access. Working away from the office become more common practice due to the advancement in communication technologies (Ciccarelli et al., 2011).

A very diverse work environment was faced by the online educators resulting using their computers in various places like within offices, laboratories, at home, and while traveling. It was anticipated that the academics should be ‘mobile’ and available for responding to any queries, irrespective of their location. Academics tend to work from home, including working long unpaid hours outside of designated office hours to meet the demand of finishing the job (Ciccarelli et al., 2011). Thus, on many occasions, the academics were not working from their designated workplace which had been ergonomically set up for them. Spending around or more than 8 to 9 hours in a sitting position can be identified as sedentary behaviour and this behaviour can pose a higher degree of a risk factor for obesity,

some types of cancers, diabetes, and death from any other cause (Blanck et al., 2007; Katzmarzyk et al., 2009).

A complication of eye and vision discomfort experienced by the online educators working long hours with a computer had been labelled as 'Computer Vision Syndrome'. One of the leading problems of extensive computer use is 'eye strain' (Abdelaziz et al., 2009) which can be described as blurred or double vision, irritation, headaches, eye fatigue, change of colour perception, a decrease in visual efficiency, increase in frequent errors (Abdelaziz et al., 2009) and decrease proficiency (Atenico, 1996). Experiencing seeing colour changes while working long time with a computer had been found by numerous computer operators. Visual discomfort and related symptoms experienced by computer users was a rising health problem (Nunoo, 1996).

In Australia as well as internationally MSDs were reported as the highest among all workplace injuries. Between the years of 2020 – 2021, 18% within total workplace injury claims were the claims related to MSDs (20,965 claims) within Australia (Safe Work Australia, 2022). MSDs account for the major source of injury and illness cases, being 31.8% of all injuries and illnesses related to days away from work reported to the Bureau of Labor Statistics in the U.S.A. (Bhattacharya, 2014; Goode et al., 2019).

2.5.3. Environmental Ergonomic Factors

To date, there had been very limited research found about the impact of environmental conditions or factors (particularly noise, temperature, lighting) on educators who teaches online classes (Realyvásquez-Vargas et al., 2020). The lighting, ventilation, temperature, and noise of the room where the online educators spend most of their time were examples of environmental ergonomic factors (Harrington & Walker, 2004). There were some ill health effects related to online teaching reported in the qualitative study conducted by Jansz et al. (2016) as one of the online educators reported that spending a large amount of time working at a computer screen in a poorly lit room. This educator developed headaches and needed to purchase stronger reading glasses to continue to do online teaching. Yu-Chi et al. (2014) reported that three quarters (75%) of individual working 6-9 hours in front of a computer screen complained of having problems with their vision. According to Kronenberg et al. (2022), elevated optical stress, resulting from looking at the computer

monitor in the same direction for extended period of time, may cause blurry vision, eye dryness, eye irritation, issues related to eye focus system of the user, and more. In long run this might damage the vision and need medical attention (Kronenberg et al., 2022).

Lighting conditions impact both the physiological and psychological health of an individual, and an active change in lighting conditions affects both positively and negatively on numerous aspects of one's well-being (Boyce, 2014). Lighting preferences vary for different individuals (Despenic et al., 2017; Haldi & Robinson, 2010; Xiong et al., 2018; Yan et al., 2015). Physiological, psychological, and contextual factors of lighting were correlated with space and window layout of the area; visual perception was also affected by the overall settings of the area (Borisuit et al., 2015; de Korte et al., 2015; O'Brien & Gunay, 2014; Sahin et al., 2014); thus, illumination limitations alone were not considered to be sufficient enough to characterise the lighting preferences and multivariate characteristics of lighting conditions responsible for significant effects (Vasquez et al., 2019). The lighting environment not only impacts individual health and wellbeing but also impacts the performance of any task (Boyce et al., 1989; Boyce, 2014). Poor or excessive lighting in a working area influences cognitive performance and problem-solving skills by interfering with physiological factors including circadian rhythms (Juslen & Tenner, 2005). The nature of lighting may impact job satisfaction by influencing the mood of the individual educator and interpersonal relationships with colleagues or students (Boyce, 2003).

Numerous studies had been performed on the impact of classroom acoustics on students learning capabilities, but the room acoustics also impacts teaching performance as the nature of the voice of the teacher determines the level of focus of the students (Rantala & Sala, 2015). Poor room acoustics were responsible for increase the level of noise; thus, the educators required to use a louder voice, and use longer speaking times (Astolfi et al., 2014) resulting higher voice symptoms (Cutiva & Burdorf, 2015) than teaching from a room with better acoustic setup (Pelegrín-García & Brunskog, 2012). The indoor air quality also impacts voice health. The presence of any kind of toxic substance or organic dust in the working area causes voice symptoms (Geneid et al., 2009), as well as dry indoor air quality, poses threat to voice disorder as it stiffens the cover of the vocal cord and rises the viscidness of mucous membrane (Hemler et al., 2001), which in turn worsens the vibration of vocal folds (Witt et al., 2011). It was common for educators to experience physical health

issues related to voice such as dysphonia and voice fatigue. Generally, one or more than one factors were responsible for these symptoms like voice abuse during teaching including speaking in an excessively loud tone and unable to take proper health care due to a hectic workload (Ramprasad et al., 2014).

Research conducted by Lin et al. (2019) identified that thermal condition parameters were significantly related to adverse health symptoms in teachers and especially excessive dryness and heat aggravates twofold risk for any symptoms, especially allergic symptoms. Wargocki et al. (2002) performed two independent investigations in Denmark and Sweden, applying the analogous experimental methodology and observed that an increase in temperature increases the difficulty of thinking and concentration. It was observed that elevated temperatures were inversely associated with productivity (Federspiel et al., 2004). A study by Mendell and Heath (2005) showed that elevated temperature above the recommended limit may cause deterioration of mental condition by increasing confusion and fatigue.

2.5.4. Organisational Ergonomic Factors

Organisational ergonomics was concerned with the organisational factors that affect online educators. The organisational ergonomic factor that affects online educators were not having enough time to do all the required updates they would like to make for their teaching materials, to be able to complete all work, including marking student assignments and to complete all university required paperwork within their workload allocation time (Jansz et al., 2016). The occurrence and/ or endurance of work-related musculoskeletal disorders (WRMSDs) can be affected by the psychosocial factors at workplace (EU-OSHA, 2020; Roquelaure, 2018). Studies shows that MSDs can be associated with physical and psychosocial factors (e.g., low influence at work, work pace, fewer rest periods, high forces on the keyboard and mouse, poor team-spirit, adverse relationships with colleagues, mental stress, and time pressure) (Jiskani et al., 2020; Roquelaure, 2018). Studies also identified that factors like role conflict, low job control, and weak leadership influence to elevate stress level, which can be associated with the prevalence of MSDs in wrists/hands, shoulders, and lower back (Eatough et al., 2012).

The workload of educators was increased, as they required to take part in continuous improvement of computer-mediated communication skills (Jena, 2015; Tarafdar et al., 2010) such as, ability to use social media platforms confidently (Salo et al., 2019) able to use mobile applications (Hsiao, 2017), mobile computing devices (Hung et al., 2015). Not only the health of the educators is compromised by technostress, but it also affects the educational organisations management (Hung et al., 2015; Joo et al., 2016). Hectic workload and high demand of communication with students cause emotional stress, exhaustion, burnout, and poor recovery to the educators which can be described as emotional health problems of educators teaching online (EU-OSHA, 2018; Gluschkoff et al., 2016; Li, & Wang, 2020; OECD, 2020).

2.5.5. Cognitive Ergonomic Factors

Cognitive ergonomics was concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. Cognitive ergonomics also focuses on the psychological characteristics of work (Choppin et al., 2018; Hollnagel, 1997). Cognitive ergonomics involves identifying, interpreting, and processing information by an individual (Attwood et al., 2004) and includes perception, learning, ability to memorise, problem-solving, and motivation (Jansz, 2011). Cognitive ergonomic factors that were reported as impacting educators teaching online included having insufficient knowledge of the university policies, procedures, the usage of modern technologies, and online educational tools (Jansz et al., 2016). Even experienced university educators had difficulty with some of the online documents they had to complete, particularly when links or formatting did not work properly (Jansz et al., 2016).

The cognitive ergonomic factor that took up the most time for educators was helping students who were studying fully online to understand what they needed to do, particularly for their assignments, sometimes educators had to go over the information many times before students understood. Students misunderstanding what to do created extra work for the educators as they had to correct the misunderstandings that students shared with each other (Jansz et al., 2016). The implications for how course materials can support teachers in designing and endorse responsive and interactive instructions can be considered using cognitive ergonomic strategies including decision making in complex environments where

controlling dynamic events like mathematics lessons can be difficult (Gonzalez et al., 2017). The number of cognitive resources required throughout an activity, from competing means, can impact the cognitive workload load which can undermine performance (Engström et al., 2017). Online educators may have trouble in dealing with the information flow in dynamic environments (Leaver & Reader, 2016).

The most common ergonomic factors that affects the online educators were cognitive ergonomic factor as stress and cognitive workload (García-González et al., 2020). Stress occurred with educators being new to using online teaching technology i.e., technostress (García-González et al., 2020) resulting from the sudden shift in mandatory use of information and communication technology (ICT). Technostress generally is an adaptability problem; educators can feel technostress when they are required to deal with new rapidly changing computer-mediated communication (Chou & Chou, 2021). The most common symptom of technostress is the failure to concentrate on one problem, petulance, and a feeling of loss of controlling power (Ibrahim et al., 2007). The factors contributing to technostress include techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty (Fuglseth & Sørebø, 2014; Li & Wang, 2021; Marchiori et al., 2019).

2.5.6. Social Ergonomic Factors

This includes the communication and interaction between students, educators, and the relationship with co-workers in the online environment. Answering emails from students and other related personnel consumed a considerable amount of educators' time in the online teaching platform as online students generally had very minimum interaction between fellow students preferring to directly communicate with their teachers rather than their peers (Jansz et al., 2016). A variety of research studies (Chen et al., 2010; Coates, 2007; Laird & Kuh, 2005; Ma et al., 2015; Smith et al., 2005; Sun & Rueda, 2012) have identified that online teachers have the most effect on student learning and have a responsibility to assist with, and enable, student learning through effective communication.

Student-related factors are one of the most frequently mentioned reasons why educators like to teach in an online environment. Online education offers more accessibility to higher education for an additional diverse student population (Bolliger & Wasilik, 2009).

Engaging students in a highly interactive communication among educator and students are another motivating factor for the educator (Bolliger & Wasilik, 2009). Though, in some instances, educators were concerned about the limited interaction with students (Bower, 2001) as they never meet the students face-to-face. Researchers have recognised a positive link between teacher satisfaction and student performance i.e., the level of teacher satisfaction is directly proportionate with level of student performance (Fredericksen et al., 2000; Hartman et al., 2000).

Online teaching was very time consuming. Most of the time spent in online teaching was a combination of one-to-one email, telephone conversations, discussion groups, chatroom questions and answers through blackboard, and finally for some students giving time for face-to-face conversation (Lazarus, 2003; Wickstrom, 2003). In the digital age, communication is frequently through emails. Students' e-mails/ question was sent at any time which hampers educators' time spent on research activities and even personal life. Studies suggested that the online educator devoted substantial amount of time to provide technical support to the students (Lee & Busch, 2005; Santilli & Beck, 2005). In online learning, some students become more demanding and expect immediate responses to their questions and assignments which impacts online educators' workloads. Online educators complained about requiring increased time to manage e-communication 24/7, which was difficult for many staff (Łukasiewicz-Wieleba & Romaniuk, 2022). Social factors identified as supporting online educators included having supportive co-workers and good communication that enabled relationship building between students and online educators that facilitated the provision of a higher standard of education and student satisfaction with their learning outcomes (Jansz et al., 2016).

The key factors behind using online teaching and learning were to improve access to education and training, and the effectiveness of learning and teaching, as well as to improve the cost effectiveness of education (Panigrahi et al., 2018). Online teaching and learning along with face-to-face traditional teaching and learning was effectively used both in industry, and academia with progressive outcomes (Chang, 2016). The table 10 below summarises the effects of ergonomic factors on online educators identified in the published literature reviewed.

Table 9
Positive effects of online teaching

Categories	Sub-categories	Ergonomic factor
1.1 Educator & Student satisfaction • Bollinger & Martindale, 2004 • Bolliger & Wasilik, 2009 • Chen et al., 2020 • Harsasi & Sutawijaya, 2018 • Liaw, 2008 • Lin, Lin, & Laffey, 2008 • Palloff & Pratt, 2013 • Panda & Mishra, 2007 • Papillion & Aaron, 2017 • Simonson et al., 2009 • Tang et al., 2018	• Improves retention of students • Encourages and provides professional development opportunities and research and partnership prospects with colleagues. • Offers lifelong learning opportunity.	• Cognitive • Organisational
1.2 Cost-effectiveness. • Bartley & Golek, 2004 • Dykman & Davis, 2008 • Nguyen, 2015	• Avoid traveling expenses. • Using existing network and platform	• Organisational
1.3 Flexible teaching and convenience. • Cantoni et al., 2004 • Daymont & Blau, 2008 • Kock et al., 2007 • Panigrahi et al., 2018 • Wild, 2002	• Flexible teaching hours as per educators' convenience • Anywhere, any time	• Organisational
1.4 Diversity. • Eshet-Alkalai & Geri, 2007 • Coppola et al., 2002 • Guri-Rosenblit, 2005 • Wong et al., 2019	• Using multimedia platform • Availability of both digital and hard copy of the material	• Organisational
1.5 Developing student participation. • Akimanimpaye & Fakude, 2015 • Andrew et al., 2015 • Furnes et al., 2018 • Gossenheimer et al., 2017 • Hsu & Hsieh, 2014 • Leite Funchal Camacho et al., 2016 • Matlakala et al., 2013 • Rogo &Portillo, 2014 • Salyers et al., 2014 • Sheringham et al., 2016 • Telford & Senior, 2017	• Support from educator • Sharing information • Mentoring • Active involvement • Take responsibility for learning. • Increased Student connectivity • Independent learning • Self-efficacy	• Social • Cognitive
1.6 Problem-solving skills/ Soft skills. • Cantoni et al., 2004 • Nygren et al., 2019 • Häkkinen et al., 2017 • Hsu & Hsieh, 2014 • Matlakala et al., 2013	• Improved critical thinking skills. • Attainment and retention of knowledge	• Cognitive
1.7 Easy to update. • Cantoni et al., 2004 • Davis et al., 2019		• Organisational
1.8 Timesaving. • Ramya & Variyar, 2020		• Organisational
1.9 Communication. • Coppola et al., 2002		• Social

Categories	Sub-categories	Ergonomic factor
1.10 The most lenient teaching environment. • Ramya & Variyar, 2020		• Organisational
1.11 Multisensory. • Ramya & Variyar, 2020		• Cognitive
1.12 Supplementary digital instructional tools. • Ramya & Variyar, 2020		• Organisational
1.13 Forming a favourable environment for learning • Akimanimpaye & Fakude, 2015 • Andrew et al., 2015 • Du et al., 2013 • Nygren et al., 2019 • Smith & Crowe, 2017	• Non-threatening • User friendly • Creating a presence by adopting a correlation with students	• Social
1.14 Developing computer literacy skills • Akimanimpaye & Fakude, 2015 • Davies et al., 2015 • Dery et al., 2016 • Holland et al., 2013	• Compulsory use of computer	• Cognitive
1.15 Improving accessibility of education • Gossenheimer et al., 2017 • Rogo & Portillo, 2014 • Salyers et al., 2014 • Schaffer et al., 2016	• Distant/remote areas • Geographically diverse areas	• Organisational
1.16 Incorporating the theory-practice gap • Agrawal et al., 2016 • Furnes et al., 2018 • Gardner et al., 2016 • Holland et al., 2013 • McCutcheon et al., 2015 • Rogo & Portillo, 2014 • Schaffer et al., 2016 • Sheringham et al., 2016	• Extensive opportunities to monitor the display • practical skills • Assimilates knowledge and skills	• Cognitive

Note: Adapted from "Effective online teaching and learning practices for undergraduate health sciences students: An integrative review", by E. van Rensburg, 2018, *International Journal of Africa Nursing Sciences, 9*(2), 73-80. (https://doi.org/10.1016/j.ijans.2018.08.004). Copyright 2018 Elsevier.

The literatures identified that factors facilitate effective online teaching were mostly related to organisational, secondly cognitive, and thirdly social ergonomic factors.

A small unpublished pilot study was carried out with seven tutors, who taught architecture online, one lecturer from the School of Education and one lecturer from the School of Public Health who provided online university student education (Jansz et al., 2016). The ergonomic factors identified in this study that facilitated and that hindered the effectiveness of online teaching are described in table 10:

Table 10

Ergonomic factors affecting online educators positively and negatively.

Factor	Facilitate online teaching	Hinder online teaching
Physical	Height adjustable desk, chair, computer screen & comfortable to use. Desk with adequate workspace. Enough room to store teaching materials. Task variation to prevent repetitive strain injury.	Nonadjustable chair, desk Incorrect height of computer screen Inadequate resources storage space Repetitive work without a break
Environmental	Adequate light. Comfortable temperature. Comfortable humidity. No glare. Adequate ventilation. Adequate room space.	Noise in shared office. Constant machinery noise through office wall. Inadequate ventilation.
Organisational	Professional development opportunities. Providing grants to allow research into improving teaching.	Lack of time for teaching, marking student assignments, marking moderation, student communication, and administrative work taking longer than allowed in the university workload model.
Cognitive	Explanation of university procedures and how to use electronic tools by co-workers. Having the person teaching the unit also mark all student assignments so that this person has more understanding of each student's learning requirements.	Lack of understanding by new sessional staff of: university procedures. how to use Blackboard. how to use Turnitin. On campus staff members' understanding of electronic documents that had technical problems. Some students were unsure of how to use electronic tools, and this required additional teaching time to explain. Some students needed face to face or additional explanation for what to do for their assignments which took additional teaching time. Some students needed to submit a draft assignment for review to ensure that they understood what to do for their assignment. This took additional teaching time. Some students struggled to learn online, and their learning style was better suited to on campus teaching. This decreased student satisfaction with online learning which made it difficult for the educator to meet student learning requirements. Despite well-organized Blackboard unit structure and materials, some students still misread terms and concepts, putting more demands on the educator.
Social	Emails facilitated student learning as the educator was able to provide individual student assistance with learning. Supportive co-workers.	Answering emails took time and prevented the educator from completing other work. While social media, such as Facebook or Ning, helped students to build their

Factor	Facilitate online teaching	Hinder online teaching
	Good communication enabled relationship building between students and online educators that facilitated the provision of a higher standard of education and student satisfaction with learning outcomes. Some staff members participate in social media activities to build better relationship understanding of the needs of the students and to find ways to bring students to participate in formal online sessions.	community of sharing there were problems such as students contradicting staff members' instructions and advice on assessment matters. When student numbers attending Collaborate sessions were low, this caused a problem for teaching staff members to effectively collaborate with students in teaching and learning.

Note: From *How do ergonomic factors affect perceptions of student learning? An exploratory study involving online students* (p. 183-184), by J. Jansz, R. Walker and J. Bay, 2016, *Curtin University*. Copyright 2016 Curtin University.

Physical constraints faced by students such as poor internet speeds, lack of good interfaces, in particular graphic interfaces such as sketch pads and tablets for architectural students, increased online teaching time. The seven Tutors and two lecturers all found that they were provided with good physical ergonomic factors that facilitated their online teaching work. Online educators also reported having good interactions with students as a social ergonomic factor and this made their work seems rewarding. Except for noise, which hindered online teaching, other environmental ergonomic factors like adequate light, a comfortable room temperature and adequate ventilation facilitated online teaching work. The major social ergonomic factor that facilitated online teaching was having supportive co-workers, particularly when there were cognitive ergonomic problems with using new technology for online teaching. Educators that had continuing employment were able to apply for research grants and other organisational support that was not available to the tutors to facilitate their online teaching (Jansz et al., 2016).

There were barriers to online teaching and learning for educators as not all students willing to engage in online learning (Yosuf & Zaini, 2007), especially those who study courses that required a face-to-face environment, such as engineering. According to Musingafi et al. (2015) challenges faced by the online educators could be situational, epistemic, philosophical, psychological, pedagogical, technical, social, and/or cultural (Musingafi et al., 2015). Attitudes and perceptions of educators could also act as a barrier in the online teaching and learning environment. Other barriers described by Muilenburg and Berge

(2005) including administrative matters, social communication, academic and technical proficiencies, inspiration, time, limited access to resources, and technical difficulties. Other barriers can be unfamiliar roles and responsibilities of the educators new to the online environment, limited technical assistance, high degrees of technology dependence, and low student performance and satisfaction (Bolliger & Wasilik, 2009; Simonson et al., 2009). Some of the ergonomic factors related barriers of online teaching and learning which affects negatively identified in the published literature reviewed were mentioned below in table 11 (Panigrahi et al., 2018).

Table 11

Online teaching barriers and ill-health effects.

Categories	Causes	Ergonomic Factor
2.1. Musculoskeletal Disorder Argus & Paasuke, 2022 Bergqvist et al., 1995a, 1995b Demure et al., 2000 Faucett & Rempel, 1994 Ferreira et al., 1997 Goode et al., 2019 Hales et al., 1994 Harithasan et al., 2022 James et al., 2018 Marcus and Gerr, 1996 Yu & Wong, 1996	Prolonged sitting in one place Bad Posture Incorrect setup of workstation	Physical
2.2. Computer Vision Syndrome Abdelaziz et al., 2009 Atenico, 1996 Harithasan et al., 2022	Long hours working with computer	Physical
2.4. Environmental effect Aries et al., 2010 de Korte et al., 2015 Galasiu & Veitch, 2006 O'Brien & Gunay, 2014 Sahin et al., 2014	Surrounding Noise Temperature Light Ventilation	Environmental
2.5. Acceptance Willett et al., 2019	Attitudes	Social
2.6. Problems with the interface Davis et al., 2019 Freire et al., 2012 Hillman et al., 1994 Moore, 1989 Swan, 2004	Lack of infrastructure	Organisational
2.7 Problems with interaction Chickering & Gamson, 1987 Freire et al., 2012 Garrison & Shale, 1990 Moore, 1989	Student-student interaction Student-teacher interaction Student-content interaction	Social
2.8 Problems with Usability Emang et al., 2017	Unavailability of internet	Organisational

Categories	Causes	Ergonomic Factor
Freire et al., 2012		
2.9 Initial set up and ongoing cost Cantoni et al., 2004 Carr, 2001	Getting software and hardware Maintenance Training	Organisational
2.10 Technology misuse Greenberg, 1998 Palloff & Pratt, 2013	Problems with understanding technology	Cognitive
2.11 Special technological skill requirement Ateya et al., 2015 Cantoni et al., 2004 Davies et al., 2015 Kowalczyk, 2014 Lam et al., 2016	Limited computer training Lack of developmental training and support of educators teaching blended courses	Cognitive
2.12 Interaction between peers and teachers Cantoni et al., 2004 Junaidu, 2008 Mansor & Ismail, 2012 Van Rensburg, 2018	Lack of physical interaction	Social
2.13 Unavoidable interruption Ramya & Variyar, 2020	Technical problems Inconsistent power supply	Organisational
2.14 Minimal interaction in class Abrami et al., 2011 Davis et al., 2019	Not joining or leave in between classes	Social
2.15 Interacting limit. Harithasan et al., 2022 Van Rensburg, 2018	Limited access	Organisational
2.16 Distraction and Inconvenience Ramya & Variyar, 2020	Children or other family members while working from home	Social
2.17 Change of role Desai et al., 2008 Fetherston, 2001 Hardy & Bower, 2004 Koehler & Mishra, 2009 Martin, Budhrani, Kumar & Ritzhaupt, 2019 Smolin & Lawless, 2003	Playing multiple roles	Cognitive

Note: Adapted from "Effective online teaching and learning practices for undergraduate health sciences students: An integrative review", By E. van Rensburg, 2018, *International Journal of Africa Nursing Sciences, 9*(2), 73-80. (https://doi.org/10.1016/j.ijans.2018.08.004). Copyright 2018 Elsevier.

The literatures identified that factors act as a barrier to effective online teaching were mostly related to social, secondly organisational, and thirdly cognitive ergonomic factors. The educators were also affected by physical and environmental ergonomic factors.

2.5.7. Section Summary

This section describes all five physical, environmental, organisational, cognitive and social ergonomic factors. Having the knowledge of ergonomic factors and how they can impact on an individuals' effectiveness while teaching online, provides better option to study the problem and rectify the problem. Once the rectification method has been implemented to reduce any ergonomic factor issues, it will directly improve the efficiency of the educators teaching online. There were a very few publications found which studied online educators' experiences and none were identified related to how ergonomic factors affected academics teaching minerals and mining engineering online. This research was conducted to address this gap in knowledge.

Figure 2
Ergonomic factors that facilitate online teaching

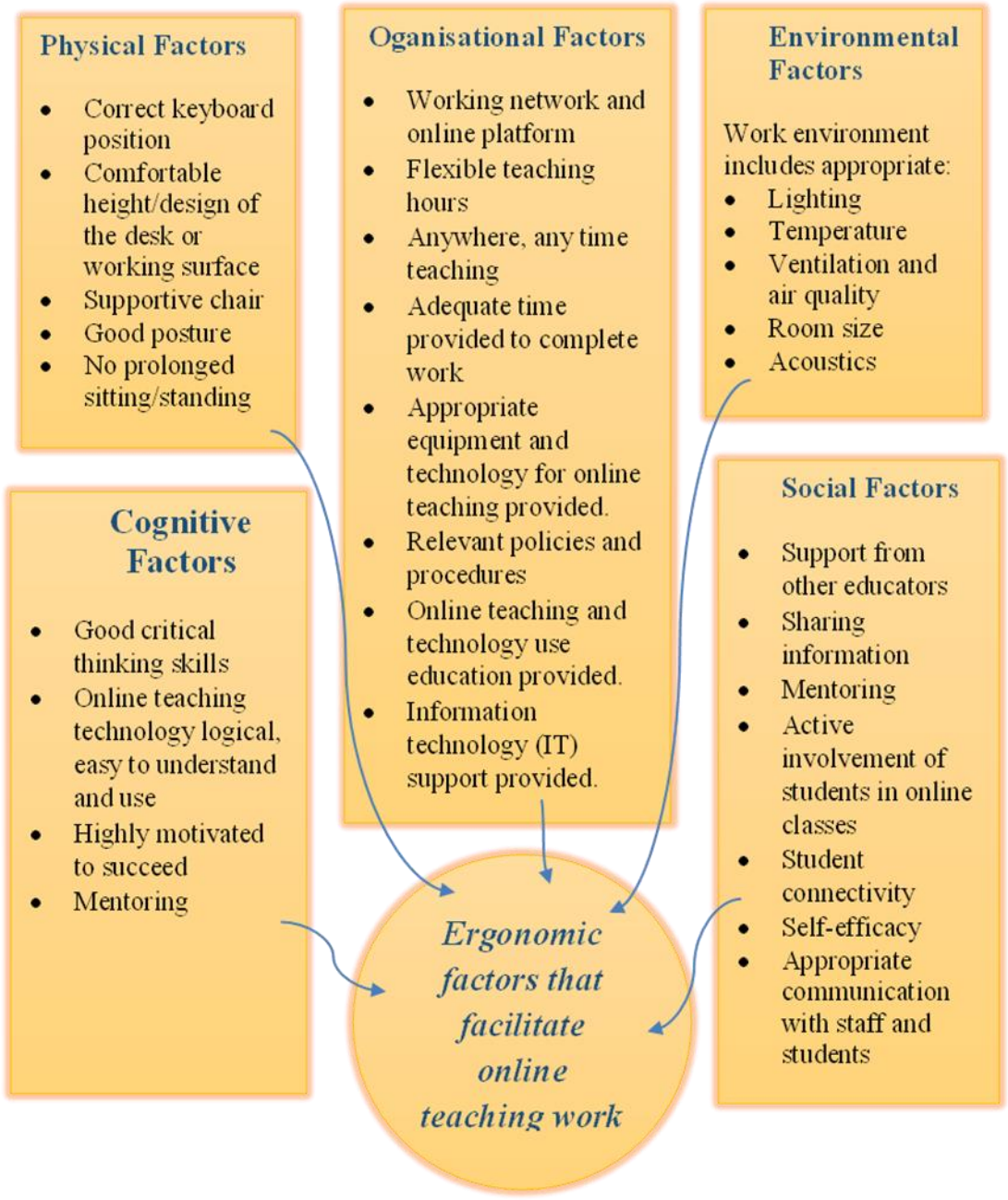
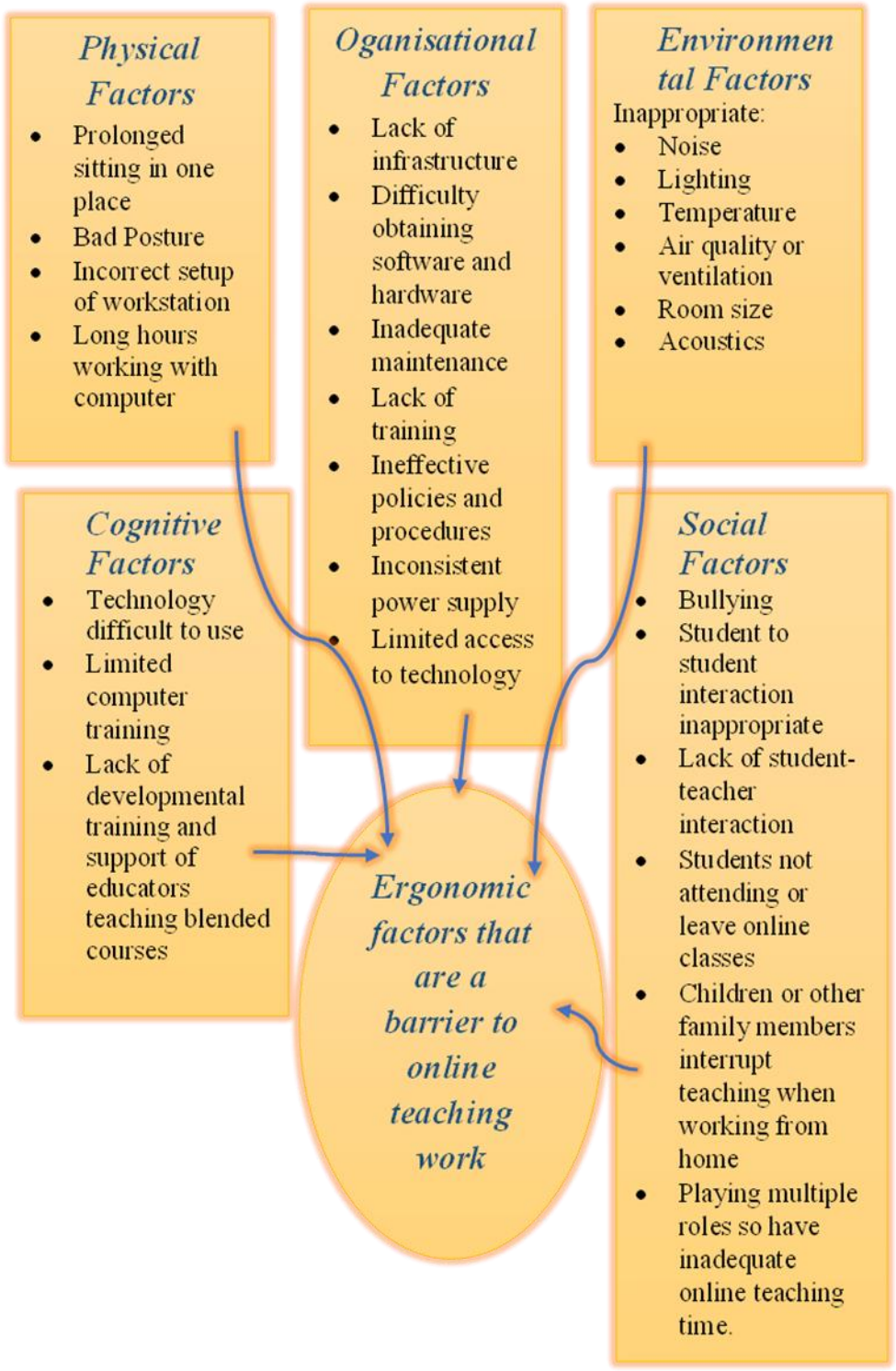


Figure 3

Ergonomic factors that are a barrier to online teaching.



2.5.8. Chapter Summary

This chapter commenced by describing the literature review methodology. The next section provided the history and gradual transformation of educational methods, pedagogy, and documents how the COVID-19 pandemic affected traditional teaching and forced a to shift to online teaching worldwide to cope with the pandemic isolation requirements. Section three focused on reporting on how the educators' employment types influenced educators. The comparison of the ergonomic factors that affected the online tertiary educators teaching engineering or other subjects were discussed in section four. The last literature review section focused on reporting on physical, cognitive, organisational, social and environmental ergonomic factors that facilitate the work of educators teaching online as well as those that hinder the work of these educators.

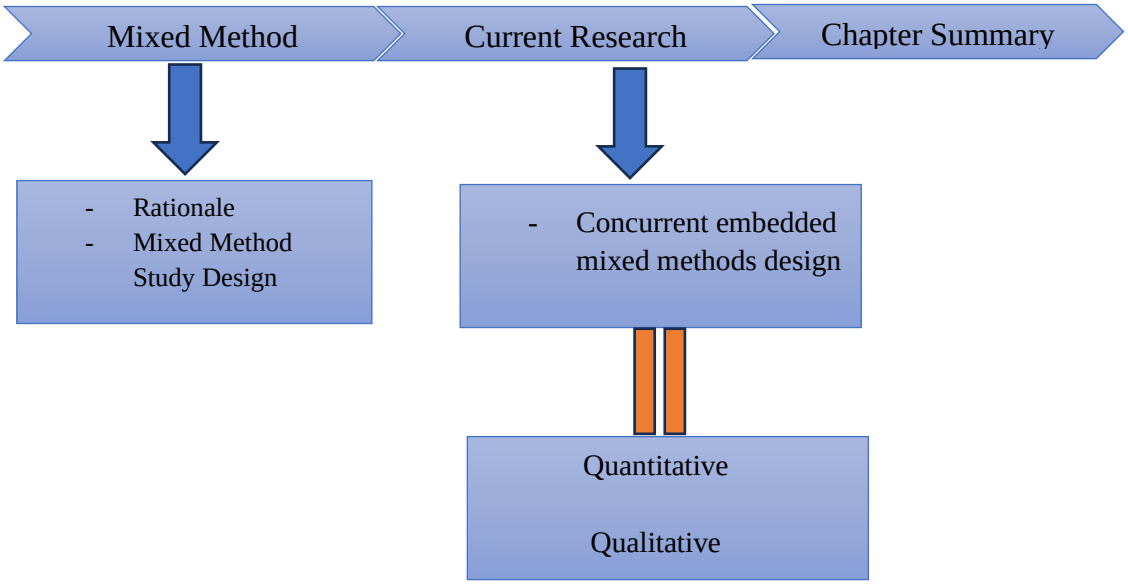
The next chapter describes the methodology used for analysing the data collected for to evaluate of tertiary educators' perceptions of online teaching related ergonomic factors.

3. METHODOLOGY

3.1. Introduction

This chapter outlines the specifics of the methodology and design adopted for conducting this research based on the specific objectives to be met and the variables selected for the study. In addition, it discusses the mixed methods approach and the current research design, prior to providing a summary, as illustrated in the following flow chart.

Figure 4
Mixed method approach



3.2. Mixed Methods Approach

The mixed research methodology can be defined as "research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches or methods in a single study" (Tashakkori & Creswell, 2007, p. 4). This research methodology utilises both quantitative and qualitative approaches to reduce the constraints of one method while strengthening the powers of another. Thus, the value driven from the mixed methodology was the combination to strengthen the research results, creating a more comprehensive understanding of the phenomenon under study (Creswell & Clark, 2011).

The mixed methods approach not only collects and analyses data separately, but also helps to integrate various predictors and perspectives of risk (Miller & Crabtree, 2005).

Generally, it has been recognised that the combination of quantitative and qualitative research approaches has greater benefits (Greene et al., 1989). The following five rationales were recognised in support of adopting mixed methods approach by researchers:

- *Triangulation* – The results identified from one method confirm the findings from the other approach (Greene et al., 1989).
- *Complementary* – The outcomes originated from one method are used to elaborate and validate the outcomes from the other method (Hanson et al., 2005).
- *Development* – The results originated from one method are used to develop or update the other phase of the study, specifically in the perspective of developing the study instrument (e.g., the findings of quantitative dataset being used to design the qualitative questionnaire) and sampling (Hanson et al., 2005).
- *Initiation* – A specific approach is used to show the contradictions and inconsistencies from the results of the other method (Hanson et al., 2005).
- *Expansion* – The extent and intensity of the research can be widened using another method for varying the factors of inquiry (Greene et al., 1989).

3.3. Research Paradigm

It is important for the researcher to declare their philosophical position while adopting mixed methods research approach, reflecting that data collection and analysis were not the main purpose but interpreting the results were similarly important (Wong & Cooper, 2016). The development and nature of knowledge describes the concept of research philosophy (Bahari, 2010). A research paradigm is defined as an ethical perspective or a predominant philosophical/shared acceptance which affects the knowledge being researched and the approach followed to collect the evidence that is interpreted (Broom & Willis, 2007). Numerical data is collected in quantitative research to analytically recognise the phenomenon of interest, the knowledge gain is created on the paradigm of positivism (Creswell, 2009). Positivists consider that actuality is constant, and that actual facts achieved through scientific experimentation (Wong & Cooper, 2016). The results and identified risk factors are strictly chosen and regulated, before establishing the relationship between them. Capturing and analysing these variables are always the main interests of

quantitative researchers. The researcher chooses which form of approach and analysis and which variables should be investigates to get the best answer to the research questions, and get credible empirical outcomes (Creswell, 2014).

In qualitative approach, non-numerical (i.e., descriptive) data are collected and the knowledge gained is supported by a constructivist paradigm (Creswell, 2003; Wong & Cooper, 2016). The descriptive data is collected from the individuals who have experienced the fact and indicated their desire to provide deeper insights into it (Yilmaz, 2013). The analysis of the descriptive data is managed by the perceptions of reality of the participants and the interpretative eye of the researcher (Wong & Cooper, 2016).

In mixed methods research studies both quantitative and qualitative approaches were combined to be able to attract the strengths of both approaches and offers an innovative approach which can be used to address contemporary issues (Fetters et al., 2013).

3.4. Mixed Methods Design

When a researcher adopts a mixed methods approach, identifying the types of design suitable for the research problem were required inclusive of the rationale for the selection. In this regard, Creswell (2003), identified five mixed methods design typologies that researchers can use when answering research problems necessitating a combination of quantitative and qualitative approaches as described in table 12.

Table 12
Types of mixed methods designs

Mixed Methods Design	Descriptions
Sequential Explanatory Design	First the quantitative data collection and analysis occurs, then the qualitative data collection and analysis. The quantitative analysis gets the priority, then the two datasets are combined at the interpretation stage.
Sequential Transformative Design	In this design, both datasets are collected and analysed independently; during the interpretation stage the integration takes place. The priority can be given to either qualitative or quantitative approach.
Concurrent Triangulation Design	Equal priority is given to both quantitative and qualitative approach while collecting and analysing the dataset to check, validate and authenticate the findings. Assimilation happens at the interpretation stage of the study.
Concurrent Nested (Embedded) Design	Both datasets are collected and analysed concurrently in this design. Though, a leading method leads the entire research, which means that primary questions were answered by one method and the secondary questions were answered by the other method. Either combine the both datasets and side-by-side display both the findings, specifically for the separate questions.
Concurrent Transformative Design	Under this strategy, the quantitative and qualitative datasets are collected at once, and equal or unequal priority is given to either of them. Incorporation generally occurs at the analysis stage, but sometimes it can be done at interpretation stage.

Note: Adapted from *Research design: Qualitative, quantitative and mixed methods Approaches (2nd ed.),* by J. Creswell, 2003, SAGE. Copyright 2003 SAGE Publications.

3.5. Research Design

This research has been conducted using a convergent parallel mixed methods design. The convergent-parallel approach is a synchronised method and comprises the instantaneous collection of qualitative and quantitative data, then these multiple data sources are combined and evaluated with each other (i.e., eventually the two methods are merged).

This approach requires the collection of different but complementary data on the same experiences. Hence, it is used for the joining and consequently clarifying the quantitative and qualitative data. This approach is also described as the concurrent triangulation design (single-phase) since the data collection and analysation are done individually but at the same time (Edmonds & Kennedy, 2017). This research methodology utilises both quantitative and qualitative approaches to reduce the constraints of one method while strengthening the powers of another. Qualitative analysis method was used for the Focus group study.

3.6. Phase 1

3.6.1. Qualitative Approach

The primary objective of using qualitative analysis had always been to help provide a thorough understanding about participants' experiences of why the phenomenon of interest occurred in the first place (Roberts, 1997), i.e., the focus was placed on the consequences gained by the participants at the receiving end of the phenomenon (Al-Busaidi, 2008). The qualitative data in the form of comments and the answers to open ended questions were pursued in this part of research to gain the opinion into the effect of ergonomic factors on online educators. This was achieved by answering research questions 1 and 2.

3.6.2. Research Setting & Scope

The target populations were the educators of universities form all over Australia as well as universities worldwide who teach online. The sampling frame included online educators from Universities of Australia, some universities of USA, Europe, India, Middle east, Singapore, and Africa.

3.6.3. Data collection procedure

A Focus group analysis was conducted to gain in depth knowledge on the perceptions of which ergonomic factors facilitates and which hinders the effectiveness of online teaching for online educators; the causal relationship between the years of online teaching experience and the subjects taught (engineering/non-engineering) with the perceived

positive or negative effect of ergonomic factors on online educators. Thematic analysis method was followed to analyse the focus group data.

3.6.4. Focus Group Methodology

3.6.4.1. Introduction

Focus Group discussions are commonly used as a starting point of the qualitative research approach to obtain an in-depth understanding of the issues and this method aims to collect data from a deliberately chosen group of individuals. A Focus Group can be defined "as a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research" (Powell & Single, 1996, p 1). The Focus Group interview is a qualitative method for data collection. According to Denscombe (2007), "Focus Group consists of a small group of people, usually between six and nine in number, who are brought together by a trained moderator (the researcher) to explore attitudes and perceptions, feelings and ideas about a topic" (p.115). The Focus Group interview delivers in a relatively homogeneous group of participants to discuss their opinion of experiences on the questions asked by the interviewer (Dilshad & Latif, 2013). According to Krueger and Casey (2000), a Focus Group offers "a more natural environment than that of an individual interview because participants are influencing and influenced by others- just as they are in real life" (p.11). It is recommended by some researchers to use Focus Group discussion in the conception of questionnaires. Focus Group can help in constructing the questionnaire by providing in-depth knowledge as participants are very familiar with the topic (Freitas et al., 1998).

Focus Group research entails organised discussion of a set of questions with a particular group of individuals to acquire their experience and views on a topic. Additionally, in group interviews participants gets the opportunity to discuss mutually normative assumptions which are generally unstated, thus able to unfold complicated motivations and behaviours (Bloor et al., 2001; Morgan & Krueger, 1993). Focus Group interview/discussion helps to obtain several perspectives about the same topic (Gibbs, 1997). A Focus Group can be defined as a small group of individuals with a common interest or characteristic assembled by a moderator, who will use the interactions of the group to gain in-depth information about a specific subject way (Gibbs, 1997; Lewis, 2000; Marczak & Sewell, 2006). As stated by Krueger and Casey (2000), the objective of Focus Group is to stimulate a relaxed

ambiance of revelation where an individual can share their ideas, experiences, and attitudes about a specific topic.

3.6.4.2. Development of Focus Group Questions for data collection.

Focus Group interview questions were developed based on a comprehensive review of published literature related to online teaching and the COVID-19 pandemic. The comprehensive literature review helped to achieve content validity. The details of the literature used for each question were listed in the following table 13.

Table 13

Published literature that informed focus group questions.

Question	Name of Article	Author/s	Year	Publisher
1	**Please share with the group your employment position, type of employment, number, and type of units of study that you teach online.**			
2	**What engages you most in teaching in an online teaching and learning environment? If none, what are the relevant ergonomic factors that might have caused this?**			
	Award-winning faculty online teaching practices: Course design, assessment and evaluation, and facilitation.	Martin, F., Ritzhaupt, A., Swapn K. S., & Budhrani, K.	2019	The Internet and Higher Education
3	**Do you come across any problems with teaching mining and metallurgy in an online environment? If yes what are these problems?**			
	Challenges in the online component of blended learning: A systematic review	Rasheed, R. A., Kamsin, A., & Abdullah, A.	2020	Computers and Education
4	**Do you find that available software and technologies influences your online teaching practice, assessment development, student engagement or anything else? If so, what are the advantages and disadvantages that you have found with technology and software in online teaching?**			
	Virtual learning environments as socio-material agents in the network of teaching practice.	Johannesen, M., Erstad, O., & Habib, L.	2012	Computers and Education
5	**Physical ergonomic factors are related to human anatomical and anthropometric measurements. Examples include having a comfortable chair, enough room to do your teaching work, a desk and a computer to use that is at an appropriate height. Are there any physical ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.**			
	How do Ergonomic Factors Affect Perceptions of Student Online Learning in Tertiary Education?	Jansz, J., Walker, R., Bay, J., Paudel, N., Swapan, A. Y., & Smith, R.	2018	World Safety Journal
6	**Environmental ergonomic factors are related to your teaching environment. Examples are the noise, lighting, workplace temperature and ventilation in your teaching environment. Are there any environmental ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.**			
	How do Ergonomic Factors Affect Perceptions of Student Online Learning in Tertiary Education?	Jansz, J., Walker, R., Bay, J., Paudel, N., Swapan, A. Y., & Smith, R.	2018	World Safety Journal

Question	Name of Article	Author/s	Year	Publisher
7	**Organisational ergonomic factors are those that are controlled by the University. Examples are allotted time for updating the materials, marking the assignments and providing feedback using Blackboard. Are there any organisational ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.**			
	How do Ergonomic Factors Affect Perceptions of Student Online Learning in Tertiary Education?	Jansz, J., Walker, R., Bay, J., Paudel, N., Swapan, A. Y., & Smith, R.	2018	World Safety Journal
8	**Cognitive ergonomic factors are related to how you think and process information. Examples are if you know and understand all university policies and procedures, Blackboard, Turnitin, and online educational tools. Are there any cognitive ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.**			
	How do Ergonomic Factors Affect Perceptions of Student Online Learning in Tertiary Education?	Jansz, J., Walker, R., Bay, J., Paudel, N., Swapan, A. Y., & Smith, R.	2018	World Safety Journal
9	**Social ergonomic factors are related to your interaction with other people. Example are the opportunities for collaborating with students and co-workers in your online teaching and all communication. Are there any social ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.**			
	How do Ergonomic Factors Affect Perceptions of Student Online Learning in Tertiary Education?	Jansz, J., Walker, R., Bay, J., Paudel, N., Swapan, A. Y., & Smith, R.	2018	World Safety Journal
10	**Are you involved in supervision of online research students? If so please describe any ergonomic factors that affect your online teaching of research students.**			
	Cross-Cultural Supervision in Cognitive-Behavioural Therapy: A Case Study	Yang, F. H., Dobson, K., Li, X.M., Hennebury, A., Gao, Y., Xin-Feng Tang, M., & Qi, L.	2018	Cognitive and Bahavioural Studies
11	**What differences have you found between traditional class room teaching and online teaching in the areas of course materials, assessment methods, and support from co-workers, and any ergonomic factors?**			
	Implications for academic workload of the changing role of Distance educators	Bezuidenhout, A.	2015	Distance Education
	Four key challenges to the design of blended learning: A systematic literature review	Boelens, R., Wever, B.D., & Voet, M.	2017	Educational Research Review
12	**In the online teaching environment what helps you to teach most effectively and why?**			
	Effective pedagogical practices for online teaching: Perception of experienced instructors	Bailey, C. J., & Card, K. A.	2009	The Internet and Higher Education
13	**Describe any barriers you have experienced in online teaching and why these were barriers. If you did experience a barrier how did you overcome this barrier?**			
	Work organisation is significantly associated with upper extremities musculoskeletal disorders among employees engaged in interactive computer-telephone tasks of an international bank subsidiary in Sau Paulo, Brazil.	Ferreira, J., Conceicao, G., & Saldiva, P.	1997	American Journal of Industrial Medicine

Question	Name of Article	Author/s	Year	Publisher
	Online learning: Adoption, continuance, and learning Outcome — A review of literature.	Panigrahi, R., Srivastava, P.R., & Sharma, D.	2018	International Journal of Information Management
14	**What are the most important factors you would recommend are required to enable you to teach successfully in the online teaching and learning environment?**			
15	**Is there anything else that you would like to tell about your online teaching experiences?**			
Question Model 1 to 15	Exploring Chinese faculty perceptions of quality standards for online education	Dai, X.	2014	Doctoral dissertation
	A Practical Guide to Focus-Group Research	Breen, R. L.	2006	Journal of Geography in Higher Education,
	Designing and Conducting Focus Group Interviews	Krueger, A. R.	2002	University of Minnesota

The first question of the 15 Focus Group questions consisted of asking participants for their employment position, type of employment, number, and type of units of study that they teach online. This was asked to enable participants' answers to be analysed against their demographic details. The rest of the 14 open-ended questions were asked to be able to develop the questionnaire to answer the research aim and objectives. See Appendix 7 for the focus Group questions asked.

3.6.4.3. Focus Group discussion methods.

Seven types of focus group discussion platforms were identified including digital varieties to utilise the growth in online platforms as listed in table 14.

Table 14
Types of Focus Group

Types of Focus Group	Description
Single Focus Group	This method was identified as the most common traditional type of focus group discussion method (Morgan, 1996), which allows an interactive discussion on a specific topic with a group of participants in one place.
Two-way Focus Group	In this method, two groups are involved within which one group will be actively involved in the discussion, whereas the other group will observe the discussion of the active group (Morgan, 1996; Morgan et al., 1998). Generally, in this case, the moderator and the observing group will observe and note the interactions, discussions, and body language of the participants of active group without being visible
Dual moderators Focus Group	In this method, the Focus Group discussion includes two moderators operating together, where each moderator will perform a different role within the same focus group (Krueger & Casey, 2000). This division of roles should lead to a smooth evolution of the discussion and guarantee that all required topics are covered.
Duelling moderators Focus Group	This type of Focus Group is conducted as a debate session where two moderators purposely posed themselves on opposite sides of the topic (Krueger & Casey, 2000). It is believed that this type of discussion helps to achieve in-depth revelation of information and/or data (Nyumba et al., 2017).
Respondent moderators Focus Group	Researchers recruit some of the participants in the focus group to act as a moderator temporarily. Having the moderator as a part of the group may influence the dynamic of the group to provide more varied and honest responses from the other individuals of the group (Nyumba et al., 2017).
Mini Focus Group	This type of Focus Group is chosen when the researcher faces a difficult situation to reach some or all the participants at one particular time, but the research design requires all of the participant's inputs. In this circumstance, the researcher convenes a small group of between 2 to 5 participants (Nyumba et al., 2017). This type of group is generally composed of individuals with a high level of expertise in certain fields (Nyumba et al., 2017).

Types of Focus Group	Description
Online Focus Group	Online Focus Group are not an entirely different type of focus group discussion. Rather it is a focus group that is conducted digitally via the internet using WebEx call, conference call, chat room, or another online audio/video means (Nyumba et al., 2017) as a variation to the traditional methods of in-person discussions. Online focus groups display an impression of vitality, innovation, and effectiveness that surpasses traditional problems of face-to-face focus group discussions (Edmunds, 1999). But these are only available to participants having Internet access and are comfortable using these types of platforms, however, there can be a risk of losing non-verbal data due to poor or loss of internet connectivity (Dubrovsky et al., 1991).

Note: Adapted from "The use of focus group discussion methodology: Insights from two decades of application in conservation," by T. Nyumba, K. Wilson, C. Derrick, and N. Mukherjee, 2018, *Methods in Ecology and evolution*, *9*(1), 20-32. (https://doi.org/10.1111/2041-210X.12860). Copyright 2018 by John Wiley & Sons Ltd

For this research, due to COVID-19 infection control distancing requirements, the researcher chose to conduct the online mini–Focus Groups discussion. This was an appropriate platform to use as the research was related to online teaching, so all Focus Group participants were experienced in using online platforms. The Focus Group discussions were conducted during the 2nd week of November 2020. This was a busy time of the semester for all the academics, so it became very challenging for the researcher to get six academics in a single timeframe, resulting in the researcher deciding to use a combined method for the focus group discussion. Thus the 'mini-focus group' method was combined with online focus group discussions. This decision was made by the researcher to obtain a rich quality of data by conducting several mini-focus group discussions (O'Brien, 2003) with expert educators rather than having 6 members in each focus group. The researcher interviewed the participant educators using four mini-focus group discussion sessions via WebEx video calling facility with three participants in each group. The participants of two mini-focus group were 'experienced' educators who had taught online for three or more years and the participants of the other two mini-focus group were 'less-experienced educators' who had taught online for less than three years and most of these participants only began online teaching when a COVID-19 lockdown commenced in March 2020 when students and educators were not allowed on campus.

3.6.4.4. Focus Group participant selection

The focus group design process began with identifying the aim and research objectives of the study. Based on the research objectives, a list of questions was prepared with the help of information obtained through a systematic literature review. After gaining ethics approval to proceed with the research an invitation was sent to prospective participants who met the selection criteria. To recruit focus group participants an email invitation was sent out to academics at one large Australian University. The invitation emails for participating in focus group, Pilot study and main study are included in Appendix 2. The focus group information letter is included in Appendix 3. The Pilot study information letter is included in Appendix 4. The information letter for main study is included in Appendix 5. The consent form, signed by each focus group member before participating in the study, is included in Appendix 6. The interview was based on a list of written questions (Appendix 8). All the focus group participants selected were academics with online teaching experience. All 12 focus group participants worked at the same university. There were two mini groups of participants with less than 3 years online teaching experience, and two mini groups of tertiary educators with more than 3 years' experience in online teaching. Some participants did know each other, and this facilitated some lively discussions about online teaching experiences.

3.6.4.5. Interview Technique and Focus Group Steps

An extensive and semi-structured online discussion was organised by the researcher with open-ended questions. Open-ended question inspires the participants to provide more detailed conversation (Doddy & Noonan, 2013), allowing the participants to explain and justify if required. Semi-structured discussions are flexible, and the researcher can freely ask for any clarification from any participants to gain more depth information and be able to identify any issues which may arise during the discussion (Doddy & Noonan, 2013). For these reasons, semi-structured open-ended questions were used for the Focus Group in this study. Kvale (1996, p. 129) stated that "A good interview question should contribute thematically to knowledge production and dynamically to promoting a good interview interaction." This was one of the most popular methods of data collection for qualitative research and for preparing the open-ended questions the following guidelines were documented by Doddy & Noonan, 2013.

- Questions for semi-structured interviews or discussion can be associated with the behaviour or experience of the participants.
- The expertise of participants in that specific topic
- Participants demographic background.

Copies of the focus group questions were sent to the participant educators before the focus group meeting so that they were familiar with the questions to be asked and had time to think about some points for their answers, particularly for the questions associated with the 5 ergonomic factors and for their online teaching work. All questions were asked according to their specific order on the focus group question sheet. The researcher assured all the participants that all their answers were valid and there was "no right or wrong answer". The researcher took additional notes of each participant's comments and video recordings of each of the focus group discussions for future references. All the notes and the comments of each participant were transcribed into a word document. They were then sent through email to each participant to check their own transcript for accuracy. This also helped to obtain information for any missed or incomplete answers for specific participants and assisted with ensuring the reliability and validity of each participant's comments.

The participants were not mentioned by their name but were described as 'FGP1', 'FGP2', etc., to hide the actual identity of each participant. Patton (2002) stated: "Interviews are interventions. They affect people. A good interview lays open thoughts, feelings, knowledge, and experience, not only to the interviewer but also to the interviewee" (p. 405). The researcher then revisited the answers of each participant educators to make sure all the information was complete and ready for analysis. The thematic analysis was performed with the use of NVivo 12 software to analyse the focus group data.

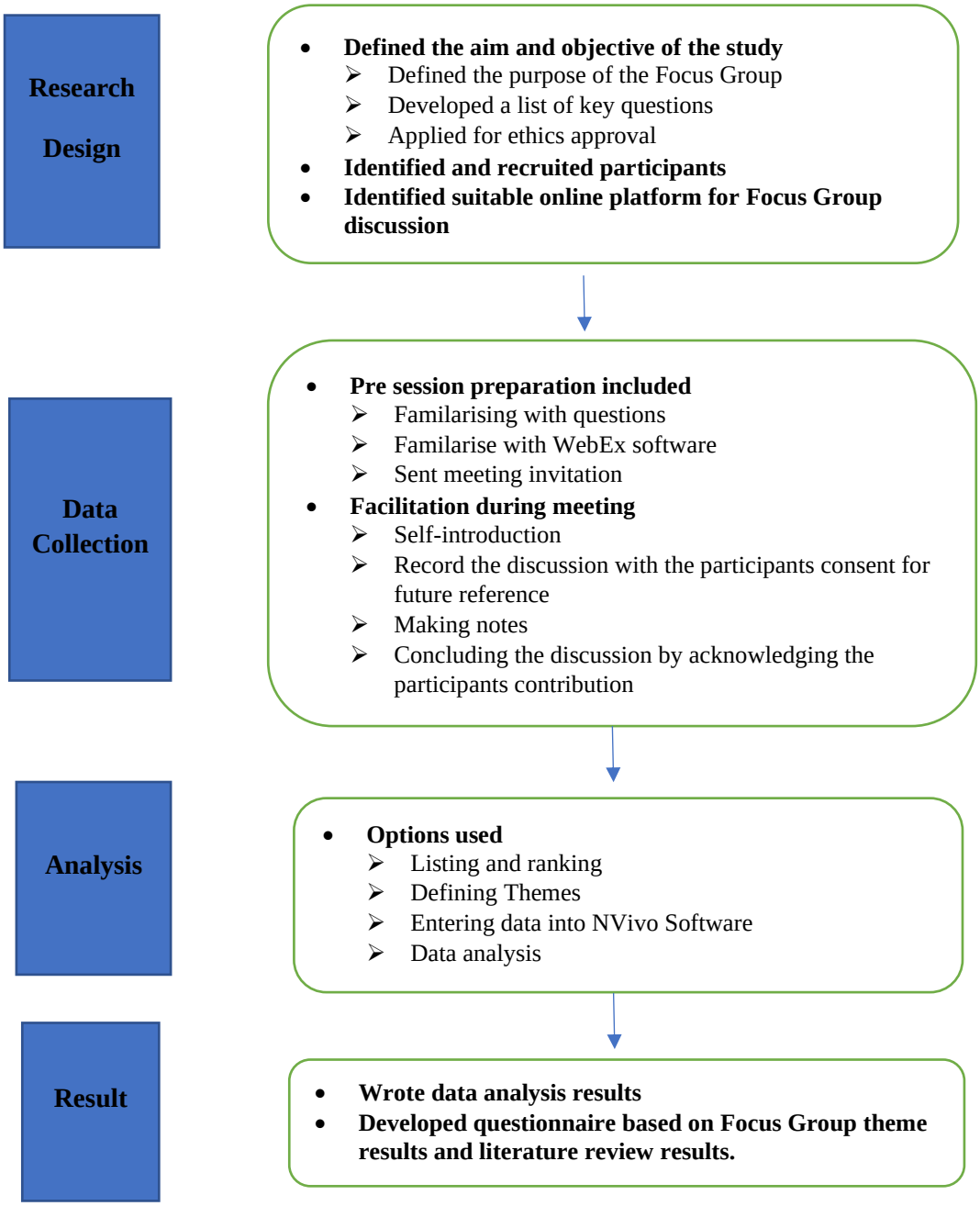
Both male and female participants participated in focus group discussion. The focus group discussions were conducted online through Webex with discussions on ergonomic factors that facilitated or hindered the provision of online teaching continued until participants felt that they had told their stories, and no new themes were emerging (Calder, 1977; Krueger, 1994;Mason, 2010). The researcher gathered information on the topic from published books, journals, news, conference papers, and another type of published sources but the knowledge gained from focus group discussion was more practical knowledge that came

from the real-life experiences of the focus groups' participants as they have experience in online teaching (Doddy & Noonan, 2013).

The focus group discussion involved four major steps. (1) research design, (2) data collection, (3) analysis and (4) reporting of results (Morgan et al., 1998). The Figure 5, below, represents the methodology followed for analysing the Focus group data.

Figure 5

Flow chart of focus group Methodology



3.6.5. Focus Groups Data Analysis Method

Descriptive statistics of number and percent were used to analyse focus group question one that asked for participants' employment position, type of employment, number, and type of units of study that they taught online. For questions 2 to 15 a qualitative analysis was performed using an Interpretative Phenomenological thematic data analysis approach to analyse the information provided by focus group participants. An Interpretive Phenomenological Analysis is a qualitative approach that aims to "make meaning out of lived experiences" (Philipsen et al., 2019, p. 46) and the meanings that participants attach to these experiences (Tutleman et al., 2019).

The results of the Focus Group analysis assisted in developing the questions that were included in the questionnaire to answer the research objectives. The analysis enabled the quantitative variables to be contextualised (Creswell, 2014). The Qualitative data analysis approach is commonly used to gain an in-depth understanding of the subject. This approach aims to gain information from a deliberately selected group of individuals rather than from a statistically delegated section of a wider population.

3.6.5.1. Interpretive Phenomenological thematic data analysis

The Focus Group interview results were analysed using the Interpretive Phenomenological thematic data analysis (IPA) to determine the objectives of the research. This approach helps to outline the ergonomic factors that contribute to facilitate and/or hinder the effectiveness of online teaching in mining and mineral subjects and other subjects. IPA is dedicated to the systematic evaluation of personal experience (Tomkins, 2017). The objective of this approach is to understand individuals' experiences, which can be considered as the "main currency" of IPA research (Smith & Osborn, 2015). There are several approaches available for conducting qualitative analysis, namely Qualitative content analysis, Narrative analysis, Discourse analysis, Thematic analysis, Grounded theory (GT), and Interpretative phenomenological analysis (IPA). The researcher chose to use the most common IPA approach. Smith et al. (2009) stated that "IPA is a qualitative research approach committed to the examination of how people make sense of their major life experiences" (p. 1). Additionally, they highlighted that "IPA shares the views that human beings are sense-making creatures, and therefore the accounts which participants provide will reflect their attempts to make sense of their experience" (p. 4). IPA is the best

method to use to analyse the detailed experience of each participant to provide the most information about the field of study (Smith et al., 2009). The researcher chose IPA over other qualitative analysis approaches, as IPA has a dual focus on the unique characteristics of individual participants (an idiographic focus) and on modelling of meaning across participants. The pre-analysis followed the six-step approach to substantial analysis: (Smith et al., 2009).

After reviewing the nature and quality of the data collected through the Focus Group discussion the researcher used an interpretative phenomenological approach to analyse the information provided by Focus Group participants. Holloway and Jefferson (2000) stated that a clear understanding of the subject matter can be developed by hearing a story and the content of the story. In this focus group discussion, the participant educators discussed their experiences with online teaching. All the experiences were then compared with each other by the researcher, to enhance the overall understanding of the subject matter. The semi-structured data were analysed using Braun and Clark's six steps, as explained below (Braun & Clark, 2006):

Step 1. Transcript data familiarisation

Transcribing all the information gathered from the interview data, into a written document can be considered as the first step of familiarising the researcher with the data (Riessman, 1993). The researcher then read and re-read the data to obtain a better understanding and create the meanings of the answers given by the participants rather than simply writing all the answers or sounds spoken mechanically on paper (Lapadat & Lindsay, 1999). This can be referred to as "a key phase of data analysis within interpretative qualitative methodology" (Bird, 2005, p. 227). The accuracy of the transcribed document was checked and approved by the respective participants.

Step 2. Data coding

After transcribing the data, the researcher drafted an initial list of the emerging themes/codes from the transcribed interview data set. Codes were defined as "the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Boyatzis, 1998, p. 63). The researcher was able to organise the interview data into meaningful groups (Tuckett, 2005) by completing

the coding process as a part of the analysis (Miles & Huberman, 1994). In NVivo 12, the classified descriptions are assigned a code called ‘nodes.’

Step 3. Developing emergent themes.

In this step, the researcher re-focused on the analysis in the broader level of themes, by sorting different codes into potentially relevant themes and collating all the data extracts in the relevant identified themes. The visualisation tools such as word cloud or word frequency provide brief overview of the themes. Which enables the researcher a chance to think about the link and relationship between codes and subsequent themes.

Step 4. Reviewing themes and searching for connections across emergent themes.

All the themes were reviewed and if required some themes were redefined, merged and or more themes, or sub-themes were introduced. These changes were performed to achieve the best outcomes of this research by achieving the research aim and objectives.

Step 5. Defining and naming themes and moving to the next case.

Here, the researcher conducted a detailed analysis for each theme and sub-themes. The analysed themes from the participants were used to adopt the themes for subsequent participants. All the outcomes were documented and NVivo software was used to analyse the data.

Step 6. Producing the report.

All the outcomes of the detailed in-depth analysis were written as a report and used for developing the research questionnaire. Presenting a comprehensible and logical story emerging from the data and the themes was the main objective of this section. Braun & Clarke (2006), stated that, the report must be prepared in a way that can convince the readers about the quality and ability of analysis (Braun & Clarke, 2006). The traditional form of reporting was implemented, where the comments received from the participants were quoted to give more insight.

3.7. PHASE 2

3.7.1. Questionnaire Development

Study questions were developed based on the findings of a comprehensive literature review on ergonomic effects on educators in online teaching platform and the results derived from focus group analysis. The comprehensive literature review helped to generate content validity. Questions were then constructed and uploaded to Qualtrics. These questionnaires were then sent to some Curtin University educators who teach online for the pilot study. No new themes emerged from the pilot study, so no amendments were made to the survey questionnaire. A copy of the questionnaire is attached as Appendix 8.

There were total of 101 questions, the questionnaire was divided into four parts as shown below:

1. Demographic questions - Fixed response • Yes / No • Comment
2. Likert Scale questions- Rank ordering • Agree / Disagree
3. Five Ergonomic factors related questions- Yes / No • Comment • Open ended.
4. Open ended questions

3.7.1.1. Demographic Questions

Demographic data are regularly collected by researchers to describe the sample population in their studies. These data are generally reported in narrative or table format, with frequencies used in quantitative and qualitative or mixed method analysis. Demography is an area of research where researchers investigate the measurable statistics of a distinct population (Vogt & Johnson, 2011). Statistics are used to detect subsections of the respondents and differentiate them at a specific factor (Connelly, 2013). In experimental research, demographics provides additional intention of permitting the comparison of the control group with the variable group. Finding differences between control and variable groups, the groups required to be similar before execution of the intervention (Furler et al., 2012). Demographic information included gender, age, employment position and type, length of time teaching, length of time teaching online, and units of study taught online. There were 21 questions in the demographic section, consisting with 7 multiple choice questions, 3 open ended, 7 ‘yes/no’ with 4 having an option to ‘provide comment’ to help researcher to obtain more in-depth information on that matter.

3.7.1.2. Likert Scale questions

Likert scales are frequently used to measure approach, providing "a range of responses to a given question or statement" (Cohen et al., 2000, p. 254). Normally, there are five categories of answers, from, for example, 1= strongly agree to 5 = strongly disagree, although there are disagreements in preference of scales with seven points, or with an even number of response categories (Jamieson, 2004). In this study there were 47 questions that needed to be answered using a five-point Likert scale that varied from strongly agree to strongly disagree. For educators that were supervising research students studying online there were a further 3 questions.

3.7.1.3. Five Ergonomic factors related questions.

Physical ergonomic factors related questionnaire comprised a total of 8 questions. Six of the questions were divided into 16 sub-questions with options for providing comments which help the researcher to get more in-depth knowledge. There were 2 were open ended questions. The first asked what physical ergonomic factors help make online teaching work comfortable. The second asked if there were any other physical ergonomic factors that affected the participant's online teaching work. This question was asked to capture any physical ergonomic factors that had not been included in the questions above.

Environmental ergonomic factors related questionnaire comprised a total of 8 questions. Six of the questions were divided into 13 sub-questions with options for providing comments which help the researcher to get more in-depth knowledge. This section ended with the open-ended question "are there any other environmental ergonomic factors that affect your online teaching?".

A total of 7 questions related to organisational ergonomic factors, including 2 questions with 8 sub questions and another 5 which were answerable with yes/ no, with an option to provide comments. This section ended with the open-ended question "are there any other organisational ergonomic factors that affect your online teaching?".

A total of 8 questions related to cognitive ergonomic factors, which could be answered with yes or no and provided space for participants to include comments if they wanted to

add further information. This section had one open ended question which asked, “are there any other cognitive ergonomic factors that affect your online teaching?”.

A total of 9 questions related to social ergonomic factors, which could be answered with yes or no and that provided space for participants to include comments if they wanted to provide further information. This section had one open ended question which asked, “are there any other social ergonomic factors that affect your online teaching?”.

The next question in this section asked participants to rank the ergonomic factors in order of importance for providing safe, healthy, effective online teaching to see which ergonomic factor participants thought was most important for them. The last section of the Questionnaire had 7 open ended questions (questions 95 -101) that asked participants to describe their experiences in online teaching.

3.8. Phase 3

3.8.1. Pilot Study

The questionnaire was tested with 5 pilot study participants as a trial of the data collection tool to identify the practicality and usability of the questionnaire and to determine if any changes were required to improve the questionnaire reliability, face validity or understandable ability by the target population prior to conducting the full study (Schachtebeck et al., 2018; Smith, 2015) in a form of pilot study.

Pilot study questionnaire answers were analysed for reliability using Chronbach’s Alpha with a value of 0.8 demonstrating questionnaire reliability. A pilot study helps to identify possible flaws in the questionnaire by pre-testing it on a small number of participants with the same professional background as those in the main study. According to Ahmad and Sabri (2015) and Dikko (2016) a pilot study also helps to identify vague or confusing statements in the research questions which might not be fully understood by the interviewees. Van Wijk and Harrison (2013) consider that pilot studies can add validity and credibility to the entire research design. Basically, a pilot study helps to determine the reliability of the research questionnaire for the actual study by detecting potential problems that may need to be adjusted (Dikko, 2016). The item-total correlation was used to identify items with poor internal reliability to help eliminate questions to maintain a parsimonious

scale. According to the feedback received from the pilot study participants any necessary changes were made to ensure questionnaire usability, understandability, validity, and reliability before the questionnaire was used for the main study to collect both quantitative and qualitative data. There was no negative feedback received from any participants of pilot study group, so no amendments were made. The Pilot Study data analysis assisted checking whether the questions provided answers to the research objectives and demonstrated an amount of time required for the participants to complete the online survey.

3.8.2. Study Population

3.8.2.1. Focus Group study population.

The four focus group discussions were performed through Webex with online educators at one Australian university. The 1st two focus groups participants were the experienced educators who had conducted online teaching for three or more years. The 2nd Focus Groups participants were the educators who had conducted online teaching for less than three years. All four focus groups included male and female educators.

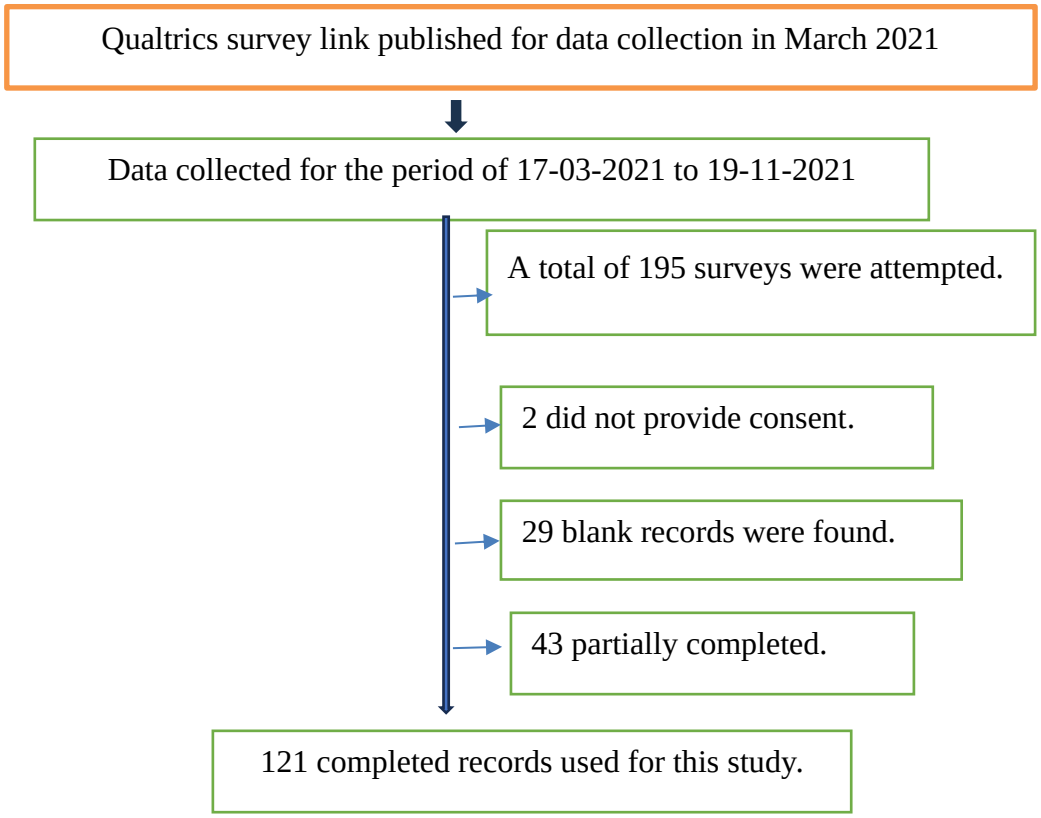
Based on the analysis of the Focus Group results a set of questions were developed for the pilot study. The questionnaire was then evaluated by two experts in minerals and mining engineering online education, one expert in online teaching from the Western Australian School of Mines: Minerals, Energy and Chemical Engineering and one expert in ergonomics from the Human Factor and Ergonomic Society of Australia. All the necessary changes were made to improve face or content validity. The questionnaire was then pilot study tested with 5 participants who taught at an Australian university.

3.8.2.2. Questionnaire study recruitment and population.

The survey of educators for both online and traditional face-to-face teaching were selected randomly by sending the online questionnaire link through email to the tertiary educators worldwide. The questionnaire was made available through Qualtrics. The questionnaire study population were Australian university staff and online teaching, tertiary educators from other parts of world.

A total 121 responses were used of which 62 were from Australian States including Western Australia, Queensland, New South Wales, Victoria, and South Australia. There were 34 responses received from India and the remaining 25 responses were from the United States of America, Croatia, Ghana, China, Singapore, Lebanon, Czech Republic, Slovakia, Taiwan, and Iran.

Figure 6
Flow chart of survey responses



3.9. Phase 4

3.9.1. Quantitative Approach

Quantitative data were collected to answer research objectives 3 and 4 i.e., the causal relationship of five ergonomic factors with subjects taught (engineering vs non-engineering) and with the online teaching experience as this required the use of inferential statistics.

3.9.1.1. Quantitative data analysis

Inadequately prepared data can jeopardise the statistical analysis and ultimately, the interpretation of results. Thus, the results derived from the analysis depends on the comprehensiveness of survey questionnaires, reliability, and proper coding. In this instance, the comprehensiveness and discrepancy of each question was checked while preparing the questionnaire. Questionnaires that were incomplete or wrongly completed were discarded. The dataset was imported directly to an Excel file from Qualtrics, then manually entered into a Statistical Package for the Social Sciences (SPSS), Version 29 for statistical analysis.

3.9.1.2. Statistical analyses utilised

Both descriptive and logistic regression analyses were used to analyse the quantitative analysis.

3.9.1.3. Descriptive statistics

Descriptive statistics of number and percent were used to analyse the demographic information and the yes, and no answers related to the five ergonomic factors. Chi-squared tests was performed to determine associations between the categorical demographic and experience variables (teaching-focused/teaching and research staff; staff with ongoing employment/fixed-term/casual; male/female/other gender; taught online for less than three years/three or more years) and ergonomic factors (cognitive/physical/ environmental/social/organisational) that impacted university educators when conducting online education.

Logistic regression analysis

Descriptive statistics analysis only illustrates the data without determining the relationships between response variable(s) and explanatory variable(s), the logistic regression analysis was used by the researcher to deal with probability outcomes. A Chi-square test was used to determine if two means were significantly different and one-way Analysis of Variants was used to determine if there was a difference in the population mean for a variety of similar categories (Seltman, 2018). A binary regression analysis was performed to predict the value of two or more variables (predictors). Logistic regression was used for

dichotomous variables to determine the relationship. Structural equation modelling was conducted to identify the causal relationships of the five factors to the experience of online teaching. Logistic model, is the fundamental mathematical concept that inspires the logistic regression model, also known as natural logarithm of odds ratios (Peng et al., 2002). Explanatory variables and the dichotomous outcome variable can be linked with logit transformation.

Odd ratios

In logistic regression, the Odds ratio (OR) is used to determine the relationship between the response and explanatory variable (s) (Sauerbrei & Blettner, 2009; Szumilas, 2010), which is broadly used in epidemiological studies as a measure of association. Commonly, simple 2 x 2 tables can be used for dichotomous explanatory variable to identify the odds of an incident's occurrence, ORs.

3.9.2. Data analysis procedure

Data for the questionnaire analysis was downloaded from Qualtrics through Excel and SPSS Version 29 statistical software program with built-in functions for executing both descriptive statistic and inferential statistics. There were three main components to the convergent parallel approach used to analyse the questionnaire data. The first component involved analysing quantitative data to generate descriptive statistics and inferential statistics. The experiences of online educators provided interpretive data from multiple cases, which were analysed through joint displays. The final component constructed meta-inferences by cross-referencing and comparing data.

For the focus group data analysis, the questionnaire qualitative data was analysed through an interpretive phenomenological thematic analysis conducted using NVivo 12. Analysing the qualitative data by using NVivo 12 software improved the reliability and validity of the qualitative data analysis as the Most Frequent Word Queries used when analysing the results assisted with discovering the research results themes through using the node classification process to compare the correlations and similarities (Clarke & Braun, 2013; Smith, 2015). All the demographic questions i.e., question 3 to question 24 and the questions related to five ergonomic factors i.e., question 28 to question 92, the ranking question 93 and rest 6 open ended questions (question 95 to question 100) were analysed

qualitatively. While the Yes/No part of all demographic and ergonomic factor related questions were also analysed quantitatively. Both the results of qualitative and quantitative analysis were then compared to obtain comprehensive information.

3.10. Validity and Reliability

3.10.1. Introduction

According to Leininger (1985), validity "refers to gaining knowledge and understanding of the true nature of a particular phenomenon and reliability focuses on identifying and documenting recurrent, accurate and consistent or inconsistent factors" (p. 68). Validity basically means to be able to measure what was intended to be measured (Field, 2013). Validity helps to identify the relevance of the collected data with the research aim and questions (Ghauri & Gronhaug, 2005). Main types of validity are face validity, content validity, construct validity, criterion validity, internal validity, and reliability (Taherdoost, 2016).

3.10.2. Face validity

Face validity implies to researchers' individual evaluations of the data and significance of the evaluating tool, to determine whether the item in the tool seems to be appropriate, realistic, explicit, and clear (Oluwatayo, 2012). The answers to demographic questions such as questions regarding age, gender, employment type, etc. have face validity as the answers to these questions are not open for interpretation.

3.10.3. Content validity

Content validity is defined as "the degree to which items in an instrument reflect the content universe to which the instrument will be generalised" (Taherdoost, 2016, p. 30). An extensive review of published literature was performed to develop an interview questionnaire to ensure the content validity. These questions were targeted to research the five ergonomic factors related to academics with online teaching responsibilities. As new research tool it was important to have experts on the research subject to review the research tool to ensure content validity. The questionnaire that was developed was evaluated by two experts in minerals and mining engineering online education, one expert in online teaching from the Western Australian School of Mines: Minerals, Energy and Chemical Engineering

and one expert in ergonomics from the Human Factor and Ergonomic Society of Australia. Having experts agree that the questionnaire was accurate gave the questionnaire *content validity.*

3.10.4. Criterion validity

Criterion validity can be defined as "a method of test validation that examines the extent to which scores on an inventory or scale correlate with external, non-test criteria" (Cohen & Swerdlik, 2005, as cited by Piedmont, 2014, p. 57). If there is a high correlation, (similar score), between the tools used in the research and previously used research tools that have demonstrated a high face validity, then the research tool used has criterion validity. This is the validity of the research tool to measure and predict. It may be determined by comparing the results of the research tool tested in the pilot study with the results of a test of known validity (Jansz et al., 2018). The criterion validity was validated by comparing the research tools used for this research with the questionnaire and checklist used for determining the effect of ergonomic factors on online students (Jansz et al., 2018).

3.10.5. Concurrent validity

This is the ability of the research tool, or research design, to measure present observable behaviour. It is assessed by the correlation of a behaviour being measured to objective data available at the same point in time. As no observations were taken in this study it was not appropriate to determine concurrent validity.

3.10.6. Internal validity

Internal validity is defined as "the extent to which the observed results represent the truth in the population we are studying and, thus, are not due to methodological errors" (Patino & Ferreira, 2018, p. 183). Leininger (1985) stated that the aim of any research is to identify the cause of the consequence and internal validity is needed to identify the cause of the results. The researcher followed the following steps to maximise validity that included (Bickman & Rog, 2009):

- A detailed interview questionnaire was created to collect rich and relevant data in form of answers to the questions.

- A test of conflicting explanation was performed to find any evidence of discrepancy or negative case.
- The results then compared across different settings, peoples, and events.

3.10.7. Factor analysis

A factor analysis identifies inherent variables or factors that explain a pattern of correlations within a set of studied variables. According to Tabladillo and Canfield (1994), the factor analysis is a powerful statistical tool for the validation of employee surveys. A varimax (orthogonal) rotation was used to acquire an interpretable factor matrix. The Bartlet test of sphericity and the Kaiser Meyer-Olkin measure of sampling adequacy were used to validate the factor analysis (Tan et al., 1999). The factor analysis performed on the respondents' answers for the Likert scale section of the questionnaire produced the factors shown in the following table 15. The 50 Likert scale questions were reduced to a smaller set of 5 factors that accounted for most of the variance among the items.

Table 15
Factor Analysis.

Factors	Kaiser-Meyer-Olkin Measure	Bartlett Test of Sphericity	P-value
Online teaching facilitating factors	0.83	595	<0.001
Cognitive Ergonomic Factors	0.82	624	<0.001
Organisational Ergonomic Factors	0.81	328	<0.001
Physical and Environmental Ergonomic Factors	0.74	115	<0.001
Social Ergonomic Factors	0.65	103	<0.001

Factor analysis was shown to be appropriate by the Bartlett Test of Sphericity, which in all cases was less than $p = 0.01$. The factor analysis was also satisfactory according to the Kaiser-Meyer-Olkin measure that was above 0.7 in all cases except for social ergonomic factors (Usukhbayar & Choi, 2020). This item is therefore treated separately rather than as a factor, or factors.

3.10.8. Reliability

Reliability can be defined as a measure of the accuracy and repeatability of the data collected. It affects the magnitude to which a measurement of an occurrence offers steady and coherent result (Carmines & Zeller, 1979). In this research, all focus group participants were asked previously prepared standard set of questions based on the findings of the reviewed published literature. Reliability was enhanced by performing the pilot study. All the qualitative data was analysed with the NVivo 12 software for this research. Comparing the node classification and 'Most Frequent Word Queries' for similarity enabled the researcher to provide good correlation, ensuring data interpretation reliability. The research supervisors who were not involved in data collection process checked the coding of the themes created by the researcher as independent reviewers to ensure internal reliability.

Rational equivalence reliability for the questionnaire was assessed through using Cronbach's Alpha that is a measure of reliability (Taber, 2018). Cronbach's alpha, is the most common test score reliability coefficient for single administration (i.e., the reliability of persons over items holding occasion fixed) (Cho, 2016). Cronbach's alpha is a measure of internal consistency, which mean, the measure of closeness within interrelated set of items reported as a group. It is a measure of scale reliability. Cronbach's alpha is a coefficient of reliability (or consistency). The formula used for calculating the Cronbach's alpha, shown below-

$$\propto = \frac{n}{n-1}\left(\sigma^2 x - \sum_{i=1}^{n} \sigma^2 i\right) / \sigma^2 x$$

where n is the number of items, $\sigma^2 x$ is the total test score variance, and $\sigma^2 i$ is the item variance (Miller, 2010).

The formula shows that if increasing the number of items, the value of Cronbach's alpha will also increase. Also, if the average inter-item correlation is low, alpha will be low. Once the average inter-item correlation increases, the value of Cronbach's alpha also increases (keeping the number of items constant). Cronbach's alpha estimates the

proportion of responses due to common factors. The alpha value is calculated through the analysis of a diagonal matrix of correlations between measurement variables. According to Bland & Altman (1997), Cronbach's alpha values between 0.70 – 0.80 are considered to have a satisfactory level of construct validity. The Cronbach's alpha score of the Likert scale questionnaire was 0.91, for dichromat questions focused on ergonomic factors the score was 0.72 for the ranking questions the score was 0.75 which supports the reliability and construct validity of the questionnaire.

The Cronbach's alpha coefficients were calculated to determine the intercorrelation of the items for all ergonomic factors i.e., Physical and Environmental, Organisational, Cognitive and Social ergonomic factors. The scores were contained by adding the points of individual items then the 90th percentiles of the scores were computed for each factor which were used as threshold values. Lower values were found when analysing parts of the questionnaire that included cognitive ergonomic factors (0.85), organisational ergonomic factors (0.81). Moderated values were found for physical and environmental ergonomic factors (0.75) and the lowest value was found for social ergonomic factors (0.64). When using Cronbach's Alpha, the reliability of the questionnaire respondents' answers is improved when a large number of items are included in the analysis (Vaske et al., 2017) and small parts of the questionnaire therefore included a lower reliability score.

3.11. Ethical considerations

This research was conducted according to the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. Ethics approval from the Curtin University Ethics Committee was obtained prior to the commencement of data collection for this research. Ethics approval number for this research was HRE2020-0585. The purpose of the study was clearly explained so that participants understood their role, and that they had a correct belief regarding their participation and research outcomes. All focus group and questionnaire responses were anonymous, and participation was voluntary. Consent was obtained before data collection from each person who volunteers to take part in this research. To maintain confidentiality the data collected did not include any identifying name, and research results were reported as group data or anonymously. All research participants had the right to refuse to answer any question or withdraw consent at any point, except for participants answering the online

questionnaire who could only withdraw up to the point of submission of the online questionnaire as all submitted responses were anonymous. The researcher did not ask any questions that could harm the participants either mentally or emotionally. This research was conducted ensuring the principle of avoidance of harm and maintaining confidentiality (Appendix 10).

3.12. Summary

This chapter has described the research methodology, questionnaire development, research participants, data analysis methods and ethical considerations. The following chapter describes the results of focus group part of the study.

4. FOCUS GROUP DATA ANALYSIS, RESULTS AND DISCUSSION

4.1. Introduction

This chapter reports on and discusses the results of the Focus Group analysis. The purpose of the Focus Group was to gather information to achieve the research aim and objectives. In conjunction with the review of published literature, the Focus Group results were used to construct a questionnaire to provide answers from a larger population to identify and assess ergonomic factors that affect educators' experience with online teaching.

Focus group discussions were organised with three participants in each group due to the difficulty of getting all the participants at the same time in a busy university semester. All the participants were educators from one University who taught online. The meetings were conducted virtually through the Web-ex system. NVivo software was used to create nodes, sub-node themes, and word clouds to be able to analyse the answers to the Focus group questions. Quotes from the focus group participants were included to highlight specific important information related to the research topic. The participants were de-identified with numbers to maintain confidentiality. The chapter continues with the description of focus group discussion data analysis.

4.2. Focus Group Data Analysis

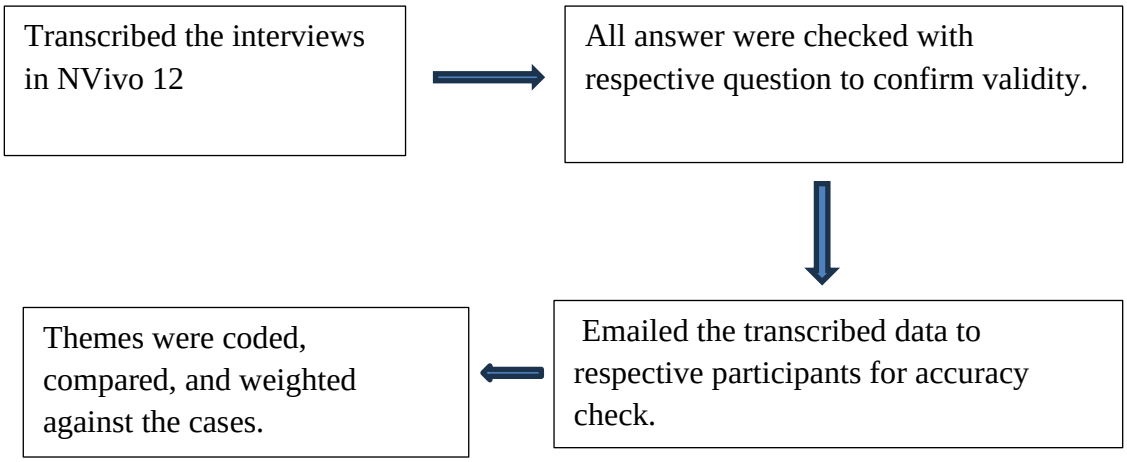
4.2.1. Focus Group Data Analysis Procedures

Data analysis involved transcribing participants' perspectives with the analysis of the qualitative content. The qualitative analysis was associated with the participants' significant expression of their experience with online teaching, (Miles & Huberman, 1994). Qualitative analysis was performed by data coding, dividing all raw data into groups containing phrases, sentences, and/or paragraphs, assigning a code to each group and finally grouping all the codes into themes (Creswell et al., 2011).

4.2.1.1. Data Coding

After completion of a focus group interview and written submissions were collected from individual participants, the following steps were executed (Figure 7):

Figure 7
Data Coding procedures



4.2.1.2. Interview Narration

A narrative analysis was performed from the experience gained from the discussions in the interviews. Listening to participants' discussions carefully helped the researcher to create a clear understanding of the individuals' points of view (Holloway & Jefferson, 2000). Participants discussed their experiences, both positive and negative, in an online teaching platform, which helped to enhance the understanding of the subject matter.

4.3. Focus Group Participants' Interview Responses

4.3.1. Demographic information

The Focus groups 1 and 2 participants were more experienced, i.e., they had more than 3 years' experience in online teaching platforms. FGP3 (Focus group participants) and FGP4 were less experienced, i.e., they had less than 3 years of experience using online teaching platforms. To determine the demographic profile of the participants, descriptive statistics were used. All the details of the participants demographic factors were listed in table 16.

Table 16
Focus Group Demographic details

	Online Teaching Experience			
	More than 3 Years		***Less than 3 Years***	
	Number	***Percentage***	***Number***	***Percentage***
Gender				
Female	*3*	*50%*	*0*	*0*
Male	*3*	*50%*	*6*	*100%*
Employment Type				
Ongoing Permanent	*5*	*83%*	*4*	*67%*
Sessional	*1*	*17%*	*0*	*0*
Fixed Term Contract	*0*	*0*	*2*	*33%*
Types of units taught				
Education	*1*	*17%*	*0*	
Health and safety	*1*	*17%*	*0*	
Bioscience and clinical practice	*1*	*17%*	*0*	
Engineering	*3*	50%	*6*	100%

The results show that there were equal numbers of male and female participants in the experienced, online teaching educators, while all the participants from the less experienced group were all male and had begun online teaching when the COVID-19 lock down restrictions commenced in March 2020. For employment status 10 participants from both experienced and inexperienced group had 'ongoing permanent employment'. One of the experienced focus group participants was a 'Sessional' staff member with more than 10 years of online teaching experience. Two inexperienced educators were fixed term contract employee. All the inexperienced online teaching educators and half of the educators with more than 3 years of online teaching experience (75%) were teaching engineering subjects.

The thematic analysis of qualitative interview data revealed sixteen main themes, which are presented in the following section. The verbatim quotes taken from the participants' transcripts were presented to support the emergent key themes or sub-themes, denoted with the code FGP (Focus Group Participant) and followed by the transcript number.

4.3.2. Online Teaching Related Information

4.3.2.1. The most and least engaging factors for the educators in online teaching platform

Most engaging factors

This question helped to reveal the positive and negative factors that helped to engage the focus group participant educators in an online teaching environment. The question was formulated with the intention of answering research objective 1, which addresses the ergonomic factors that are perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering. Both experienced and inexperienced educators identified 'flexibility', 'no travel time', and 'receiving and providing feedback as the most engaging factor in online teaching platform. While 'IT support' and 'availability of new technological tools' was identified as engaging factors by the experienced educators. 'Ability to have live sessions', 'Screen Sharing', 'Discussion Boards', 'Online students group', and 'Better for overseas student' were the engaging factors identified by the inexperienced educators.

An experienced online educator described how she felt at the time of shifting from face-to-face teaching to teaching online. (FGP2)

> *Started teaching online approximately 20 years ago. At first did not like the concept of online teaching very much, preferred face-to-face traditional teaching as in online teaching physical interaction was missing and I felt it was important. Then for about 5 years, there used to be two versions of all the classes, i.e., one was traditional face-to-face, and the other was online. Same course materials and assessments were used for both versions, but the pedagogy was entirely different. Gradually online courses got more acceptance and the platforms and support improved dramatically. At first for online courses all the printed course materials used to be sent to the students, there was no visual contact opportunity available. Over the last 10 years, the online education platform has improved dramatically with the availability of various interactive platforms including Blackboard and Internet. The online education platform has become incredibly streamlined. We started getting lots of support from the IT staff of the university. Support mechanisms got better with the availability of more collaboration options. Still personally prefers traditional face-to-face classes instead of online versions though accept the inevitable and like to be able to do all my teaching from home with no travel.*

There are role changes and other challenges are faced by the teachers during the transition from face-to-face teaching to teaching in the online platform (Coppola et al., 2002;

McShane, 2004). Researchers have attempted to identify the new skills and roles of online educators (Anderson et al., 2001; Berge & Collins, 2000; Goodyear et al., 2001; Graham et al., 2001; Guasch et al., 2010) and the change of role of the educator during the change from face-to-face teaching to online teaching (Conceição, 2006; Coppola et al., 2002; Major, 2010). Using Word Frequency queries, the word cloud (Figure 8) identified 'flexibility', 'support', 'engaged', 'interact', as the most frequent word used by the Focus Group participants (FGP).

Figure 8
Most engaging factors for online educators

Here 'flexibility' represents the flexibility of time of attending class, the flexibility of place of attending class (FGP4), the flexibility of arranging extra class, the flexibility of revisit lectures as many times as required, and others. 'Support' represents the support from the Information Technology (IT) staff of the university and overall support mechanism in online teaching platform. 'Engaged' represents the level of engagement of the student, keeping students engaged throughout the online class duration, etc.

A comment made by an experienced educator FGP4, supported flexibility as an engaging factor in online teaching:

> *The flexibility of availability of the courses for the students living in other countries, level of engagement, topic, receiving feedback from students, replying to the questions of the students makes me feel more engaged.*

The trend of choosing online study within Australian higher education is increasing (Canty et al., 2020). The online student cohort is considerably different in comparison with the on-campus student cohort, having more mature-aged, with paid employment students, having career responsibilities and/or having responsibilities towards children or aging parents. Pre COVID-19 students studying online were "older with responsibilities of family and work" (Stone et al., 2016, p. 163; Hewson, 2018; O'Shea, Stone & Delahunty, 2015; Ragusa & Crampton, 2018). A higher proportion of domestic online students are from rural, remote areas or other equity categories identified by the Australian Government such as background with low socio-economic status (SES), students with disability and Aboriginal and Torres Strait Islander (Indigenous) students (Stone, 2017). Another major portion of online students were international students studying from overseas. With government required lock downs almost all students studying at Australian universities had periods of time when they had to study online during 2020, 2021 and in 2022.

It was identified by Cars Guide Australia, that Australians spends an average of 4.5 hours commuting to and from work each week (ABC News, 2020). Stutzer and Frey (2004) documented that travelling involves more factors than just completing the distance between home and work as it not only requires time, but also incurs out of pocket costs, causes stress, and affects in the relationship between work and family. It appears that daily travelling generates a relatively high level of negative effects (Kahneman et al., 2004). The comment made by an inexperienced educator FGP8, supports the above.

> *These are the main engaging factors for me for online teaching. For example, you do not have to worry about the delay due to traffic or any other cause, so, you can be better prepared. You can also start classes through the phone while you are on your way. These are the main motivating factors for me. (FGP8)*

Least engaging factors

The least engaging factors mentioned by the experienced online educator participants were 'Missing physical interaction', 'Prefers face-to-face traditional teaching platform' and 'Collaborating with students.' While the educators with less than three years of online teaching experience did not mention any least engaging factors while teaching online.

The word cloud (figure 9) identified 'face', 'physical', 'interaction', 'prefers', 'misses' were the most frequent word used by the experienced Focus Group participants in an online

teaching environment. Here ‘face’ represents prefers face-to-face traditional teaching, ‘physical’ and ‘interaction’ stands for missing physical interaction. The word ‘Collaborating’ is having less opportunity of collaborating with students.

Figure 9
Least engaging factors for experienced FGPs

Some participants stated that online teaching is too computerised as eye contact, social feelings and physical interaction among teachers and students were lacking which supported by the comments received from FGP1. Their preference is to teach in an actual classroom atmosphere, and it was said that in-person teaching is better than online teaching. Lack of discipline was also observed, due to minimal teacher-student contact (Aziz et.al., 2020).

> *Prefer face-to-face teaching. In online teaching I miss collaborating with students and physical interaction. (FGP1)*

Though, with advanced technology, the virtual classroom simulates many features of a face-to-face teaching environment, still the teachers are unable to see the non-verbal cues of the students (Tremblay, 2006). According to some researchers, distance teaching in an online education environment can create experiences of isolation, dissatisfaction, monotony, overload, and low student course completion rates (Berge, 1999; Hara & Kling, 2001; Northrup, 2009). Carefully planning course content with emphasis on making students interact more (Moore, 1989), can help the students as well as the teachers to achieve the course learning goal. (Berge, 1999).

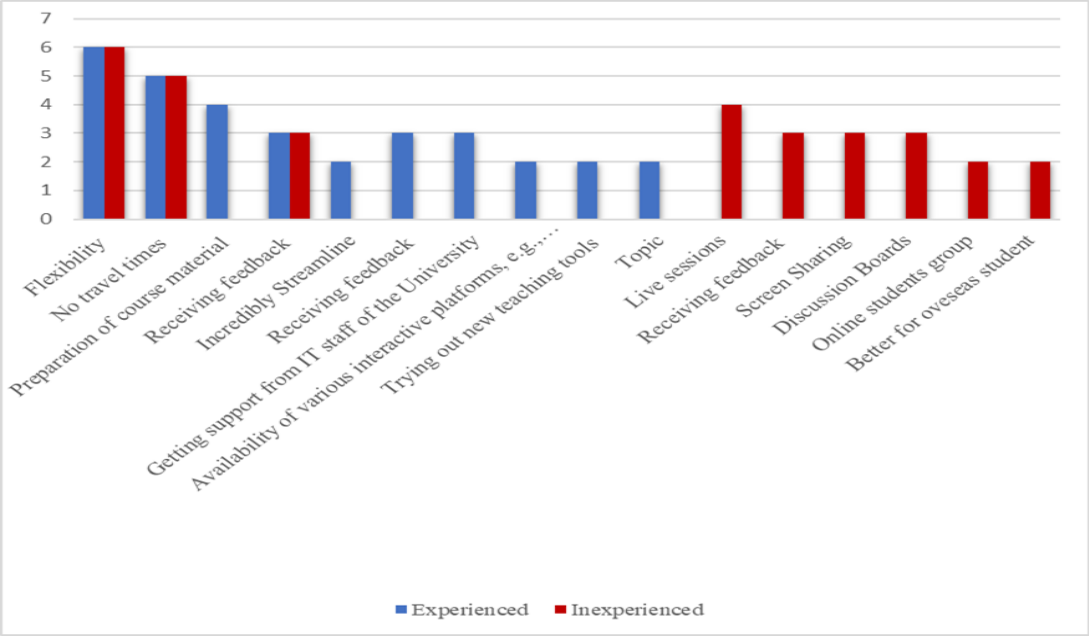
Comparison for most and least engaging factors between more and less experienced educators

Similarities- After carefully analysing the answers of both groups, the participants of both groups felt positive about the overall flexibility and having less or no travel time requirement when teaching online.

Differences- The more experienced online educators engaged themselves in preparing course material using new pedagogy, learning, and using new technologies, receiving queries, and providing feedback, etc. while the less experienced educators engaged themselves in live sessions, shared screens while solving any mathematical problem from scratch and forming online groups of students.

The least engaging factors for experienced online educators were missing physical interaction, missing traditional face-to-face class settings, missing collaborating with students. The less experienced educators did not comment on anything that negatively affected them with online teaching so seem to have adapted well. This may have been because they received a lot of support from the university IT department and from co-workers when commencing online teaching. For example, one university provided teaching academics with a week free from student contact to spend adapting face-to-face teaching materials to online teaching at the commencement of the first COVID 19 lockdown time. figure 10 shows the comparison of the most and least engaging factors of online teaching.

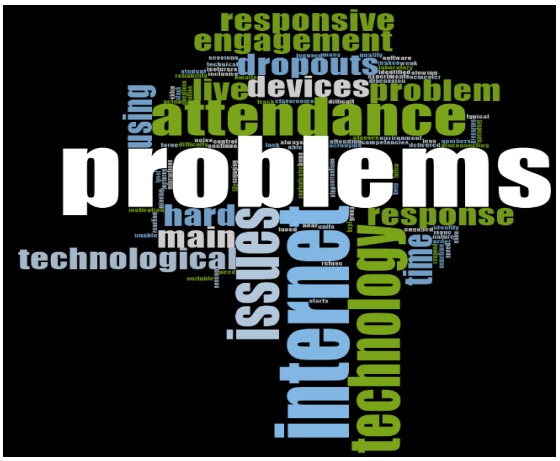
Figure 10
Most and least engaging factors between both FGPs group



4.3.2.2. Problems faced with teaching in an online environment.

Answers to this question helped to reveal the problems faced; in other words, the factors that act as a barrier to the online teaching. This question was formulated to answer research objective 2, which considers the ergonomic factors that are perceived by university educators to act as a barrier to online teaching for minerals and mining engineering. The experienced educators identified ‘problems with technology’, ‘problems with internet’, ‘no show or missing attendance’, ‘lack of motivation / engagement’, ‘visual interaction’, ‘noise due to working from shared office’ and ‘inadequate time’ as the main barriers faced with online teaching. Inexperienced educators also identified similar issues including ‘problems related to technology’, ‘lack of visual / physical interaction’, ‘time’, ‘attendance’ and ‘internet related issues’.

Figure 11
Problems faced by online educators.



The Word Frequency queries for experienced educators are displayed in figure 11. The word cloud identified 'technology', 'internet', 'attendance', 'interaction', and time. Here 'technological' stands for technology related issues.

FGP4, an experienced educator, gave insight into the issues with technology and FGP2 commented on the engaging issues facing by the educators while teaching online:

> *Usually, the main problems faced are about encountering problems with technology, internet dropouts or slowing down, hard to identify who is attending class as most of the time students does not use video. Unlike face-to-face teaching in an online environment, teachers are unable to see the students' reactions such as whether the student looks puzzled or needed help etc. Hard to identify who is attending class. Hard to identify what the students are taking in as they usually turn off the audio /video function. (FGP4)*

> *The main problem encountered is difficulty in engaging students. No show to class. Internet speed/dropout. Stuck with technological issues, etc. (FGP2)*

Consistent with the statements made by Wilson and Whitelock (1998) as the accessibility of information, assistance, and feedback plays a very big part in students' attendance in online education and, irrespective of how advanced the technology used for online teaching was, it appears that educators still face difficulties from the negative impact of lack of student engagement and technology as pointed out by FGP2. The disruption or denied accessibility due to technical problems, make the students feel frustrated, as their learning process gets hampered or discontinued. Vonderwell (2003), suggested that the key success factor in online education depends on the extent of communication between educators and

students, and that interruption or delayed communication due to technological issues may cause frustration and demotivation. FGP9, a less experienced educator, discussed the issues related to engagement and responses received from the students in online teaching environment.

> *Very weak engagement with the students and students are not always responsive if you ask questions. They do not respond so sometimes I stop teaching and refuse to continue until they respond to force them to be more responsive.*

FGP10 described his experience with technical problems.

> *Typical problems are technical in nature, e.g., students disconnecting from live sessions due to Internet issues or setup problems in classrooms/home office before the live session starts.*

The research performed by Palvia et. al. (2018) supports the comments of FGP10 of finding internet issues were a barrier in online teaching. Different countries face different types of problems. In Australia, Hillier (2018) identified the major bottleneck for the online platform is the lack of infrastructure particularly high bandwidth connectivity in remote locations, which can be improved by offering an offline processing capability for online educational platform. One model fits all strategy had not worked as different themes were originating from different countries. To be able to produce universal strategy which can be used by everyone, a combination of localisation, cultural diversity adjustments and technology which include the Learning Management System in the perspective of lack of availability of resources and infrastructure in some parts of the world is required (Palvia et al., 2018).

Comparison between More and Less experienced online educators

There were some common problems stated by both experienced and inexperienced educators and some issues the experienced educators talked about and some issues the inexperienced educators felt were problems in online teaching.

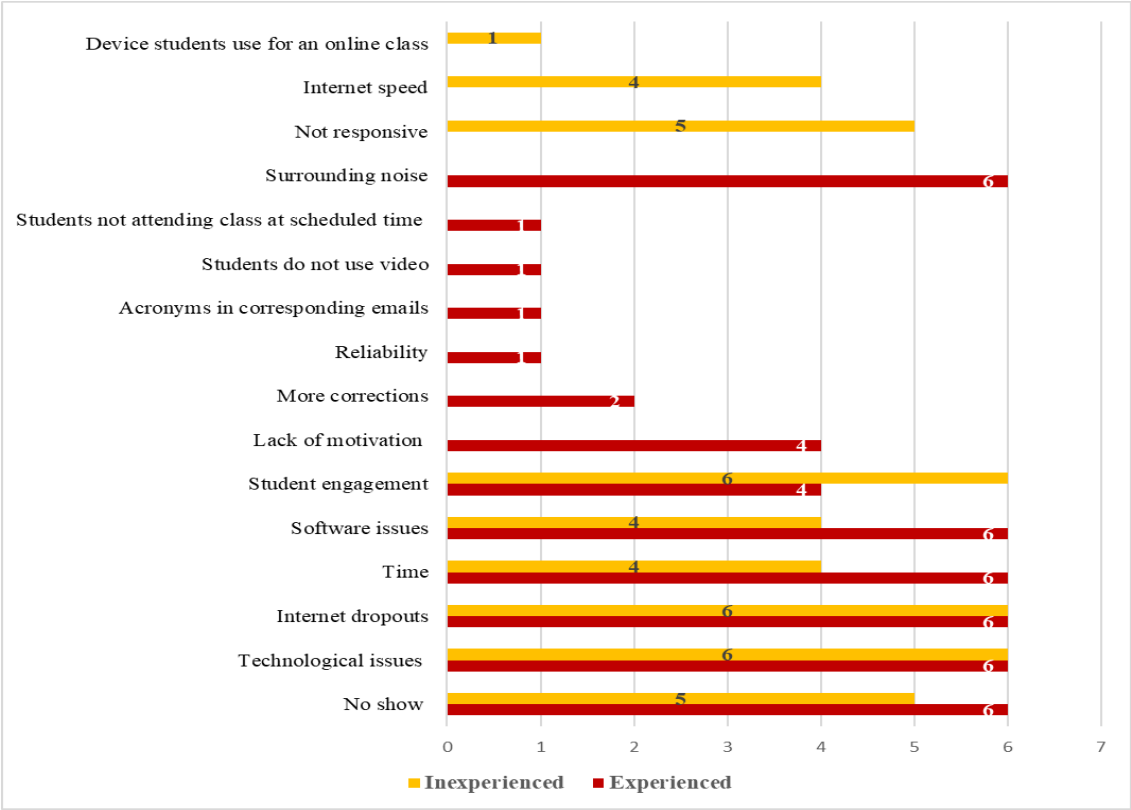
Similarities- Both groups declared that the main problems faced were 'Lack of interaction (physical/visual)', 'Missing attendance or No show', 'Technological issues', 'Internet issues/dropout,' etc.

Differences- The educators with more than 3 years online teaching experience stated that they encounter problems with 'surrounding noise' from shared office or corridors at university, or neighbourhood noise while working from home. When teaching online these

educators felt they had to do ‘more corrections’ than if teaching in a classroom. Another problem reported was that the students do not use videos while attending the online class resulting in educators being unable to connect with students as well as they do not see their facial expression or body language to understand the students’ level of understanding on that topic, which results in lack of motivation. Online class sizes could vary from a few participants to over 2,000 students so having all student on video may not be a practical option for large classes.

Educators with less than 3 years online teaching experience were more concerned with the non-responsiveness of the students while attending the online class. Educators also faced difficulties due to the devices used by the students as some software does not work with all computers. The types of issues faced by both experienced and inexperienced educators are shown in figure 12.

Figure 12
Problems faced by both FGPs groups



4.3.2.3. Software and technologies influence your online Teaching.

Positive influence of software and technology

According to most participant educators, overall, the available software and technology were good, flexible and user friendly. FGP2 teaches in two different universities within Australia, and she felt that the technology provided by one university is better than the other one.

> *Being a sessional academic in two different universities across Australia, meaning it was necessary to get experience in using two different software platforms. As I was involved in the Interact platform since the first trial, I developed my skills as the platform developed. I do prefer this platform; it is more intuitive. However, as the Learning Designers (not teaching staff) gradually take over the sense of ownership of one's subject is taken away by too much interference for 'efficiency'. The marking system for Interact suits me better as I can download all the assignments at one time, mark them then upload them all at once, but another one (Blackboard) does not allow to download all the assignments and it requires to mark online so track changes are clunky, and I do not find comment banks.*

Some students and educators were exposed to a technological era where they were overwhelmed with a selection of mobile technology and learning tools such as, iPads, computers, smartphones, interactive audio or videoconferencing, webcasts, instructional videos via CD-ROM or DVDs and computer-based systems communicated through the Internet (National Centre for Education Statistics, 2011). With the growth of these devices' instructors found new and innovative tools to stimulate teaching and learning for students with various educational requirements. Social media like Facebook, Twitter, Google Doc, Blogs could be used to improve teaching and learning in educational institutions through discussions, chats, group activities, and videos of lessons (Oladele et al., 2023). Often instructors were collaborating with each other, sometimes globally, to share their ideas and strategies for instruction, and presentation of lessons through virtual conferences, which helps to promote effectiveness in the teaching and student learning. Professional development helps the educators in the journey of transition from teaching in a classroom to teaching online (Palloff & Pratt, 2013).

The experienced FGPs identified nine positive influences which helped them to achieve effectiveness in online teaching which were the 'availability of good technology', 'accessibility of technology', 'flexibility', 'screen share', 'paint and writing tool', 'marking tool 'interact'', using different method' and 'video recording on any topic by an expert'. Inexperienced FGPs also identified nine positive influences that included six similar to the experienced educators, and the other three influences were 'collaboration', 'engagement' and 'tools'.

The word cloud produced by the responses of the more experienced educators (Figure 13) supports the influences of software and technology in online teaching platform. The main words identified were 'good' and 'software'. Which relates to the availability of good software as well as equity and accessibility of technologies, flexibility, blackboard. Availability of software represents the availability of software such as 'Paint and writing tool', 'Qualtrics', 'Interact', and 'iLecture'.

Figure 13
Positive influence of software and technology

Once the correct setup was identified participants stated that the software could be safely reused for multiple units. Commonly used software and technology for online teaching reported by the participants were WebEx, Blackboard, Interact, Collaborative ultra, iLecture (recorded lectures), Echo 360, screen share software, Paint and write tools. Another advantage of having software was the opportunity of using video recordings of an expert on any topic to provide more in-depth knowledge of that topic. The comment made by FGP3 supports these facts.

> *Interested in using different online learning methods, including a video presentation on a topic by an expert with extensive practical experience. Qualtrics was found to be useful in engaging the students in online learning. Postgraduate students are generally working in the industry, so they like the flexibility of doing their online study at a time that suits them. In general, postgraduate students are more self-directed in their learning than undergraduate students.*

In context of above comment on video presentation, numerous studies agreed on the effectiveness of showing videos as part of course material (Allen & Smith, 2012; Hsin & Cigas, 2013; Kay, 2012; Lloyd & Robertson, 2012; Rackaway, 2012; Stockwell et al., 2015). As for example, video demonstrations may have certain value for student preparation in biology classes, as students might feel more engaged while watching the video (Stockwell et al., 2015). Introducing videos as part of course material impacts on following three areas (i) Cognitive load, (ii) Student engagement (iii) Active learning of students (Brame, 2016). The inexperienced participant educators also described the flexibility of using technology from anywhere having internet access, which can be

supported by the comments made by FGP12 and the influence of good technology supported by the comments made by FGP9.

> *The technology we are using is collaborative ultra, which is a good technology, it has a lot of flexibility, preparing materials, having workshops as such do not have any problem. (FGP9)*

> *Anywhere and anytime. More engaged environment. Improves collaboration. Students can learn useful life skills through technology. (FGP12)*

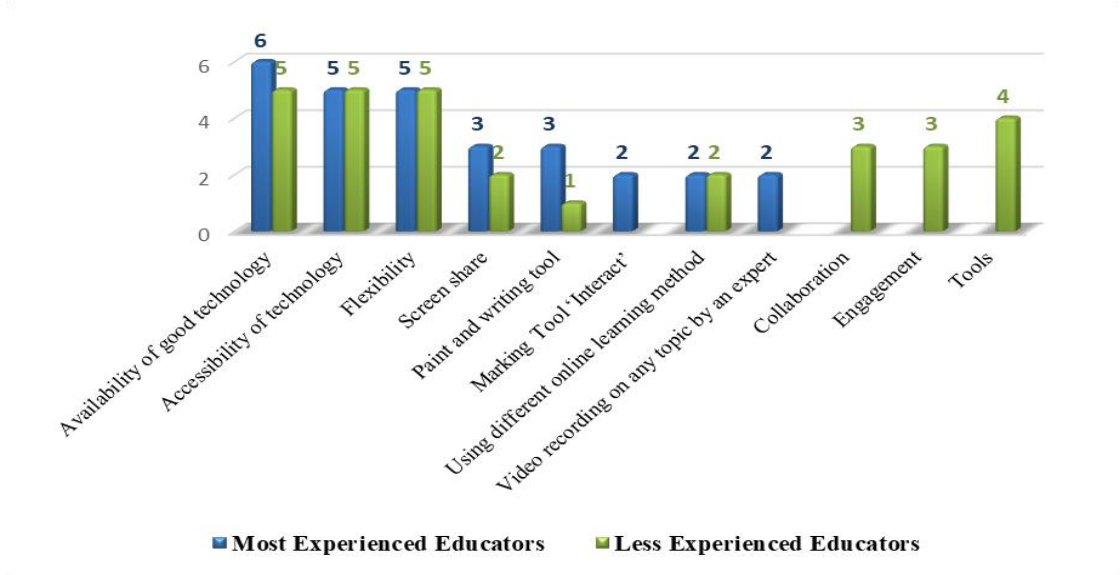
Bennett and Lockyer (2004) wrote that the availability and accessibility of information and communication technologies (ICTs), particularly online technologies, has been observed as opportunities to be able to meet the challenges that arise from shifting traditional higher education to online education by offering increased flexibility and supporting learner-centred approaches (Collis & Moonen, 2012; Ling et al., 2001; Taylor, 1998). Various software packages and technological tools are available for online teaching, and some are specially made for subject requirements. It had been observed that the younger educators were using technology more frequently than their senior colleagues who had in-service training (Winter et. al., 2021).

Comparison between positive influence of software and technology experienced by experienced and less experienced online educators.

Figure 14, below, identifies the percentage of each factor, provided by both experienced and inexperience online educators, which positively influenced the effectiveness of online teaching. Some of the factors were common for all FGPs and others were identified either by the experienced educators or inexperienced educators. The common ones are discussed under the ‘similarity’ heading and others under the ‘differences’ heading.

Figure 14

Positive influence of software and technology experienced by all FGPs



Similarities- The participants of both groups acknowledged that the software and technology helped to increase teaching flexibility and that there were good software packages and technological tools available.

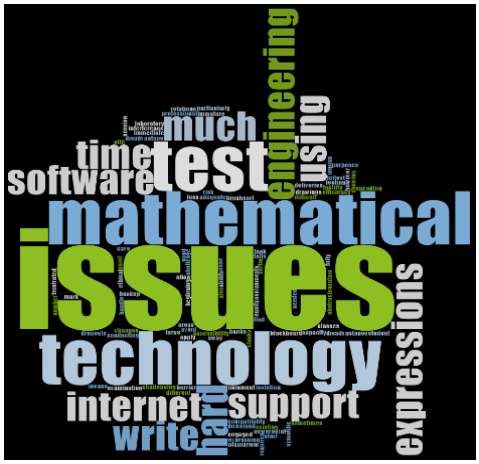
Differences- The experienced educators felt that the marking tool 'interact' influences their online teaching effectiveness. The inexperienced educators felt that collaboration and engagement with students in online educational platform was good, that the software tool skills learned by the students during their online classes added extra value in students future practical life. Less experienced educators in this group were conversant with technology and other mobile devices, which may be the reason for them feeling more engaged and collaborative online.

Negative influence of technology and software in online teaching

The experienced FGPs identified seven negative influences which act as a barrier to achieve their desired effectiveness in online teaching. These factors were 'issues with internet', 'technology not sufficient for laboratory experiments', 'issues with compatibility of mining software', 'technical issues', 'time', 'inability to handle large classes' and 'insufficient technology to handle mathematical expressions'. The inexperienced FGPs identified nine negative influences which hindered effectiveness that included five similar factors, and 4

others which were ‘online tests’, ‘isolation’ and ‘non-availability of immediate backup’ and ‘lack of technology training’.

Figure 15
Negative influence of technology and software in online teaching



The word cloud (figure 15) identified ‘expression’ ‘mathematical’, ‘obstacle’, ‘changes’, ‘challenge’, ‘technology’. Currently available technologies are not always sufficient for teaching engineering contents and mathematical rotation expression as described by FGP5.

> *Lot of good software and technology is available such as WebEx, BB, Collaborative ultra, iLecture (recorded lectures), Echo 360, but these technologies are not sufficient for the laboratory classes. Mining software is difficult to apply in a fully online course due to incompatibility issues with a different platform. (FGP5)*

Similarly, according to an inexperienced educator FGP6, the available resources and tools were not adequate but accepting the fact that this might have happened due to the emergency shift of the teaching method after the outbreak of the pandemic.

> *The available online resources/tools have been very useful but sometimes they do not have the adequate capacity to handle a large number of students at once. That is because so far, the University has not experienced a widespread situation similar to what was brought upon us by the COVID-19 pandemic. But I am aware that the University is working to expand the existing capacities to make things more streamlined in upcoming semesters.*

The ’technology’ term also represented internet issues, including unable to handle a large number of students at a time, non-availability of immediate backup, etc. as explained by FGP9,

> *The challenge with technology in online teaching is the ability to do mathematical expressions, drawings, etc. Conducting an examination is also a bit challenging. The existing technology does not support these areas very much.*

Educational institutes were expected to use technology to improve the educational delivery of their students, still facing challenges with its use (Johnson et al., 2016). Factors external to the educators were students having the required equipment, access to resources, training, and support. Other factors were internal to the educators and included attitudes and beliefs about technology use, their skills, and knowledge as explained by FGP7.

> *In some instances, lack of training obstructs using the software to its fullest.*

Ertmer (1999) argues that insufficient training in technology, meaning educators lacked necessary skills to use the technology. These factors were described as ‘first and second-order barriers’ by Ertmer (1999). The educators with less than 3 years online teaching experience had concerns with ‘technological issues’, ‘internet issues’, and issues with having the correct software or technological platform to deal with mathematical expressions, different subjects and each student may need distinct types of teaching and course delivery methods. For example, an engineering subject may require a hands-on laboratory-style experience in a virtual laboratory equipped with virtual instruments in addition to the lectures (Simoff, 2001). Traditional learning has been stressed by new technologies responsible for online teaching and learning (Tremblay, 2006). There were many investigations and research projects performed to develop best practices for face-to-face classroom instruction methods, but less is known about research and development of best practices for delivering instructions through the internet (Veal et al., 2004).

Challenges with technology in online teaching reported by the research participants in this study included the ability to do mathematical expressions, drawings, etc. Teaching in the online learning environment combined with conducting examinations and laboratory work it was commented that the existing technology did not support these areas well. Mining software was difficult to apply in a fully online course due to compatibility issues. Other disadvantages described by participants were ‘no immediate backup if there were Internet

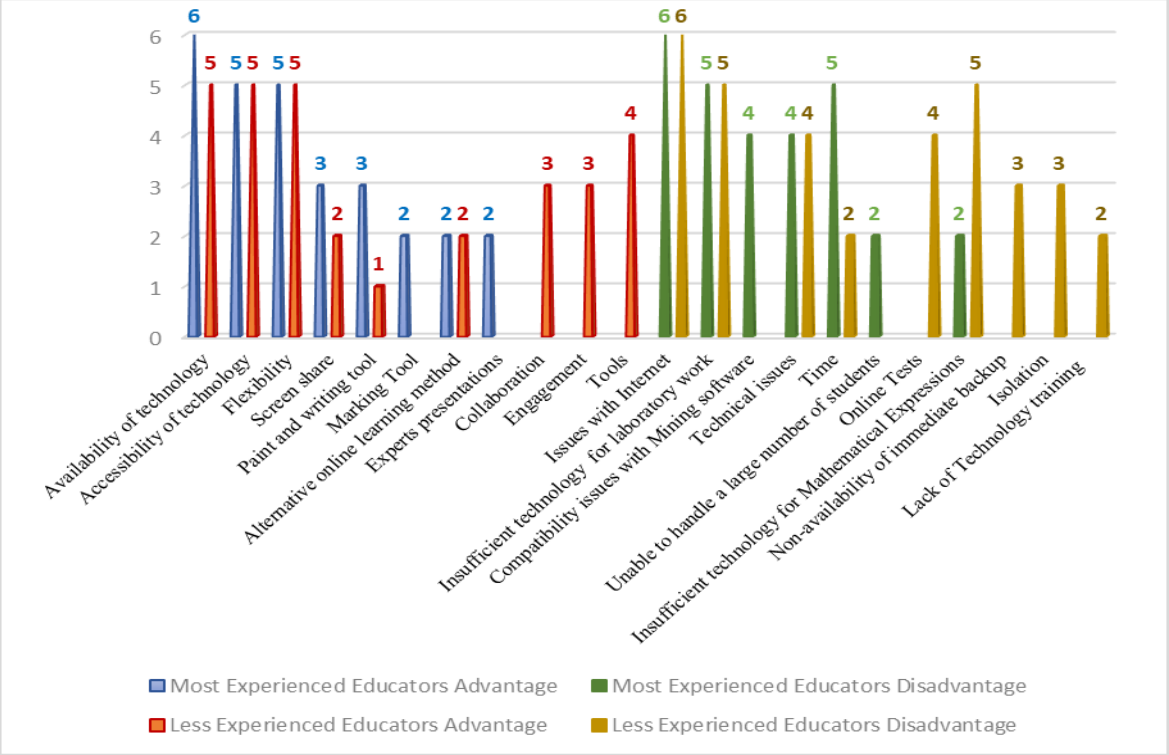
issues', and 'in some instances, lack of training obstructed using the software'. Tremblay's (2006) comment can be used in support of the participants' comments on lack of training: "since live online learning is relatively new, training professionals have been creating programs without the benefit of successful models, without best practices, and without full knowledge of how to use the technology to its best advantage. Best practices are developing but haven't been widely shared. So, a promising tool has gone misused and underused despite its bright prospects" (Tremblay, 2006; p. 2).

Comparison of how the positive and negative influences of technology and software for online teaching affect experienced and less experienced educators.

Figure 16 interpreted which factors related to technology and software facilitate and which factors pose as a barrier to online teaching for experienced and inexperienced focus group participants. There were some common areas which both experienced and inexperienced focus group participants identified in both areas. The common factors are discussed after figure 16 as similarities and the other factors were discussed as differences.

Figure 16

Positive and negative influence of technology and software faced by FGPs



Similarities- Both groups shared internet issues, technical issues, and competency of software use when teaching mathematical expressions, engineering rotation, laboratory work, etc. 'Availability and accessibility of technology', 'using different online learning methods' and 'flexibility' were the factors which both groups agreed they were most influenced by. Participants of both groups agreed that the 'issues with internet', 'unavailability sufficient technological support', 'technical issues and issues with mining software compatibility' also were factors that acted as a barrier to online teaching.

Differences- Less experienced educators reported feeling isolated in online teaching while more experienced educators did not mention this. Less experienced educators also described a lack of software training, no-availability of immediate back up in sudden internet disruption due to low speed, server breakdown, disruption in power supply, or any event of device breakdown. More experienced educators felt that online classes were not suitable for big numbers of students. Experienced educators identified that 'screen share', 'paint and writing tools', and video recording of experts' were factors that influenced online teaching positively. 'Time,' 'collaboration', 'tools', and 'engagement' were positive influences and 'lack of technological training', 'isolation', 'non-availability of immediate backup', and 'insufficient technology for mathematical expression' were negative influences for less experienced educators.

4.3.3. Online teaching related work affected by ergonomic factors

4.3.3.1. Physical ergonomic factors.

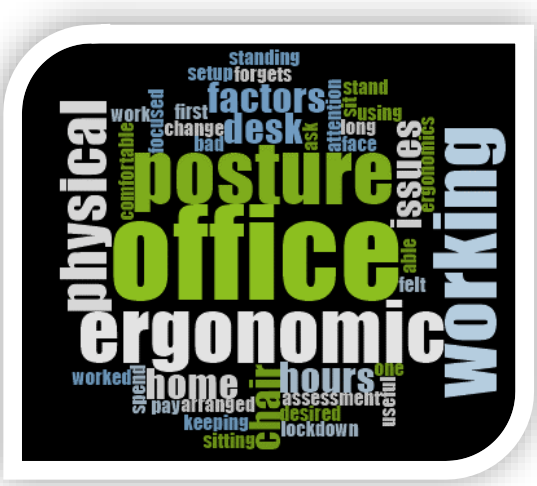
The next question was focused on Physical ergonomic factors (PEF). Physical ergonomic factors are related to human anatomical and anthropometric measurements such as having a comfortable chair, enough room to do teaching work, a desk, and a computer to use that is at an appropriate height. Most of the participant educators were working from a university office and did not experience any issues with physical ergonomic factors regarding their workstation setup.

Negative effect of Physical ergonomic factors

The discussion with all four focus group participants identified the same eight physical ergonomic factors as a barrier to achieve desired effectiveness in their online teaching

work. The factors were ‘posture’, ‘long hours’, ‘desk’, ‘office chair’, ‘sitting position’, ‘stress’, ‘shared office’, and ‘neck and shoulder pain’. In the word cloud (Figure 17) for both experienced and inexperienced educators, ‘posture’ was highlighted as sometimes educators spent long hours sitting in one position, particularly when they were marking student assignments or conducting online teaching.

Figure 17
Physical ergonomic factors that negatively affect online educators.



The main cause of musculoskeletal disorders is bad posture (Karwowski et al., 1994; Yang & Cho, 2012). Gallagher et al. (2021) suggested that there is sufficient evidence found to support the fact that the use of multiple monitors affect neck rotation. Studies showed that neck discomfort and upper back discomfort increased while using four monitors in a linear orientation (Stringfellow, 2007). Nimbarte et al. (2013) and Stringfellow, (2007) and other studies confirmed neck rotation increased while using multiple monitors. The comments received from FGP2, an experienced educator, and FGP8, a less experienced educator, supported the above information.

> *When working from home at first, I felt that the chair was not comfortable so did some research on chairs and arranged to use an ergonomically designed chair. In the busy periods I get involved with teaching and marking so forget to pay attention to my posture and sometimes spend hours working with a bad posture and sitting for long hours in one posture. This affect my overall health so after the end of each semester i.e., after marking for continuous two weeks, I get a remedial massage to relax the muscles, especially my neck and shoulder muscles. (FGP2)*

> *Prefer working from the office. I did ask for an ergonomic assessment of my office setup as I feel uncomfortable at work due to sitting for extended hours in the same*

> *posture. Working with three monitors so getting neck and shoulder pain and stiffness. (FGP8)*

In recent years, educators use more than one monitor, to be more efficient and effective while teaching online. But working with two or more screens side by side can lead to more frequent neck rotation and muscle strain in the neck and shoulder region (Nimbarte et al., 2012) resulting in neck and shoulder pain and stiffness, which were supported by the comment received from FGP4, an experienced educator.

> *I work with three monitors, and I am developing neck and shoulder pain and stiffness.*

One of the changes identified during the lockdown due to outbreak of the COVID-19 pandemic was introducing work from home as an isolation requirement. Ensuring using correct posture when working from home is very important (Waters & Dick, 2015). Occupational MSD's due to incorrect working postures can have serious adverse long-term health effects on shoulder, neck, and upper extremities, wrist, elbows (Birimoglu Okuyan & Begen, 2022; Madhwani & Nag, 2017). An ergonomically approved working environment and using ergonomically setup equipment, tools, and methods can help to prevent possible fatigue and long-term musculoskeletal disorders (MSD'S) as well as increase job satisfaction and productivity (Morgeson & Humphrey, 2006). The comment made by inexperienced educator FGP10 support the statement.

> *Yes, initially the effect of ergonomic physical factors was bad – my home office chair was not comfortable enough and my desk was not well-arranged for online teaching. After replacing my office chair and reorganising the desk space (location of the keyboard, notes, tablet plus stylus, etc.), the effect was much improved.*

In a shared office educators have little control over their levels of privacy. Overhearing irrelevant conversations is a major cause of distraction in shared office environments and, further, that distraction is negatively linked with educators' performance, negative perceptions of the workplace, and/or stress (Loewen & Suedfeld, 1992; Maher & von Hippel, 2005; Nemecek & Grandjean, 1973; Smith-Jackson & Klein, 2009; Sundstrom et al., 1994). The comment made by inexperienced FGP11 supports the above statement.

> *Now I and other three of my colleagues are sitting in the same office. Online teaching could disturb other colleagues.*

Positive effect of Physical ergonomic factors

Four physical ergonomic factors which helps both experienced and inexperienced educators to achieve desired effectiveness in their online teaching, were 'Posture', 'Working from office', 'Sit-to-Stand Desk', and 'Variation'.

Figure 18
Physical ergonomic factors that facilitate online teaching

The word cloud (figure 18) identified 'working', office' as working from a university office. 'Posture' and 'desk', as some of the educators mentioned using a sit and stand desk to allow for posture variation with some work activities performed in a seated position, and others in a standing position, with the educators making the decision on their working positions.

Numerous interventions have been applied to increase workplace physical activity (Conn et al., 2009), but very few investigated reducing sedentary behaviour despite there being guidelines recommending regular postural change by introducing variation in jobs during periods of working on a computer in a sitting position (International Ergonomic Association (IEA), 2008; Occupational Safety Health Administration (OSHA), 2009 as cited by Straker et al., 2013). Chau et al. (2010), suggested redesigning the work environment to prevent occupational sedentariness. Using sit-to-stand desks can increase burning calories as well as reduce sedentariness in the workplace (Alkhajah et al., 2012; Commissaris et al., 2016; Grunseit et al., 2013; Pronk et al., 2012). This was reflected in the comments made by experienced FGP3.

I work in an office with a sit and stand desk so I can change posture as desired. No problems with any physical ergonomic factors.

The FGP9, a less experienced educators said that he takes regular breaks to avoid any physical discomfort.

Working from office, so no issues with physical ergonomic set up. I take regular breaks for 15 to 12 mins, so do not have any discomfort.

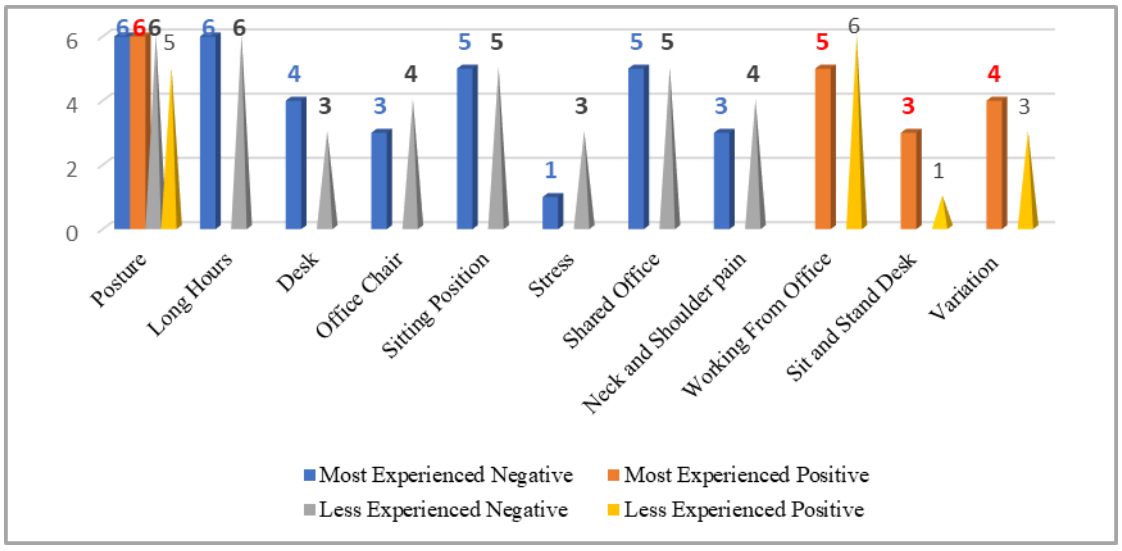
Comparison of Positive and Negative Physical Ergonomic Factors Effect on experienced and less experienced online educators

A comparative graph was produced (figure 19) to visualise how both experienced and less experienced FGPs identified the same physical ergonomic factors which facilitates or act as a barrier to the effectiveness of their online teaching work.

Similarities- Participants from both experienced and less experienced focus groups, 5 FGPs out of 6 FGPs from most experienced group and all 6 FGPs of less experienced group stated that they were working from the university office. All FGPs from both groups reported working long hours while sitting in the same posture.

Differences- Three of six FGPs experienced educators mentioned using sit stand desks to allow for changes in working posture.

Figure 19
FGPs affected positively and negatively by Physical Ergonomic Factors



4.3.3.2. Environmental ergonomic factors that affect online teaching.

Negative effect of Environmental ergonomic factors

Most of the FGP educators of both experienced and less experienced groups were working from their university office and stated that environmental ergonomic factors were generally satisfactory. Three main issues were identified by both experienced and less experienced FGPs which hinder effectiveness of online teaching work, and they were 'noise', 'temperature', and 'light' (figure 20).

Figure 20
Environmental ergonomic factors negatively effecting online teaching

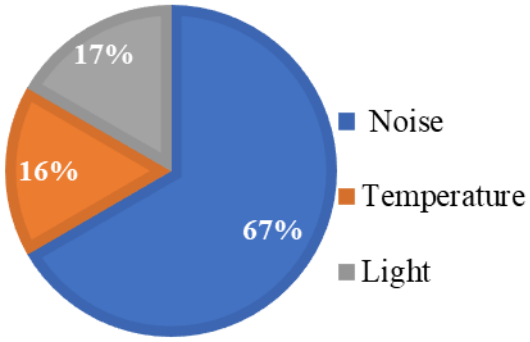
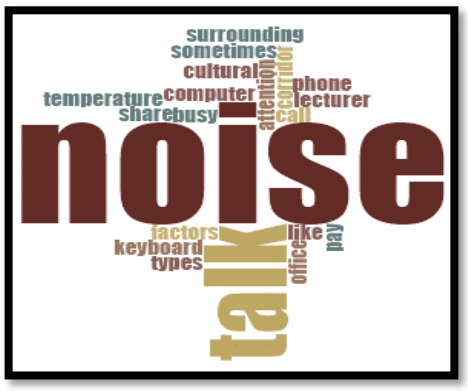


Figure 21
Environmental ergonomic factors that negatively affect online educators



The word cloud (figure 21) identified 'noise' as the major environmental factor. All experienced online educators and four FGPs from the less experienced groups said that they work in a shared office. They experienced distraction when conducting online teaching due to noise initiated from phone calls or other activities performed by other

colleagues in the room, or students talking to their lecturers, as well as noise coming from the corridor outside of their room. Comment made by FGP3, an experienced educator, and FGP8, a less experienced educator, reflected similar issues.

> *Noise can be a problem. I work in an office with 6 people. Our desks are next to each other with no barriers between them. When there are online classes, being held if a phone rings and the person answers the phone call, if a student comes in to talk to their lecturer and talks to them, or if anyone types on their computer keyboard, the noise disturbs the online lecture. Because of the closeness of the desks, these noises can also disturb the other people in the room and make it difficult to concentrate on work particularly when people talk together for a period of time of more than 5 minutes. There are some cultural factors such as one of the people in this room is Muslim so he needs to pray at set times of the day and pray in the centre of the room on his prayer mat. No one minds, but I think that he would like more privacy when praying as he has asked for an office of his own for religious reasons. (FGP3)*

> *I am working in a shared office. The noise of having other academics in-room disturbs me. My room is next to the laboratory. The sound generated from mechanical instruments also becomes a disturbing factor. (FGP8)*

Irrelevant speech noise (ISN) is "the noise that is generated from conversations between colleagues, telephone calls and laughter" as cited in Di Blasio et al., 2019, p. 1. Kaarlela-Tuomaala et al., (2009) and Kang et al., (2017) agreed with this definition. Individuals working from shared office space reported that irrelevant speech caused by the general noise level and comprehensible discussions between colleagues is recognised as an extremely troubling effect of noise (Banbury & Berry, 2005; Haapakangas et al., 2008; Hongisto, 2005; Jahncke et al., 2011; Kaarlela-Tuomaala et al., 2009; Pierrette et al., 2015; Schlittmeier & Liebl, 2015). Noise annoyance has been defined as a "multi-faceted concept that includes behavioural noise effects, such as disturbance, and interferes with intended activities and evaluative aspects, such as nuisance, unpleasantness and getting on one's nerves" (Guski et al., 1999 as cited by Di Blasio et al., 2019, p. 2). A variety of symptoms including fatigue and headaches (Pejtersen, et al., 2006), problems with maintaining concentration (Banbury & Berry, 2005; Kaarlela-Tuomaala et al., 2009; Pejtersen et al., 2006), physiological stress (Evans & Johnson, 2000), loss of enthusiasm, fatigue (Jahncke et al., 2011) and an increase in cognitive workload (De Croon et al., 2005), have been identified in shared offices. FGP10 reported:

> *The environmental ergonomic factors that affected me most were the noise inside and outside the home office. To rectify this, we arranged together with my spouse proper childcare so that live sessions can be done in a quiet environment. Also,*

> *times for recording lectures and tutorials were selected to minimise potential interruptions.*

According to another experienced educator, FGP5, the environmental ergonomic factor of background noise caused distraction or lack of concentration for both educators and students.

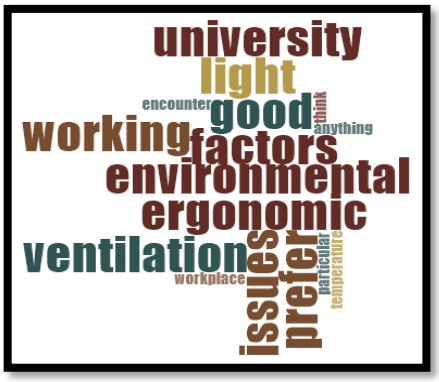
> *Four academics in one room. It is difficult in teaching online from that room due to surrounding noise and activities. Generally, going to any empty classroom or meeting room for online teaching but then using a different room each time makes it challenging. During COVID-19 it was also hard as having a young kid at home and other family members' presence disturbs the concentration. In case of students in online classes, the students can join from anywhere that includes the airport, café, office lunchroom so they also struggle to concentrate and levels of participation of all students are not the same.*

While working from home some FGPs reported other environmental ergonomic factors as well, such as temperature, light, etc.

Positive effect of Environmental ergonomic factors.

The educators from both groups identified that as they mostly working from university campus they have good temperature, light ventilation control, thus they were not experiencing any discomfort due to any of these environmental ergonomic factors, as supported by the word cloud (figure 22).

Figure 22
Positive Environmental ergonomic factors affect online teaching



The word cloud identified as ‘light’, ‘ventilation’, ‘university’, ‘good’ as most common words said by the FGPs. Five within six experienced FGPs and all less experienced FGPs

worked at the university when conducting their online teaching work. The comments provided by experienced educators FGP1 and FGP3 were as follows.

> *Prefer working from university so again no issues with environmental ergonomic factors. (FGP1)*

> *Workplace lighting, temperature and ventilation are good. (FGP3)*

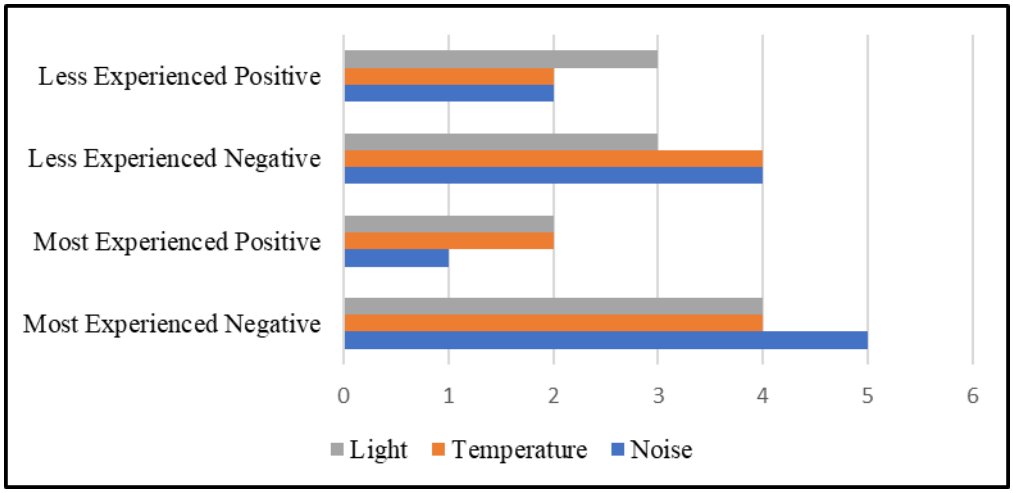
FGP7 and FGP9 from the less experienced FGP groups stated that they work from an individual office and none of the environmental ergonomic factor including noise affected their online teaching.

> *Working from individual office set up, no issues with environmental ergonomic factors. (FGP7)*

Comparison of Environmental Ergonomic Factors Positive and Negative Effects

The comparison of positive and negative effects of environmental ergonomic factors by both experienced and less experienced FGPs are displayed in the following graph (Figure 23).

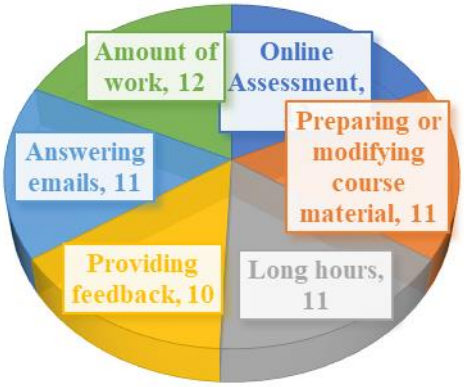
Figure 23
Environmental ergonomic factors affect both FGPs positively and negatively



Summary- Five of the 6 experienced and 4 of the 6 less experienced educators were disturbed by background noises when using a shared office, from corridor noise, from having a laboratory situated next to the room, etc. One experienced FGP member worked

from home and her home office had no environmental ergonomic issues. Four experienced and 3 less experienced educators had a problem with lighting. Four experienced and 4 less

Figure 24
Negative effect of Organisational ergonomic factors



experienced educators had a problem with the room temperature when doing their online teaching work. For the environmental ergonomic factors, the less experienced educators had slightly less problems with lighting and noise.

4.3.3.3. Organisational ergonomic factors that affect online teaching.

Organisational ergonomic factors are those that are controlled by the University. Examples are allotted time for updating teaching materials, marking the assignments, and providing feedback using Blackboard.

Negative effect of organisational ergonomic factors.

Six main themes were identified in discussion with both experienced and inexperienced FGPs regarding their experience on organisational ergonomic factors that affect them negatively. The frequency of each theme mentioned by the participants is displayed in figure 24.

The word cloud (figure 25) for most experienced educators identified ‘hours’ allowed for work to be completed as the major organisational ergonomic problem supporting the above graph. Both experienced and inexperienced FGPs stated that they required more time to prepare and to modify course materials, mark assignments, answer emails, provide feedback, etc. Remuneration not covering the extra hours of work was also a cause of dissatisfaction.

Figure 25
Negative effect of Organisational ergonomic factors

Sellani and Harrington (2002) stated that online educators faced many unique challenges, and that lack of time was an important challenge. They wrote that "Faculty complained that the online delivery was more labour-intensive in the amount of time to grade papers and respond to questions" (Sellani & Harrington, 2002, p 2). The disproportionate workload of university educators was also related to their added diversified roles beyond their teaching duties, which included administrative tasks, research, or organising seminars, etc. as this affects online teachers negatively (Kinman, 2001; Sliškovi´ & Serši´, 2011). A variety of reasons were identified as the cause for requiring extra time by the educators that included time required for communicating and providing feedback to the students (FGP3), modifying the course material (FGP4), University policy (FGP2). Some comments made by experienced educator participants are listed below.

> *Time is the biggest factor. Educators are not given enough time for marking student assignments, so assignments can only be work that requires a short answer, rather than being a good practical learning experience. There is insufficient time to provide students with good feedback. There is a lack of time for updating and changing study materials to improve online teaching. (FGP3)*

> *I would like to have enough time to try out new and different creative or innovative features of software to modify the course material to be more engaging and interesting to the students. Always too busy to do this. Teaching online requires spending long hours before a computer which results in headaches and neck pain. (FGP4)*

> *I do not like the Blackboard platform that we have to use for online teaching as it is not user friendly. The remuneration paid for online teaching is fixed with*

> *certain hours. Online classes need more time that cannot be claimed. As per the universities policy, the academics should be available 24/7 so I ended up spending around 4 times more hours than I am entitled to get paid for. (FGP2)*

Students need to develop basic subject knowledge before developing advanced subject knowledge. FGP8 reported that:

> *In the case of online classes, it is very hard to assess the level of knowledge of the students. You have to assume that the students do not have the basic knowledge, so you need to explain the subject from basic concepts and provide more detailed explanations. So, it requires more time.*

Enhanced time dedication is a major challenge to the educators involved in online education (Berge, 2002; O'Quinn and Corry, 2002; Schifter, 2000). Other findings mentioned that the time required for online course delivery is approximately similar to face-to-face delivery but the main difference in time is the time required for grading and answering emails on an online platform (Van de Vord and Pogue, 2012). Kebritchi et al. (2017) stated that formal technical skills training is necessary for the efficient use of computers and the internet, which is very important for having successful online education.

Organisational ergonomic factors that affect online educators positively

In the discussion with FGPs the experienced educators identified five organisational factors including 'setting up online assessment', 'preparing or modifying course material', 'providing feedback', 'autonomy in preparing course material' and 'autonomy in preparing assignments' that affect them. The less experienced educators also identified five organisational factors including online teaching is 'more engaging', 'adequate time allotted for online teaching related work', 'providing feedback', 'autonomy in extending any lecture' and 'autonomy in arranging extra lecture' which affect positively online teaching. Below is a graphical representation of positive organisational ergonomic factors in (figure 26).

Figure 26

Positive effect of Organisational ergonomic factors on all FGPs

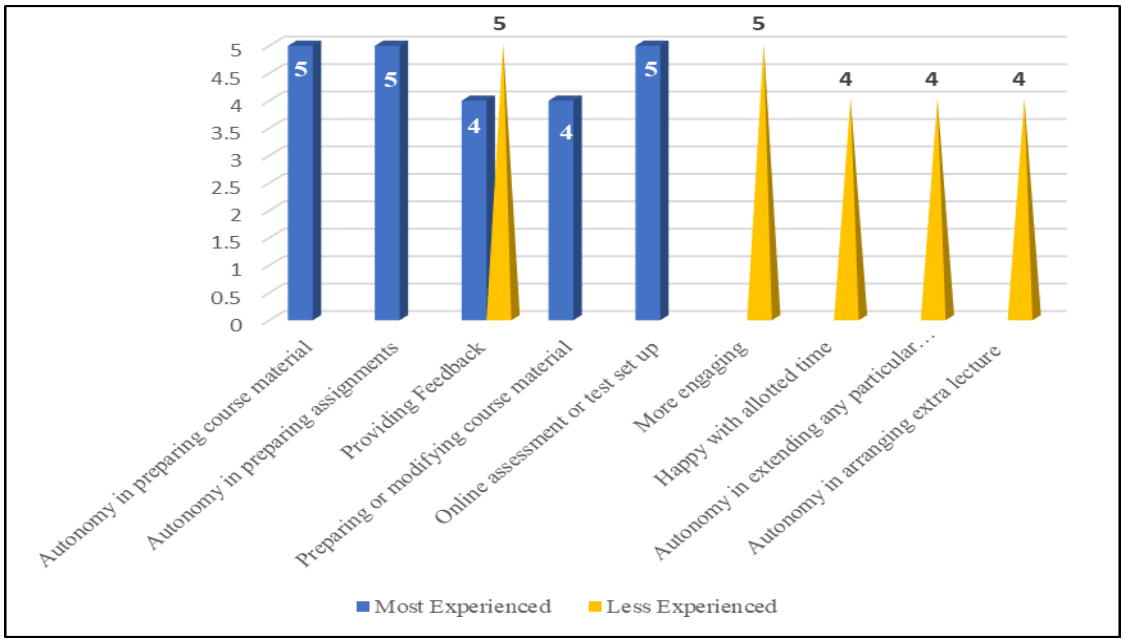


Figure 27

Organisational ergonomic factors affect positively the online educators

The word cloud (figure 27) for most experienced educator identified 'teaching', as representing the transition of traditional teaching to online teaching, the support provided by the university for setting up online teaching from home due to COVID-19 outbreak lockdown. Most of the FGPs were happy to have autonomy while preparing course material, assignments, etc. Some of the experienced FGPs' comments are listed below.

> *Lecturers have a high level of autonomy to conduct many of their teaching and learning activities (conducting tests, marking papers, updating material, etc.) at*

> *a time that suits them best. The only unchangeable item would be actual lecture/tutorial timings which are fixed. (FGP6)*

During the COVID-19 pandemic, the university assisted in setting up the computers and networks at home for staff to be able to have a good transition from face-to-face teaching to online teaching. Some students, pre COVID-19 chose to study by distance education so that they could combine their work and study thus these students were not affected by the transition of face-to-face classes to online mode.

> *A greater number of students can attend online classes as the students are busy with their work or other responsibilities. Especially in Kalgoorlie some of the students are not on campus. They are in either Bentley campus or mine sites so the attendance in an online class is better. University offered all types of support to shift to online teaching. During the COVID-19 pandemic, the university assisted in setting up the computers and networks at home to be able to have a good transition from face-to-face teaching to online teaching. No negative organisational factors related to online teaching. (FGP5)*

The flexibility of extending any class without disturbing by next class scheduled for that room was described by a less experienced participant, FGP7.

> *Another reason for that is in the case of face-to-face class there are only two hours allotted for the class and there will be another class in that room after that so there is no time available to extend the class. However. online this situation does not exist so if needed the class can be extended beyond two hours.*

Another less experienced participant, FGP10, said that the potential interruptions could be avoided by having the options of pre-recording the lectures for online teaching.

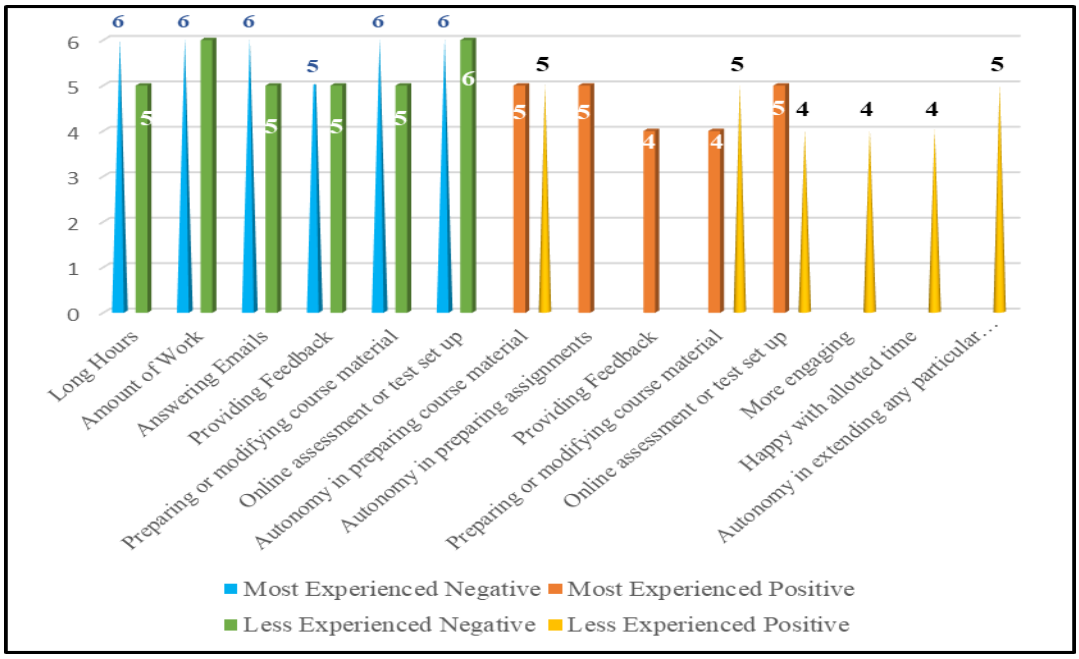
> *Times for recording lectures and tutorials were selected to minimise potential interruptions.*

Comparison of Positive and Negative effect of Organisational Ergonomic Factors.

While comparing the organisational factors that facilitate or hinder the most experienced and less experienced educators the following similarities and differences were identified as shown in figure 28.

Figure 28

Positive and Negative effect of Organisational Ergonomic Factors on all FGPs



Similarities: FGPs of all focus groups mentioned the extra time/hours requirement for efficiently completing all the demands of online teaching such as course material preparation, proving feedback, answering emails or messages, etc. Preparing online test material and conducting the test was also mentioned as challenging.

Differences: One educator with less than 3 years online teaching experience thought that the allotted time for online teaching and preparation was sufficient and another suggested that there should be some guideline of pre-existing knowledge introduced by the university to prepare prospective future students for learning online.

4.3.3.4. Cognitive ergonomic factors that affect online teaching.

Cognitive ergonomic factors are related to how an individual thinks and processes information. An example is where an individual knows and understands the university policies and procedures, Blackboard, Turnitin, and online educational tools.

Negative Cognitive ergonomic factors effect.

The discussion with FGPs both experienced and inexperienced educators identified six negative cognitive factors. These included setting up technology, collaborative ultra,

interactive, no show of students for classes, mathematic expression, and missing support from colleagues. The less experienced group identified that not knowing university policies and procedures as negative cognitive factors in online teaching platform. While comparing the negative effect of cognitive ergonomic factors between both experienced and less experienced educators' similar areas which hinder online teaching work, they were technological and student no-show for classes. Not knowing the university policies and procedures was most common with less experienced educators. More experienced educators had more issues related to 'Collaborative ultra and interactive' while less experienced educators were more concerned with the issues related to 'mathematical expression and missing support from colleagues.' Figure 29 and word cloud figure 30 show cognitive ergonomic factors that negatively affected focus group participants.

Figure 29

Cognitive ergonomic factors effecting negatively FGPs

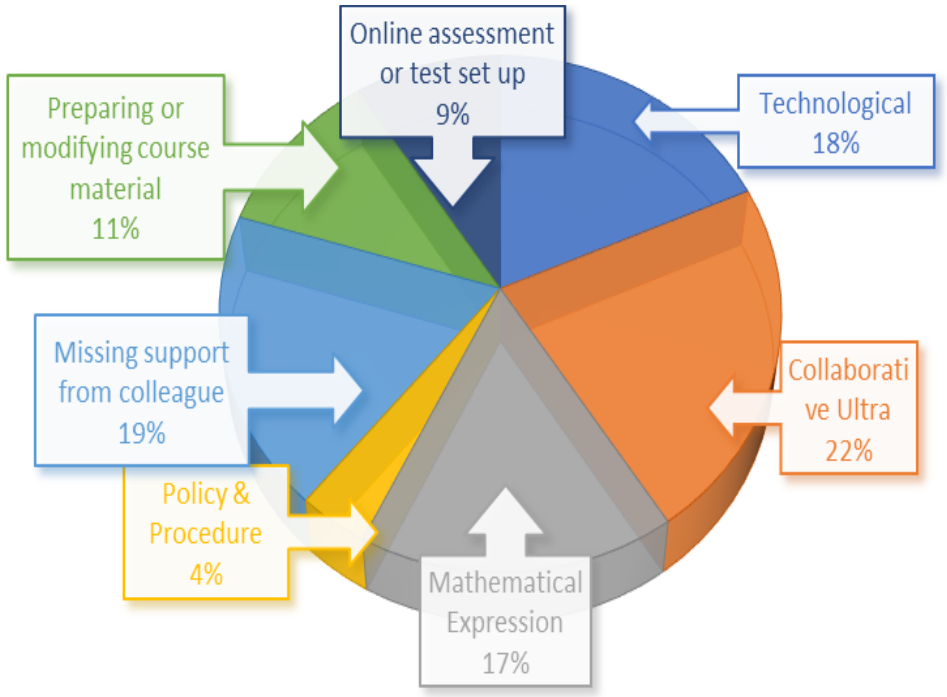


Figure 30
Cognitive ergonomic factors negatively effecting all FGPs

The above word cloud identified ‘collaborative’ as collaborative-ultra software, and ‘technological’ as technological issues, support from universities technological department, ‘interactive’ as interaction with other Curtin technological platform and ‘show’ as no show of students for online classes. The word cloud highlighted that the educators sometimes missed learning from each other, talking to other colleagues, and being able to brainstorm. Educators missed the support from their colleagues when they were forced to work from home during COVID-9 lockdowns. The sudden introduction of new technology due to the emergency shifting of teaching to online hindered the effectiveness of online teaching work as supported by comments provided by experienced educator FGP5:

> *During the COVID-19 pandemic fully online courses were introduced using collaborative ultra-software. Did not use this software before and experienced some issues with interaction with other Curtin technological platforms. I was not able to draw or do other interactive things. Collaborative-ultra is good but has some issues. It is hard to use with a docking station and without a docking station is unable to use two monitors. There are a lot of mathematical expressions that I need to teach in class which was not easy with collaborative ultra. In Face-to-Face class or in iLectures, there are no issues in teaching in an interactive way.*

Increased workload and less interactive collaboration elevate the psychological stress of the educators as stated by FGP2.

> *The University has mandatory student/teacher collaborative sessions online each week. For these classes, academics are required to prepare a PowerPoint presentation and schedule to deliver the classes at a fixed time. The main*

frustrating thing is academics spend more hours, but the students generally do not bother to show up as there is no penalty on their part for no show. This affects the academic motivation'. 'At the time of the commencement of the pandemic I missed all the support I previously had from a colleague.

Some of the less experienced FGPs faced cognitive ergonomic problems with policies regarding the requirement of online delivery of class, marking assignments, and setting up exams as described by FGP10.

At the beginning, all the tools, policies, and procedures related to online teaching were communicated in a short period of time which was perhaps a bit overwhelming. After delivering the first unit online, I had much more familiarity with them which improved my comfort and confidence in delivering other units of study online. There are some challenges I face with the policies related to online assessment setup and marking. Especially for plagiarism or in the case of open-book exams. I am not very clear this semester on how it works.

FGP8, a less experienced educator, also felt that there should be more education provided regarding the policies and procedures.

I have some conflicts with understanding the requirements in the policies in case of online delivery, assessment, and feedback which should be matched and corrected together. There are issues with the authenticity of the assessments, the quality of feedback is not suitable for online. They should be corrected.

On the topic of policies FGP11 said that:

One of the policies is 'The online tests should be at least 4 hours.' I do not understand why this should be applicable for my unit. My unit includes several computational questions. Usually, the students have 2 hours to solve all of the question problems. Due to the policy, I have to give 4 hours and this year everyone has a very high mark.

Some online educators may struggle to develop course delivery in ways where they could maximise the transfer of learning material due to constant up-grading of technology in the digital world (Kong, 2000).

Positive effect of cognitive ergonomic factors on online teaching.

Figure 31 and 32 shows the positive cognitive ergonomic factors affecting all focus group participants.

Figure 31
Cognitive ergonomic factors affecting all FGPs

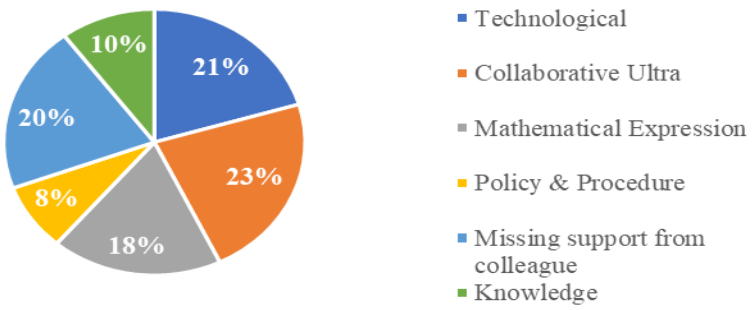
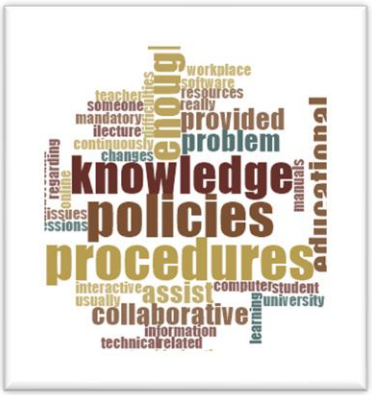


Figure 32
Positive Cognitive ergonomic factors affecting all FGPs



The word cloud (figure 32), for both experienced and inexperienced educators identified key positive factors are ‘policies,’ ‘knowledge’, ‘educational tool’, ‘knowledge’ and ‘procedures’.

The experienced educators of this group had enough knowledge of online teaching-related policies and procedures. FGP1, FGP3 referred to having adequate knowledge on policies and procedures.

> *I have enough knowledge of policies, procedures, and other educational tools manuals but these do not provide enough support when facing online teaching problems. (FGP1)*

> *I have a good knowledge of work-related policies and procedures. If there are any changes in workplace policies or procedures this information is provided to all staff by email. (FGP3)*

While FGP6 an experienced educator was happy about receiving adequate training and resources.

> *Adequate training and troubleshooting resources have been continuously provided by the University. So, I have not faced any difficulties in this area.*

The FGPs with less online teaching experience mentioned that they had enough knowledge of work-related policies and procedures.

> *I have a good knowledge of work-related policies and procedures. (FGP7)*

While according to FGP10 the familiarity comes with the experience.

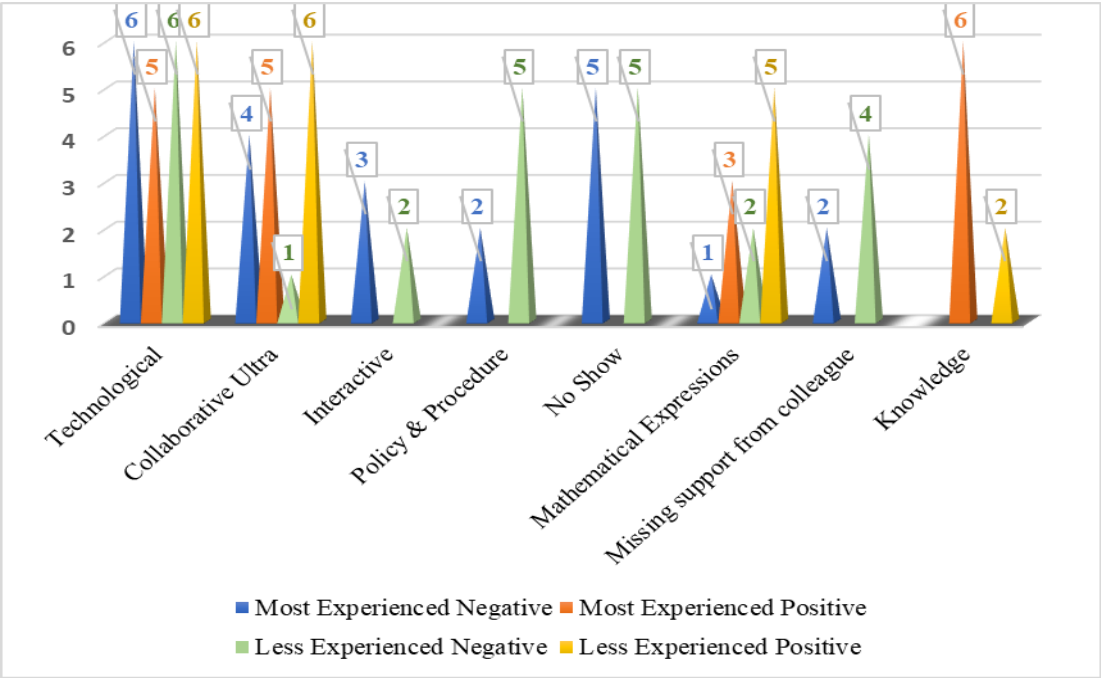
> *After delivering the first unit online, there was much more familiarity with online teaching which improved my comfort and confidence in delivering other units online.*

Comparison of Cognitive Ergonomic Factors Positive and Negative Effect on Most and Less Experienced Educators.

There were similarities and differences in the cognitive ergonomic factors identified as the facilitator or act as a barrier to online teaching by both FGPs as described below. Figure 33 shows the graphical representation of the comparison.

Figure 33

Positive and Negative effect of Cognitive Ergonomic Factors affecting all FGPs



Similarities –Majority of the FGPs of both groups acknowledged that there was enough support provided by the university as well as from their colleagues when they need, it can either be the technological support or related to any other matter. The support and guidance help all the educators to understand and execute out the online teaching work smoothly.

Differences – The educators who had more than three years of online teaching experience were very conversant with the university's policies and procedures towards online teaching-related matters. Whereas the educators who had less than three years of online teaching experience struggled with the university policies and procedures.

4.3.3.5. Social ergonomic factors that affect online teaching.

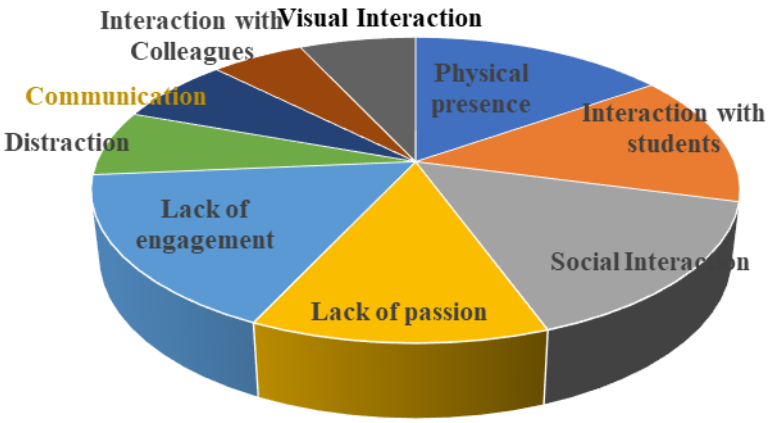
Social ergonomic factors are related to individuals' interactions with other people. Examples were the opportunities for collaborating with students and co-workers in online teaching and all other communication.

Negative Social ergonomic factors effect.

Nine social ergonomic factors were identified by the experienced educators as the factors that act as a barrier to online teaching (figure 34).

Figure 34

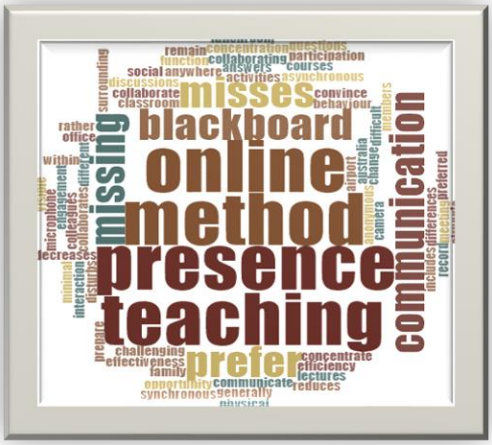
Negative Social ergonomic factors for Focus Group Participants



Five out of nine factors were also identified as a barrier by the inexperienced educators: physical presence, interaction with students, social interaction, lack of passion, and lack of engagement. While distraction, communication, interaction with colleagues, and visual interaction were the factors which were identified by the experienced educator as barriers to the effectiveness of online teaching.

The word cloud identified ‘presence’, ‘missing’ as missing of physical/social presence or interaction, ‘communication’ with students as well as with co-workers (figure 35).

Figure 35
Negative Social ergonomic factors for Focus Group Participants



The negative social ergonomic factors discussed by the FGP educators were the lack of physical and visual interaction, lack of passion, lack of engagement, etc. FGP2 reported the following.

> *In an ideal world, I would prefer to pre-record lectures rather than prepare for collaborates. The synchronous method of teaching is hard because of the time differences even within Australia but in online courses there are students from all parts of the globe. So, for these reasons Asynchronous method is preferred. Missing the presence of co-workers, brainstorming, walk and talk kind of opportunities.*

Lack of student engagement was identified by an experienced educator, FGP6.

> *Sometimes, lack or low level of engagement from students reduces the efficiency and effectiveness of online teaching delivery but often it is hard to convince students to change their behaviour.*

The main social ergonomic factors talked about by inexperienced educators were the lack of physical presence of students, missing collaborating and discussing with colleagues during the COVID-19 pandemic lockdown period. Some of the mathematical expressions, or coding were easier to explain in a face-to-face class rather than in the online platform where the educator was unable to see the expression or the body language of the students to understand the students' level of understanding on that area, which works as a motivator to the teachers while teaching a face-to-face class. Comments provided by FGP8 and FGP9

support the observation that the lack of interaction hinders the effectiveness of online teaching.

> *The negative side of online teaching is that you cannot see the students personally, so you cannot relate to them in the same way you are able to do with a face-to-face class. (FGP8)*

> *The main challenge in online classes is the level of interaction and eye contact. It upsets me as I am a very passionate person but in online classes, I do not feel that passionate. (FGP9)*

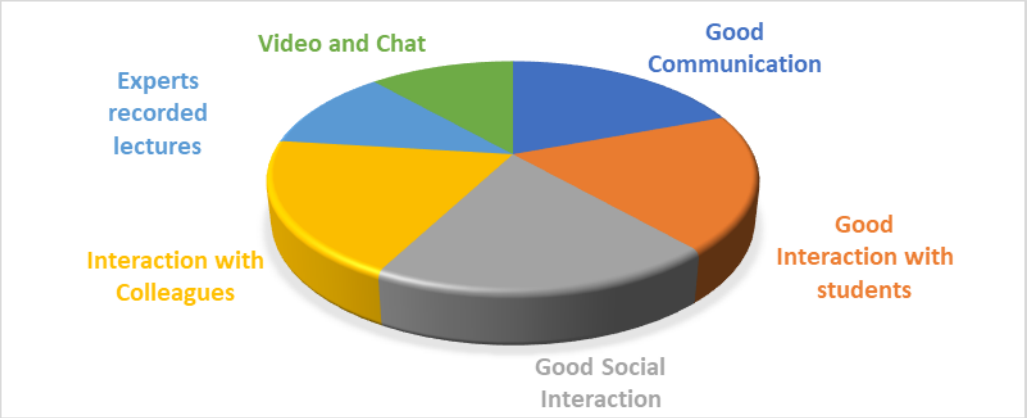
Social presence is one of the most important theories that has been investigated about social interaction. Social presence can be defined, "as the degree to which a person is perceived as 'real' in mediated communication" (Sung & Mayer, 2012, p.1; Yen & Tu, 2011). Social presence can also correlate with the degree of feeling interacted with real people while teaching online. Studies show that the learner's and teachers' interaction and satisfaction, achievements of the students, enhancement of perception of the community are impacted by the social presence factor in online teaching (Polhemus et al., 2001; Tu & McIssac, 2002; Sung & Mayer, 2012). A high level of frustration, a negative attitude toward the effectiveness of the class, and a lower level of motivation may result from a lack of social presence (Hughes et al., 2007; Song et al., 2004). The comment made by an inexperienced educator FGP10 supports the perception that lack of social presence hinders the effectiveness of online teaching.

> *The only negative effect was about student meetings which had to be changed from face-to-face meetings to online live sessions. The interaction between supervisor and student was not as good as a result (e.g., explaining some aspects of the problem or pointing improvements in Matlab code would have been easier face to face with the students sitting with his laptop next to me).*

Positive social ergonomic factors effect.

Five social ergonomic factors were identified by both experienced and less experienced educators as factors that facilitate online teaching. Access to video and chat facilities were identified by the less experienced educators as positive factors. Good communication, good interaction with students, good social interaction, interactions with colleagues, and ability to use experts recorded lectures were identified by both experienced and less experienced educators as positive factors (figure 36).

Figure 36
Positive Social ergonomic factors for Focus Group Participants



The word cloud identified 'interaction' as representing good social interaction with co-workers (figure 37).

Figure 37
Positive Social ergonomic factors for FGPs

The importance of interaction could be identified by the comment made by an experienced educator, FGP3:

> *Everyone in the room that I work in gets on well with each other so there is good social interaction. For people in the department who work in other rooms, social interaction occurs in the tearoom and the corridor. We also usually have our lunchtime together and discuss anything that we like during this mealtime. There is sharing of food. The department culture is friendly and supportive.' 'At the end of the Collaborate ultra-class, I switch off the recording and allow students time to talk about anything that they like so that they have some social interaction with*

other students and with me. Most of the time this brings up issues, not related to the course topics but with other things, such as the student losing their employment due to COVID 19, needing to find new accommodation, where to buy food at a reasonable price, etc. The students have been helping each other with advice and support during this time.

Interaction was also identified as good social interaction with the use of video and chat, and to be able to utilise expert presenters from any part of the world, which is not possible in a traditional classroom, unless a video link is used. The comments from less experienced educators FGP7 and FGP8 support the above advantages.

It's two-way, yes. Online teaching is less socially interactive than face-to-face classroom teaching, but in some classes, the social interaction is better as students interact with videos and chats, but the level of interaction is different for every class. (FGP7)

A positive aspect in an online class is that you can invite a guest lecturer to your class even if he/she is not on the campus at that time or is on leave. (FGP8)

Comparison of Social Ergonomic Factors Positive and Negative Effect on Experienced and Less Experienced Educators.

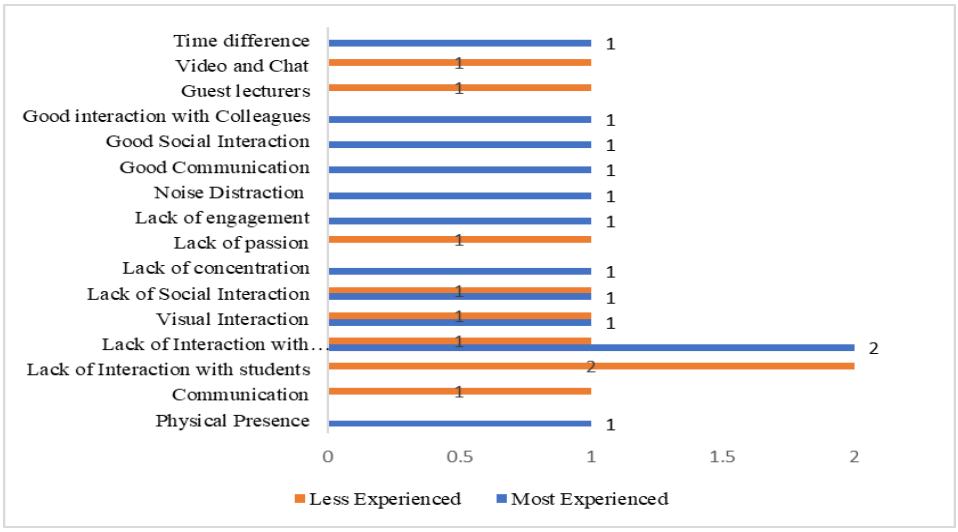
A total of fifteen factors, both positive and negative, were identified by FGPs.

Similarities- FGPs of both groups missed physical/visual interaction with students.

Differences- Half of the less experienced FGPs thought that the online teaching platform provided better visual interaction through video, chat, etc. A comparison of positive and negative social ergonomic factors displayed in figure 38.

Figure 38

Social Ergonomic Factors for experienced and less experienced educators

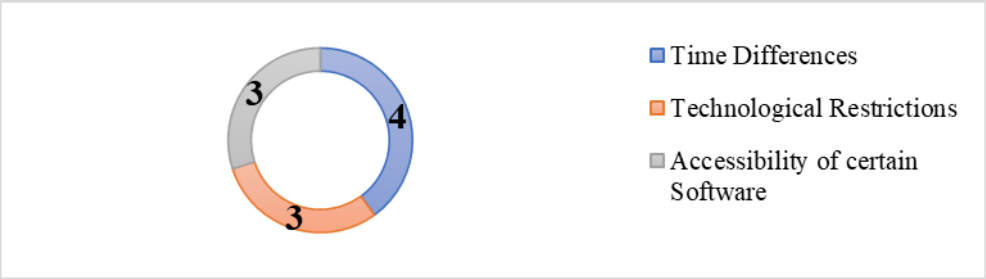


4.3.4. Involvement in the supervision of online research students.

A mixed response was received. Four out of six experienced focus group participants were involved with research supervision, and of these two educators were involve with online supervision. Also, four less experienced focus group participants were involved with supervising research students with only one student online. The other three educators supervising face-to-face only. Three areas were identified by the educators that affected the online supervision of research students as displayed in figure 39.

Figure 39

Ergonomic factors that affect online teaching of research students



These were time zone differences with students (50% of the 8 supervisors), and technology problems that included lack of student software access and restricted technology (38% of the supervisors).

The word cloud for the ergonomic factor identified by the educators indicated that the major problems were doing research supervision online and phone calls with the online students from other parts of the world (figure 40).

Figure 40

Ergonomic factors that affect online teaching of research students.

FGP5 and FGP1 expressed their concerns about lack of physical contact with the students:

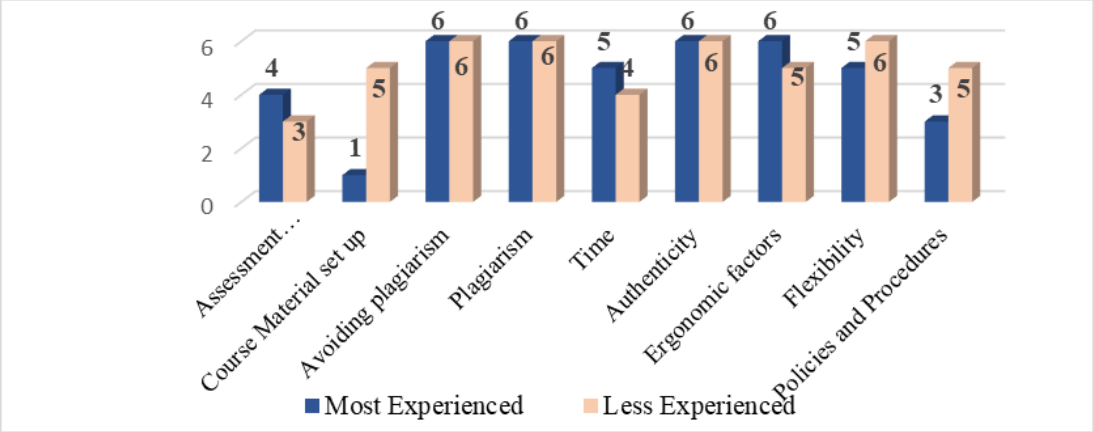
It is difficult not having any physical contact with the students. Sometimes it's like out of sight out of mind. While discussing conceptual things it's easier face to face than online. Less productive in collaborating with research students through the online teaching platform. (FGP5)

I supervise 6 research students online; they are from Kalgoorlie. I speak to them twice per week for around 2 hours each time and also visit Kalgoorlie once a month to get direct interaction with them. (FGP1)

4.3.5. Differences between traditional vs online teaching.

The factors identified by both the 6 more and the 6 less experienced educators between face to face and online teaching are displayed in the following Figure 41.

Figure 41
Differences between traditional vs online teaching by FGPs



The word cloud identified ‘assessment’, ‘activities’, which includes set up assessment questionnaire / course material, avoiding plagiarism, interaction, authenticity, ergonomic factors, flexibility, etc. and connection as the main themes (Figure 42).

Figure 42
Differences between traditional vs online teaching for all FGPs

All the FGP educators said that they preferred face-to-face classes over online classes where possible.

The main differences that emerged were communicating, collaborating, engaging with students as well the attendance being a problem in some cases.

> *The main difference found is in the communication and collaboration with the students. In case of traditional teaching environment, the collaboration and communication are higher than online setup. Another issue is for the assessment, requires extra effort like adding recording facility for the students while doing the assessment or exams to avoid cheating. There are other methods used for this purpose e.g., providing 24 hr window to complete certain task but in this method, there are possibilities of discussion between students. The ergonomic factors can be the organisational ergonomic factor which the stress of completing everything in allotted time, this factor is more stressful for casual/sessional/part-time staff as they are not getting any remuneration for these extra times. (FGP1)*

FGP3 expressed concern at students not attending online classes.

> *When teaching in a classroom the students come to class each week and worked with each other to learn. With online teaching, very few students attend the online classes as these are recorded, and students can watch the class at another time if they feel like watching it. Some of my colleagues have had no students turn up week after week for their online classes. Not all subjects are suitable for online teaching. For example, in the weekly on-campus laboratory classes for workplace human factors the students use equipment to conduct experiments and write their results. This forms one of the unit assessments. There was 100% student attendance and satisfaction with this learning experience. Online a video is shown with someone else doing the experimental work. Students do not have hands-on experience with using the equipment and have no personal interest in the results because it is not their work. There is much less student engagement in online learning. Students just watch via a YouTube video a recorded version of laboratory activities and have to use a previous class's results for their work, which affects their motivation, and they feel less engaged.*

Following is a description of online assessment methods used by focus group participants.

Assessment methods

Assessment in an online environment was reported by FGPs as being challenging. Preparing assessment material for online classes required extra time and effort. Measures were needed to prevent cheating, such as when preparing questions for open book tests the educator needed to consider that the students were able to communicate with each other to answer the questions. Discovering an efficient method to assess the learning outcome of students in online courses is being addressed (Robles & Braathen, 2002). Some academics consider that effective ways of assessing students of online courses need to follow similar characteristics of face-to-face teaching and learning, such as students being given varied and meaningful assignments that will challenge them to think harder (Marshall, 2003). However, online assessment requires a more systematic approach than on campus teaching (Robles & Braathen 2002). The assessment techniques must accomplish desired competency levels; thus, the educators are required to use more innovative ideas to modify the method of instruction and assessment than for on campus teaching and assessments (Liang & Creasy, 2019) as in online platform the nature of human interaction, communication, learning process are all different (Robles & Braathen, 2002).

A study by Asgari et al., (2021) identified that cheating remains one of the major worries for the online examinations and requires using available techniques including online invigilating and randomisations of the examination questions. The comments made by FGP1 illustrate this:

> *Another issue is for the assessment. This requires extra effort like adding recording facility for the students while doing the assessment or exams to avoid cheating. There are other methods used for this purpose e.g., providing a 24-hour window to complete a certain task, but in this method, there are possibilities of discussions between students.*

FGP4 recognised that the creation of the assessment poses difficulty in online teaching platform.

> *In case of assessment creation, online assessments generally use different methods and structures. The students' computer literacy also affects in case of fulfilling some of the specific assessment tasks.*

Similarly cheating also posed a concern for FGPs.

> *For assessment, it is quite difficult as you need to design the assessment in such a way that students are not just copying from the book in the open book exam scenario. (FGP7)*

> *Authenticity of the tests is a major factor. (FGP8)*

FGP9 and FGP11 were also concerned about plagiarism.

> *In the case of assessment methods, it is hard to find a way to help our students to do their work in a proper way to avoid plagiarism. Support from co-worker not much difference, the ergonomic factor is good. (FGP9)*

> *The biggest difference is test/exam. Without an invigilator, it is hard to avoid plagiarism or other misconduct behaviours. (FGPP11)*

The next section discusses comments received concerning online teaching course material.

Preparation of course materials

Designing and preparing course materials for online delivery and on campus are different in many ways. Barker (2002) stated that, using the same course material used for classroom teaching in case of online teaching is not enough. Generally, four basic methodology needs to be followed while creating course material for online delivery. These are:
1) it should be accessible through intranet and/or via internet, 2) facilitate asynchronous and synchronous activities; 3) providing opportunities for shared workspaces to encourage collaborative group working; 4) having scope of on-going assessment to capture regular progress (Barker, 1999; 2000; 2001; 2002). Another area identified by FGP5, was that online laboratory classes were challenging:

> *Laboratory classes are more challenging as the students cannot get hands-on experience. (FGP5)*

According to Barker (2002), online teaching is different from face-to-face instruction, because in online teaching platform teachers and students are not present physically and can be in different geographic zones. According to Baker (2002) the amount of preparation work required increased for online teaching due to the requirements of adding extra activity sessions in order to make the course more collaborative and engaging (Baker, 2002) the comments received from FGP7 and FGP9 supported the above observations.

> *In terms of course material you need to prepare the online course material in such a way that all students can understand irrespective of the basic knowledge i.e., in more detail than in face-to-face class material. (FGP7)*

> *Course materials mainly same only need to add activities at regular intervals to keep the students engaged and make the class more interactive. (FGP9)*

However, FGP4 reported that:

> *Main difference from traditional classroom teaching is missing physical connection. There is not much difference in areas of course materials. (FGP4)*

The need for difference in course materials for online teaching depended on the subjects taught.

Ergonomic factors

The ergonomic factors that affected online teaching were described by FGPs as being mainly the physical and environmental ergonomic factors if the educator was working away from the university and their home office was not set up ergonomically. Other than this, sometimes-organisational ergonomic factors also caused stress and feeling isolated was described as a social ergonomic effect. FGP1 identified organisational ergonomic factor related issues.

> *The difference in ergonomic factors can be the organisational ergonomic factor of the stress of completing everything in the allotted time. This factor is more stressful for casual/sessional/part-time staff as they are not getting any remuneration for these extra times.*

There were mixed responses received from less experienced educators. FGP8 said that not having university access could pose ergonomic related discomfort.

> *Ergonomic factors are very bad for the teachers who do not have access to the university facilities. (FGP8)*

> *Ergonomic factors are good. (FGP9)*

Support from co-workers

The educators working away from the office often experience isolation, the absence of another member of the teaching team, a quick discussion with co-workers regarding some

issues, etc. However, in normal situations, like not in lockdown situation when the educators are allowed to come to university, though they are involved in online classes but still they receive all types of support from co-workers as needed. The less experienced educators thought that there was not much difference in receiving support from co-workers specially at the time when it needed

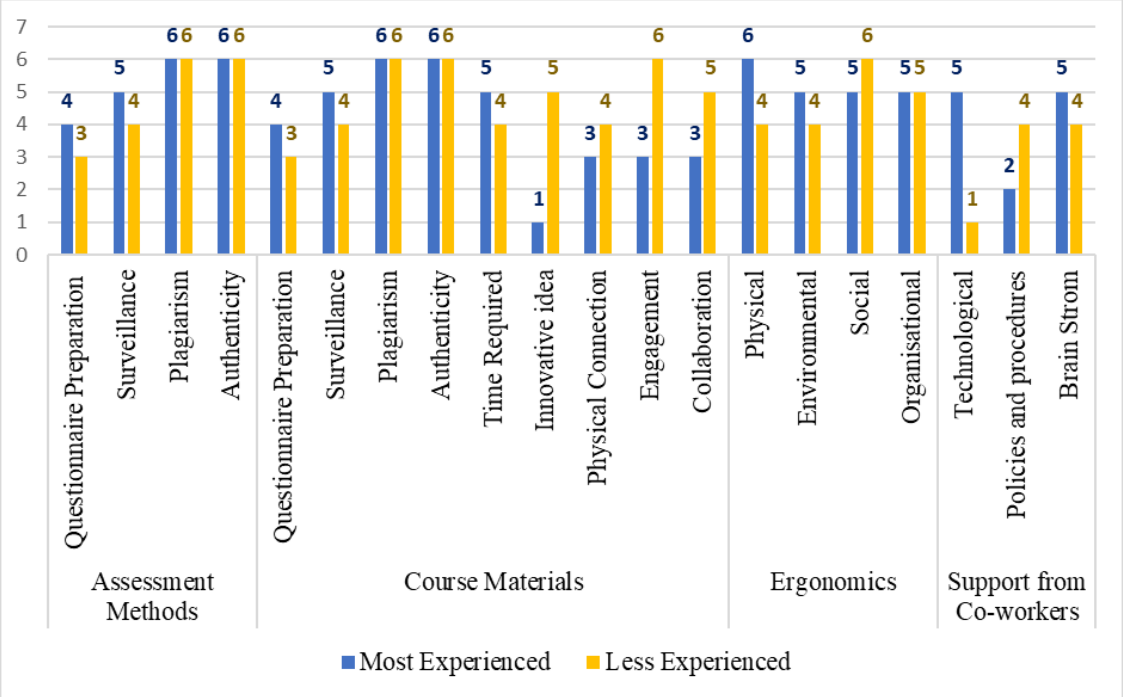
> *Co-workers are all busy but if there is a need always, I get help from my co-workers unlike in the COVID-19 situation when you have to work from home and cannot meet your co-workers. (FGP7)*

The Comparison of differences and similarities between traditional vs online teaching for Most and Less Experienced Educators

The Comparison of differences and similarities between traditional vs online teaching for Most and Less Experienced Educators were displayed in the graph below (figure 43).

Figure 43

The comparison of on campus vs online teaching for all FGPs



Similarities- Both the educators with more than and with less than 3 years' experience in online teaching said that the hardest part of online teaching was to develop the questions especially for science subjects, the authenticity of the assessment and reducing plagiarism

in an open book examination scenario. Preparing course material was also challenging as they needed to develop it in such a way that it would engage the students in online classes.

Differences- Five (83%) experienced educators reported stress due to time constraints, while only 4 (67%) of the 6 educators with less than 3 years online teaching experience reported lack of time as a problem.

4.3.6. What helps you to teach most effectively in online teaching.

While discussing the factors affecting the educators positively with online work the more experienced FGPs identified interaction, support, time, classroom, flexibility and computational. The less experienced educators identified similar factors except 'time' and 'support', but they additionally mentioned 'software' as a positive factor (figure 44).

Figure 44

Factors helps online educators to teach effectively.

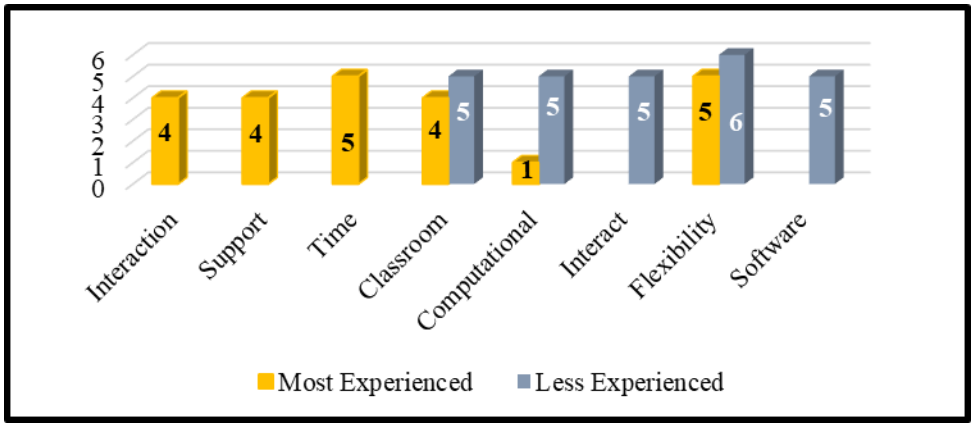


Figure 45 shows the most used words describing the factors that helped participants teach effectively online.

Figure 45
Factors helps online educators to teach effectively

The above word cloud identified ‘interaction’ representing student-teacher interaction, ‘support’ represents receiving good support from different departments of the university in the process of preparing for the online class, ‘time’ meant online teaching requires more time and the extra hours spent will be directly proportionate with increasing the effectiveness of the online teaching. ‘Room’ was interpreted as there was no rush to make the room available for the next lecture as well as it’s easy to schedule another class without the hassle of going through all the formalities to book a classroom. Also, the students can revisit their lecture anytime they want which gives them the flexibility to watch the lecture repeatedly to clear their doubts. The availability of enough time was reported as being required to help to improve the effectiveness of online teaching. Many students join online classes from different countries as well as from different socio-economic backgrounds, which affect their accessibility towards required equipment (e.g., laptop computer) and fast internet service.

> *Time –the more time spent the more effectively the class is taught, so despite getting remuneration for fixed hours lecturers work more hours to teach effectively. Different students work differently, as well as generally. In traditional courses the students are generally full-time student with part-time work but in online platform, most of the cases are opposite like full-time worker and part-time student, for this reason, students generally do not spend enough time but of course, always there are exceptions.*

According to FGP3 receiving adequate support from each level helps her to teach effectively online.

> *Getting good support from the university on an educational level and learning different ways of teaching and of using new educational tools. The learning support people assist with making films for teaching and with using new teaching technology, all of which can improve teaching effectiveness.*

Access to resources were the main area FGP4 thought helps to enhance effectiveness.

> *Having a computer, good internet service, and online access, a lot of the effectiveness comes from interaction from the students. Also depends on the topic you are teaching.*

Other factors like 'Flexibility' represents the flexibility of time, place, etc. as mentioned by FGP8.

> *Like the time flexibility factor for an online class. Everything is against online class, growing up with on campus teaching environment so still quite uncomfortable with online teaching platform. Also, there are a lot of areas in online teaching that needs improvement. Online teaching has a long way to go.*

FGP9 talked about interaction.

> *I am not for online teaching. I like to work with my students face-to-face and interact with them. Still cannot figure out yet if there is anything that helps me to teach effectively in an online scenario. I am taking an online class as I am required to do this, so maybe in future I will figure it out.*

Quick access to the software, getting enough and timely support and assistance from relevant departments was reported by FGP10 as helping to teach effectively online.

> *Quick access to software (e.g., switching between online lecture notes, blank pages to scribble on, Matlab editor) and the fact that students can see what I see on my screen allows them to understand how a problem is solved from scratch and what material is important to achieve that.*

The similarities and differences identified as the most effective factors to teach online are described below.

Similarities- Both groups agreed that better technology, the internet, and device such as smart phone, tablet etc. were important factors for effectiveness in online teaching.

Differences- Educators with more than 3 years online teaching experience reported that spending extra time makes their online teaching more effective. Support from the technical team at the university also helped. Educators with less than 3 years online teaching

experience reported that flexibility was the main factor required for them to teach effectively.

4.3.7. Barriers experienced in online teaching

The barriers identified in online teaching by both experienced and less experienced educators were ‘physical interaction’, ‘internet issues’, ‘no show’, ‘missing attendance’, ‘less communication’, ‘technological issues’, ‘delayed feedback’, ‘time differences.’ ‘Initial setup’ and ‘able to use recorded lectures’ were also identified by experienced educators. While the inexperienced educators additionally identified ‘phycological’, ‘engaging students’, ‘handling new tools’, and ‘accessibility to technology’ as barriers to achieve desired effectiveness in online teaching platform. The following graph (figure 46) described the issues identified as a barrier to online teaching work by more and less experienced educators.

Figure 46

The barriers of identified by experienced and less experienced educators

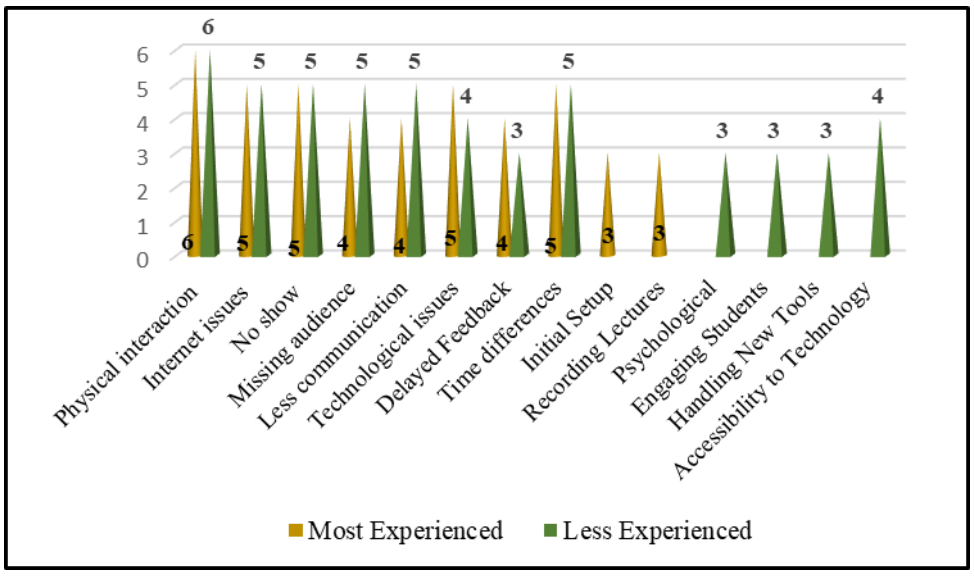
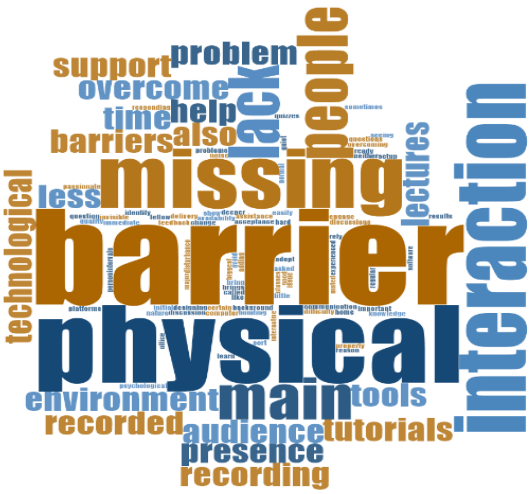


Figure 47
Factors identified as barrier to online teaching



The word cloud (figure 47) identified 'interaction' between student and educator and between students, 'missing', 'audience' as in the missing audience, 'interaction', 'physical' represents lack of physical interaction from the students as mostly they either do not show up or they stay invisible, and students do not ask any questions throughout the class. Other factors showed up in the word cloud were 'technological', 'internet' issues, 'feedback' as in receiving delayed feedback, etc. For the educators working away from the office the biggest barrier was the initial set up of the home office and tools for the online delivery of lectures i.e., a workstation, chair, environment, internet and properly working software. FGP5 identified the main barrier for was teaching from a shared office.

> *Fixed set up is preferable, due to difficulties in teaching online from a shared office. Generally, try to do the teaching from empty classroom or meeting room, which sometimes becomes challenging to find.*

The FGPs of the less experienced educators' group stated that they did not feel comfortable transitioning from on campus classroom teaching to online teaching.

> *If there is an option, I would like a face-to-face class. The main barrier is the psychological acceptance of the change from face to face to online, but maybe after a number of years when online will be the normal way of teaching then we will adopt it more easily. Need to learn how to engage the students. Technological issues like internet dropouts are another issue. In some instances, the IT support team is very good but, in some cases, they were also not aware of the technology so they cannot help. Technology use in the online teaching area is still growing and is not very advanced. (FGP7)*

To overcome the barriers, the educators reported trying to be more compassionate with the students while taking classes or workshops or tutorials, as well as adding interactive tools e.g., quizzes and discussions at regular intervals to engage students. Also, answering the students' questions or clarify information through a phone call after class when required. The similarities and differences in the factors identified as barriers to online teaching work for online educators are as follows.

Similarities – FGPs from both experienced and less experienced groups thought physical interaction, internet issues, no show or missing audience, less communication between students and educators as students are reluctant to switch on their camera and to talk were the main barriers.

Differences – Three educators who had more than 3 years of online teaching experience reported that the initial setup for online teaching at home, getting a quiet place for recording, setting up new classrooms as per availability for recording online class were the main barriers. For educators with less than 3 years of online teaching experience knowledge of technology, knowing the best way to utilise software, issues related to being able to use software outside the university campus were the main barriers.

4.3.8. The most important factors recommended as required to enable online teaching work

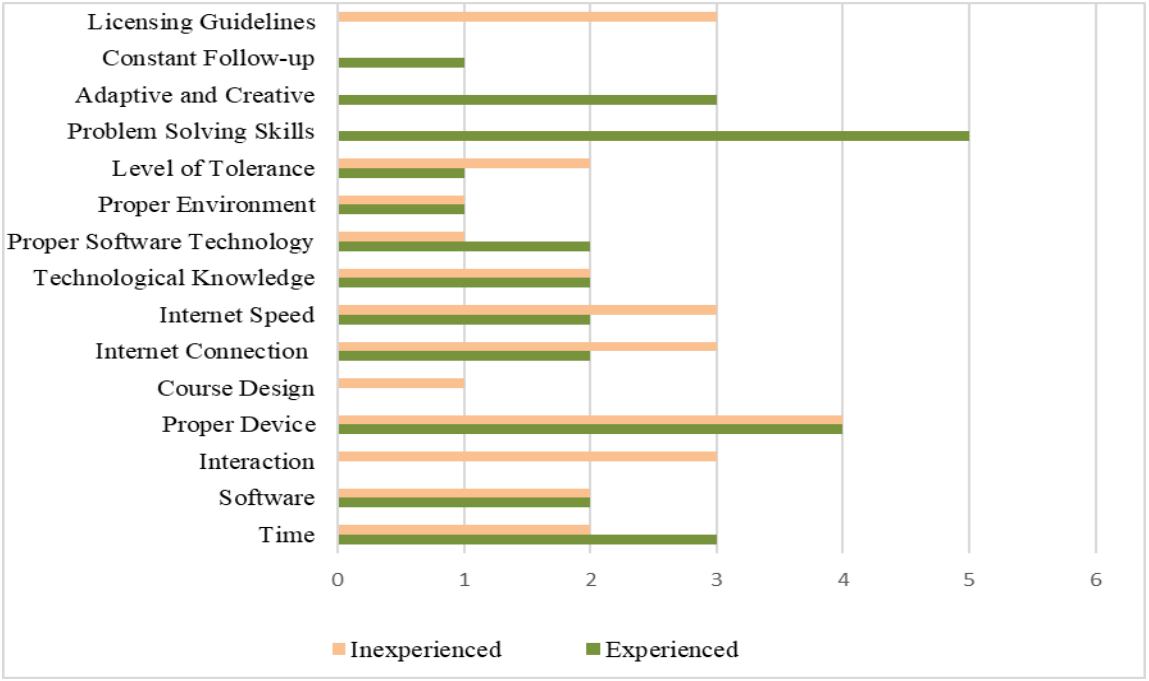
The most important factors described were to be patient, tolerant, ability to understand the students, open to quick problem-solving attitude, being creative in designing online learning strategies for students, being adaptable, a good understanding of the subject and pedagogy, and being aware of online teaching barriers and ready to give extra attention to the students with English as a second language (Baran et al., 2013). Both educators and students should have access to software (e.g. shared screen where we can show: blank notes to scribble on with table+stylus, pdf lecture notes, Matlab editor, etc.), be computer literate, understand the software they were working with, have an internet connection with good speed, a suitable environment when teaching or learning from home, space, and a quiet area plus good physical ergonomic factors such as chair and desk arrangement (OECD, 2016). Getting regular feedback from students and enough time also helped educators to improve their work. For online teaching work the educator has to be computer literate, know about the software they are working with and receive the necessary training ahead of

time, establish a mutually respectful relationship/partnership with students so students feel the urge to engage back, do constant follow-ups with students going under the radar, have a good understanding of the subject and pedagogy and be aware of online teaching barriers (Bennett & Lockyer, 2004).

Both experienced and less experienced FGPs identified nine similar factors as the most important factors which enables them to successfully do their online teaching work. The factors were ‘time’, ‘appropriate software technology’, ‘correct device’, ‘technological knowledge’, ‘good internet connection’, ‘good internet speed’ and ‘correct work environment’. The other factors identified by the experienced educators were ‘problem solving skill’, ‘adaptive and creative’, and ‘constant follow-up’, while the inexperienced educators identified factors like ‘course design’, ‘interaction’, and ‘licensing guidelines’, as facilitating factors in online teaching environment. Figure 48 displays the similarities and differences of both groups.

Figure 48

Facilitating factors identified by More and Less Experienced Educators



The word cloud (figure 49) identified the following words to enable successful online teaching work, the most common words were ‘different’, ‘time’, ‘technology’ and ‘need good software.’ The discussion with the educators identified that students should have a suitable ‘device’ to successfully join the online courses.

Figure 49

Recommended enabling factors to teach successfully online

The comment of FGP1 supports this.

> *The most important factors recommended for successful online teaching are proper equipment for both educator and student, software, internet connection and speed, proper environment while teaching or learning from home, space. (FGP1)*

FGP3 said that the technology used for the teaching upgrades can be a challenge.

> *Technology changes frequently. There is the challenge of using the latest version and identifying better ways to use technology to improve online teaching. The learning support team is very helpful. University-provided educational sessions are good. In those sessions, we can also learn from other participants by discussing with them what they do in their online teaching, what works, and what does not work. (FGP3)*

The word ‘different’ represents that online courses require different ways to design the course contents to engage students. ‘Time’, refers to requiring more time for course design. Educators struggled with the licensing issues of engineering software and had to check all the licensing restrictions so that students in other countries were able to study online.

FGP7 identified that the time zone differences between countries affected students studying online.

> *Need to improve the involvement between the audience and the online educator. In the university forum the students should have some control over choosing their class timetable as different students join from different parts of the world with different time zones, so sometimes for some students' classes are in very odd hours which affect their concentration and motivation. Need to consider the time difference between different countries. Need to increase the efficiency of the platforms. Sometimes you post something on Black Board, but students want this information via email, so there must be some option for choosing the way you want to send the message.*

FGP8 recommended that the licensing guidelines should be checked so that students were able to study online as the licence for some software only allows the software to be used at the university, or on university computers.

> *When we are teaching engineering software, most of the time students struggle with the licensing criteria as students are working from home and these licenses only work in Curtin computers. Sometimes students use their phones or tablets for class and some students do not even have a computer. Therefore, universities should have some prerequisites for students before they join online courses. It is very hard to maintain the level of quality if students join the class with different devices like smartphones, tablets, etc., and this makes the online classes inefficient.*

The similarities and differences in factors identified by both groups are described below:
Similarities– FGPs of all groups mentioned that spending more time was required, as different subjects required a different way to design the course material, availability, and usage of the correct device was required so that all the technology was compatible with the university technology.

Differences- Only the online educators with less than 3 years online teaching experience said that students struggle with the licensing criteria of software as some software only worked within the university campus.

4.3.9. Exit question:

Exit question.

The exit question asked participants if there was anything else that they would like to talk about regarding their online teaching experiences.

Figure 50
Online teaching experiences additional information.

Everyone was happy to be involve in online teaching as this provided an opportunity to have flexibility and to accommodate a large population of students from different countries. Both more and less experienced educators talked about eight common factors related to their online teaching experience as ‘Internet’, ‘course design’, ‘noise’, ‘time difference’, absenteeism’, ‘technology’, ‘flexibility’ and ‘physical interaction’. While the more experienced educators described an additional four areas of experiences in online teaching as ‘time’, collaboration’, ‘assessment’ and ‘shared office’.

Using Word Frequency queries, the word cloud (figure 50) identified the main words which were frequently used in the discussions. The most common words used were time, physical interaction, and flexibility. Educators stated that while teaching online students from different parts of the world it was recommended that the educators should be aware of the culture and the restrictions in the countries, they had students from. A challenge identified by the experienced FGPs was that not all subjects were suitable for online teaching as stated by FGP5.

> *All types of subjects are not suitable for online teaching. Some subjects are very suitable some are less, and some are very difficult. So, it needs to be identified which subjects are suitable and not try to teach unsuitable subjects online. (FGP5)*

FGP4 was concerned about the quality of online courses as some of the courses were only available face-to-face and emergency shift to online version was made quickly to deal with the restrictions imposed after the outbreak of COVID-19 pandemic.

> *Always have online courses in order to accommodate students from different countries/ mature age students which already have been designed appropriately. However, in the time of the COVID-19 pandemic the sudden requirement of pushing all students to study online urgently, in some instance it might have compromised some good practices as everyone did not get enough time to design the transformation of face-to-face classes to an online class version. It was a very stressful situation for everyone.*

Other educators emphasised implementing policies regarding minimum attendance or penalty for no show and to limit the number of students per class to increase engagement. FGP7 stated that, experience in online teaching had an important role in the effectiveness of online teaching.

> *The online teaching improved the way we do it over time, the way you know the platforms, the training sessions provided by the university are quite good and helpful. Once you know all the functions of the technology platform you can utilise them in a better way.*

There were no common positive or negative themes identified by both experienced and less experienced focus group participants.

4.4. Summary of focus groups findings

A purpose of the focus groups was to identify and assess ergonomic factors that affect educators' experience with online teaching and to use the results to develop an online questionnaire for the main part of the research study. Based on the research aim the objectives identified were the following:

1. Ergonomic factors that are perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering.

This objective was achieved through the answers provided to focus group questions 2, 4, 11, 12 and 14.

Positive- After carefully analysing the answers, the FGPs of both groups felt positive about the overall flexibility and having less or no travel time requirement when teaching online.

It was stated that the main factor for effectiveness in online teaching work were the availability of good technology, having an internet connection with good internet speed, and having device such as a computer, smart phone, tablet etc. The software and technology help to increase flexibility, and good software packages and technology tools were available.

Negative- It was obvious that online teaching was very time consuming and that it required more time than allotted to the educators. Different subject areas also require different ways to teach the unit of study and required different types of software, design, assessments, etc. Everyone agreed that absenteeism, non-collaborative nature of some students in class, lack of physical interaction and plagiarism were the main obstacles.

2. ***Ergonomic factors that are perceived by university educators to be a barrier to providing online teaching.***

This objective was achieved through the answers provided to focus group questions 3, 11, and 13. 'Lack of interaction (physical/visual)', 'Missing attendance or No show', 'Technological issues', 'Internet issues/dropout', internet issues, less communication between students and educators as students are reluctant to switch on their camera were the main barriers. Another difficult part of online teaching was described as developing questions especially for science subjects, the authenticity of the assessment and reducing plagiarism in open book examination scenarios. Preparing course material was also challenging as asses.

3. ***The differences in perceived factors between engineering and other academics.***

Focus group question one asked for demographic information. Of the 12 academics who took part in the 4 focus groups 9 taught engineering subjects and 3 taught non engineering subjects. The 3 FGPs who taught non engineering subjects were the only female focus group FGPs and all had more than 3 years' experience in online teaching, which may have biased the results. The educators that taught engineering subjects mainly described their challenges teaching mathematical expressions online, facing challenges with using university supplied software outside the university campus due to licensing restrictions and facing difficulty with regulations for using some software in other countries. To keep

working with the students for online laboratory experiments was hard due to lack of physical work by students which sometimes de motivated students.

4. Causal relationship of five ergonomic factors towards experience in online teaching. This objective was achieved through the answers provided to focus group questions 5, 6, 7, 8, 9 and 10. Five FGPs out of 6 FGPs from most experienced group and all 6 FGPs from less experienced group stated that they were working from their university office. All FGPs from both groups stated that they worked long hours sitting in the same posture if they did not have a sit stand desk. Educators emphasised the background noises due to using shared office, corridor, laboratory situated next to the room, etc. disturbed them when doing online teaching work. FGPs of both groups missed physical/visual interaction with students in online classes. FGPs of both focus groups described taking extra time/hours to complete all the demands of online teaching, such as unit of study teaching material preparation, providing feedback, answering emails or messages, etc. A challenging part of their work was preparing online test material and conducting the actual test while maintaining the authenticity and avoiding student plagiarism. Time differences between countries and the accessibility to some software also affect the educators.

Three of the experienced educators described using sit stand desks to allow for changes in working posture while the remaining focus group participants did not. The educators who had more than three years of online teaching experience were very conversant with the university's policies and procedures towards online teaching-related matters whereas the educators who had less than three years of online teaching experience struggled to identify the university policies and procedures related to online teaching.

4.5. Questionnaire development

Based on the answers of the focus group participants the following table 17 shows the questions developed from the answers to each focus group question.

Table 17
Questionnaire Development

	Focus Group Question	***Questionnaire Questions developed.***
1	Please share with the group your employment position, type of employment, number, and type of units of study that you teach online.	Demographic section, Questions 5, 6, 9, 10, 14.

	Focus Group Question	*Questionnaire Questions developed.*
2	What engages you most in teaching in an online teaching and learning environment? If none, what are the relevant factors that might have caused this?	Open ended Question 119.
3	Do you come across any problems with teaching in an online environment? If yes, what are these problems?	Question 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 48, 49, 51, 53, 55, 58, 60, 61, 62, 63, 64, 66, 67
4	Do you find that available software and technology influences your online teaching practice, assessment development, student engagement or anything else? If so, what are the advantages and disadvantages that you have found with technology and software in online teaching?	Question 28, 40, 41, 44, 46, 47, 49, 5, 52, 53, 54, 55, 64
5	Physical ergonomic factors are related to human anatomical and anthropometric measurements. Examples include having a comfortable chair, enough room to do your teaching work, a desk, and a computer to use that is at an appropriate height. Are there any physical ergonomic factors that affect your online teaching? If so, is the effect good or bad? Explain why.	Physical Ergonomics Section Questions 70 (a, b, c, d, e), 71 (a, b, c, d, e, f, g), 72 (a, b, c), 73 (a, b), 74 (a, b, c, d), 75, 76, 77.
6	Environmental ergonomic factors are related to your teaching environment. Examples are the noise, lighting, workplace temperature and ventilation in your teaching environment. Are there any environmental ergonomic factors that affect your online teaching? If so, is the effect good or bad? Explain why.	Environmental Ergonomics Section, Questions 78 (a, b, c), 79 (a, b, c, d, e), 80 (a, b), 81(a, b), 82 (a, b, c), 83, 84 (a, b, c, d), 85
7	Organisational ergonomic factors are those that are controlled by the University. Examples are allotted time for updating the materials, marking the assignments and providing feedback using Blackboard. Are there any organisational ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why.	Organisational Ergonomics Section, Questions 86, 87 (a, b, c, d, e, f), 88 (a, b, c, d),89, 90, 91.
8	Cognitive ergonomic factors are related to how you think and process information. Examples are if you know and understand all university policies and procedures, Blackboard, Turnitin, and online educational tools. Are there any cognitive ergonomic factors that affect your online teaching? If so, is the effect good or bad? Explain why.	Cognitive Ergonomics Section, Questions 92, 93 (a, b), 94, 95, 96, 97, 98, 99.
9	Social ergonomic factors are related to your interaction with other people. Examples are the opportunities for collaborating with students and co-workers in your online teaching and all communication. Are there any social ergonomic factors that affect your online teaching? If so, is the effect good or bad? Explain why.	Social Ergonomic Section 100, 101, 102, 103, 104, 105, 106, 107, 108.
10	Are you involved in supervision of online research students? If so, please describe any ergonomic factors that affect your online teaching of research students.	Question 65, 66, 67, 68, 70
11	What differences have you found between traditional classroom teaching and online teaching in the areas of course materials, assessment methods, and support from co-workers, and any ergonomic factors?	Open ended question number 112
12	In the online teaching environment what helps you to teach most effectively and why?	Open ended question number 18, 20, 21, 22, 23, 24, 25, 26, 113

	Focus Group Question	*Questionnaire Questions developed.*
13	Describe any barriers you have experienced in online teaching and why these were barriers. If you did experience a barrier, how did you overcome this barrier?	Open ended question number 114, 115
14	What are the most important factors you would recommend are required to enable you to teach successfully in the online teaching and learning environment?	Open ended question number 116
15	Is there anything else that you would like to talk about your online teaching experiences?	

A copy of the questionnaire is included in Appendix 8.

4.6. Chapter Summary

The qualitative thematic analysis method was determined to be the best method to conduct the analysis of the focus group question answers for this research for exploring the factors that affected the educators teaching online. The answers of the 12 focus group participants helped to determine the questions for the Pilot study. The next section of this report included the pilot study results and main study questionnaire answers.

5. QUESTIONNAIRE RESULTS AND DISCUSSION

5.1. Introduction

This chapter reports the results of the main study in which data was collected through a questionnaire to answering the research aim and objectives. The questionnaire was administered through Qualtrics. This chapter includes and discusses the quantitative and qualitative data analysis on data collected from the completed questionnaires. The first part of the questionnaire contained 17 demographic questions. The 2nd part included 47 Likert scale questions. The answers to this part of the questionnaire were analysed using quantitative statistics.

5.2. Quantitative Data analysis

5.2.1. Data coding, factors, and analysis methods

A total of 121 participants completed the survey. The collected data from closed ended survey questionnaires was critically reviewed, the clean dataset and subsequently entered and coded in SPSS software. The study collated and segregated the response under the variables of: (i) demographic factors; ii) Likert scale questions and iii) Ergonomic factors related questions. The demographic factors were further coded into the classifications of (i) No = 0, and (ii) Yes = 1; or (i) Male = 0, and (ii) Female = 1; and so on. Descriptive statistical analysis was conducted using SPSS (v29) data analysis software for frequency distributions and percentages of demographic factors.

To achieve the research objective #3 (differences in the perceived effects of ergonomic factors between engineering and other academics who conducted online teaching) and #4 (relationship of the five ergonomic factors towards experience in online teaching), a quantitative analysis was performed using SPSS (v29) software. Descriptive statistics were used to analyse the demographic details along with binary logistic regression analysis to measure the association between two variables.

This research has captured and analysed the educators' online teaching experience against the various demographic factors of the participants including Gender, Subjects taught (Engineering/Non-Engineering), Country (Developed vs Developing), Permanency status (Fixed-term vs Ongoing and Casual vs Ongoing), Total teaching experiences, Teaching

from (university campus/ outside of university campus), and if extra support was required due to the COVID-19 pandemic.

The quantitative analysis was conducted in four stages: The first descriptive data analysis was performed through SPSS to identify the frequency and percentage of respondents' demographic factors. The second stage involved assessing and establishing the relationship between demographic factors against each ergonomic factor. The third stage involved assessing and establishing the relationship between demographic factors against years of online teaching experiences. The fourth stage entailed assessing and establishing the relationship between each ergonomic factors and years of online teaching experience of the participant educators.

This was followed by the bivariate and multivariate logistic regression analysis to assess the associated risk factors between each ergonomic factors with the demographic factors including gender, age, subjects taught and permanency status of the participant educators, and the associated risk between each ergonomic factors with years of online teaching experiences.

The educators' online teaching experiences were also analysed against each ergonomic factor to discover if there was any significant relationship between them. The continuous variable online teaching experience was then converted to a categorical variable. For analysis, the participants' responses were categorised into less than or equal to 3 years and more than 3 years of online teaching experiences and then subjected to multivariate (binary) logistic regression. Experience was coded in this way because the format of the questionnaire had nine categories and the number of responses received for each category were less than one year (16) / 1-3 years (60) / 4-6 years (11) / 7-9 years (14) / 10-12 years (14) / 13-15 years / 16-18 years/ 19-21 years and more than 22 years. None of the participating educators had online teaching experiences for the last four categories, and the 63% had less than, or equal to, 3 years of online teaching experiences. The amount work experience was adjusted in the crude odds ratio (COR) and adjusted odds ratio (AOR) as described in following sections.

5.2.2. Crude Odds Ratio (COR)

In bivariate analysis, COR is calculated by normalising the factors/effects with respect to experience (number of years teaching in online teaching platform).

Less Experienced – Yes =’a’. No = ‘b’. Total =’a+b’.

More Experienced – Yes = ‘c’. No = ‘d’. Total = ‘c+d’.

Odds (for Less Experienced) = a/ (a+b) ≈ a/b [‘a’ being very small compared to ‘b’, a+b ≈ b]

Odds (for More Experienced) = c/(c+d) ≈ c/d [‘c’ being very small compared to ‘d’, c+d ≈ d]

In bi-variate analysis

$$Crude\ Odds\ Ratio\ (COR) = \frac{a/b}{c/d} = \frac{ad}{bc}$$

COR may give the deceptive result, as the influence of other variables is not adjusted. In multivariate (binary) logistic regression analysis, the influence of all variables is adjusted, and it gives the AOR.

Multivariate (binary) logistic regression analysis is an extension of bivariate (i.e., simple) regression in which two or more independent variables (x_i) are taken into consideration simultaneously to predict a value of a dependent variable (Y) for each subject and gives AOR.

If x_{gend}, x_{sub}, x_{age}, $x_{country}$, x_{perma}, x_{atype}, $x_{totalexp}$, x_{teacf}, and x_{stress} represent the risk factors gender, subjects taught, age, country, permanency, academic type, total teaching experience, teaching from and stress (independent variables), respectively, and y is a binomial outcome variable with p = probability of injury, then the multivariate (binary) logistic regression model is given as follows:

$$\text{logit}(p) = \ln\left[\frac{p}{1-p}\right]$$

$$= \beta_0 + \beta_{gend}\, x_{gend} + \beta_{sub}\, x_{sub} + \beta_{age}\, x_{age} + \ldots + \beta_{country}\, x_{country} + \ldots\ldots\ldots + \beta_{stress}\, x_{stress}$$

$\ln\left[\frac{p}{1-p}\right]$ is called the logistic transformation and it is used as the dependent variable.

The term $\left[\frac{p}{1-p}\right]$ is known as the odds of risk.

5.2.3. Adjusted odds ratio (AOR)

Considering two individuals with different values for online teaching experience (coded as '0' which represents less experienced and '1' which represents more experienced) and the same values for all other variables in a multivariate (binary) logistic regression model is shown as follows:

Risk Factors								
Individual	gender	subject		age	…	type	…	stress
A	x_{gend}	x_{sub}	0	x_{age}	…	x_{type}	…	x_{stress}
B	x_{gend}	x_{sub}	1	x_{age}	…	x_{type}	…	x_{stress}

In this case, the multivariate (binary) logistic regression equations will be as follows:
For individual A:

$$\ln\left[\frac{p_A}{1-p_A}\right] = \beta_0 + \beta_{gend}\, x_{gend} + \beta_{sub}\, x_{sub} + \beta_{age}\, x_{age} + \ldots + \beta_{country}\, x_{country} + \ldots\ldots\ldots + \beta_{stress}\, x_{stress}$$

For individual B

$$\ln\left[\frac{p_B}{1-p_B}\right] = \beta_0 + \beta_{gend}\, x_{gend} + \beta_{sub}\, x_{sub} + \beta_{age}\, x_{age} + \ldots + \beta_{country}\, x_{country} + \ldots\ldots\ldots + \beta_{stress}\, x_{stress}$$

Subtracting 2nd equation from 1st, we obtain

$$\ln\left[\frac{p_A}{1-p_A}\right] - \ln\left[\frac{p_B}{1-p_B}\right] = \beta_{exp}$$

$$\ln\left[\frac{p_A/(1-p_A)}{p_B/(1-p_B)}\right] = \beta_{exp}$$

$$\left[\frac{p_A/(1-p_A)}{p_B/(1-p_B)}\right] = e^{\beta exp} \qquad \text{i.e., } \frac{Odds_A}{Odds_B} = e^{\beta exp} \qquad \textit{Adjusted Odds Ratio (AOR)} = e^{\beta exp}$$

During the analysis, all the risk factors with $p < 0.05$ were examined first. Next included were other factors with $p < 0.1$ to explore their effects. The risk factors that returned $p < 0.05$ were considered as a predictor of significant effect, and their CORs and AORs at 95% confidence interval were noted. The CORs were generated by testing one risk factor against the number of factors and AOR by inputting several factors in the model.

5.2.4. Results

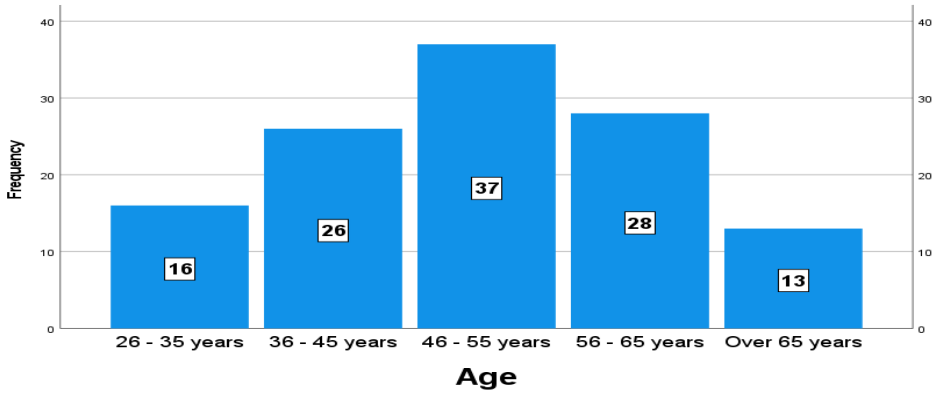
5.2.4.1. Demographic Analysis

The first questions asked respondents for their demographic information including gender, age, employment permanency status, employment position and years of online teaching experience.

Age Distribution:

Most respondent educators were in the age group of 46-55 years (n = 37, 31%) with a little lower percentage of the respondents being in the age groups 56 - 65 years (n = 28, 23%) and 36-45 years (n = 26, 22%). Other respondents were 26 - 35 years (n=16, 13%) and over 65 years with (n= 13, 11%). None belonged to the less than 25 years age category. The following graph, figure 51, shows the age distribution of the participant educators.

Figure 51
Age distribution of online Educators



Years of Teaching Experience.

Figure 52
Years of Teaching at a University

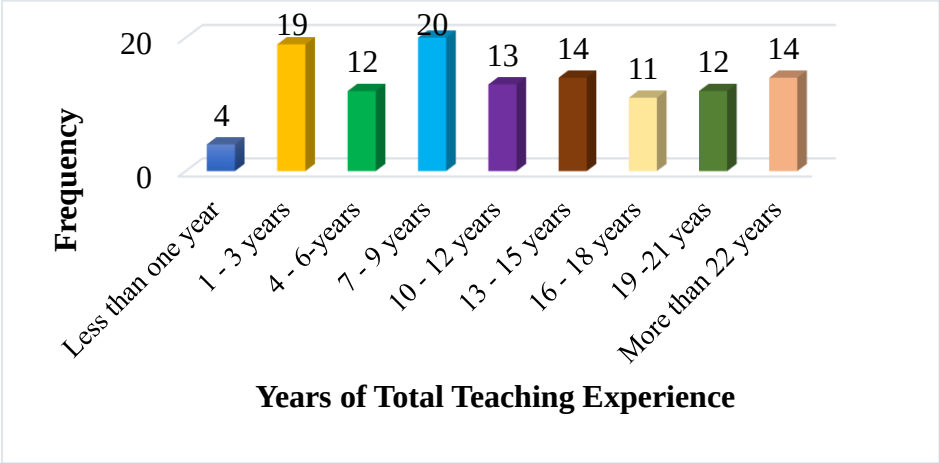
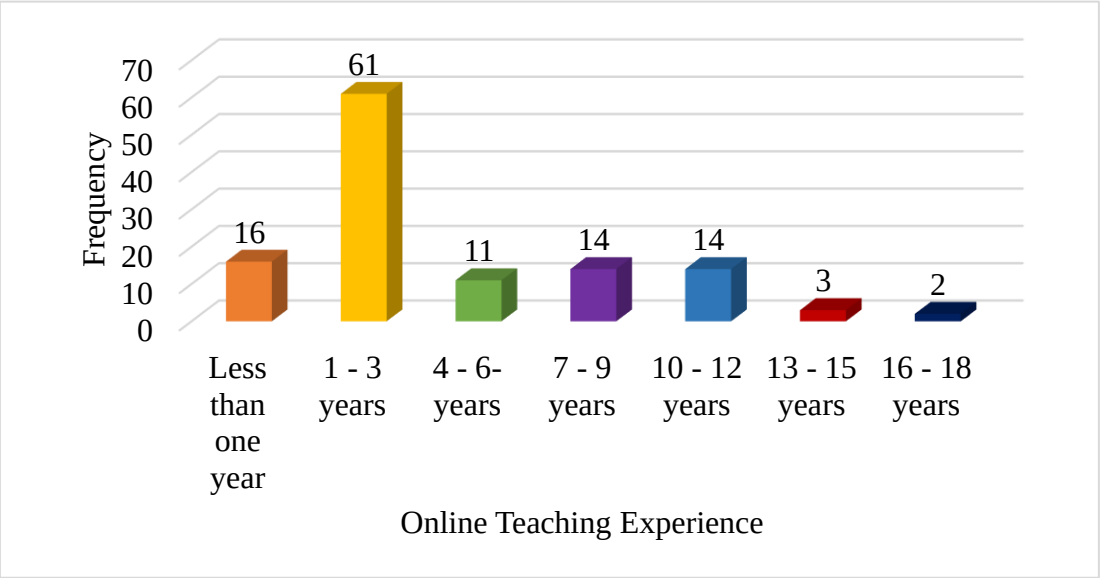


Figure 52 shows that the main two groups of educators i.e., '1-3 years' and '7-9 years' had the highest number (n= 19, 16% and n=20, 17% respectively) of participating educators. This was followed by teaching at a university for 'more than 22 years' and '13-15 years' (n=14, 12% each), '10-12 years' (n=13, 11%), and the same number (n=12, 10%) for both '4-6 years' and '19-21 years.' Only 4 (3%) of participants had less than a year's university teaching experience indicating that most were experience educators as 70% had 7 or more years of university teaching experience. Two respondents did not answer this question indicating that they did not consider that they had significant teaching responsibilities.

Online Teaching Experience.

Sixty-four percent of respondents (77) had been teaching online for 3 or less years and no educators reported teaching online for more than 18 years, even though 12% (14) of the participants had more than 22 years of university teaching experience.

Figure 53
Years of Experience in Online Teaching



As shown in figure 53 the most frequently occurring value (mode) was 1-3 years of online teaching (61). The mean (average years of online teaching divided by the number of participants) was 4.3 years (calculated by using the middle value of each range multiplied by the number of that age group, then dividing the total years by the total number of participants). The median is the midpoint of the frequency distribution, and this was 14 years. The Standard Deviation (how much the range of online teaching years differ from the mean of 4 years) was 20years, which is a high standard deviation value indicating that the values are spread out over a wider range. The data shows that experience in online teaching for less than 3 years was higher (77) than more than 3 years of online teaching experience (44 participants). This indicates online teaching has become more common in the last three years. This survey was conducted at the end of 2022. According to a UNESCO report, in December of 2019 Coronavirus (COVID-19) started rapidly spreading worldwide (Ali, 2020). Consequently, countries began introducing distance education as a relevant strategy to reduce the spread of this virus. Since 12th of March 2020 forty-six countries in

five different continents had announced off campus learning for school and university students and changed from face-to-face teaching to online teaching to contain the spread of COVID-19 (Huang et al., 2020).

Frequency and percentage of respondents' demographic factors.

The following table 18 describes the frequency and percentages of the demographic factors for all 121 respondents.

Table 18

Demographic details of participant educators (n=121)

Characteristics	**Number**	**Percentage**
Gender		
Male	52	43%
Female	67	55%
Prefer not to say	2	2%
Age		
Lower Age Group	42	35%
Middle Age Group	38	31%
Older age Group	41	34%
Subject Taught	**Participants**	**Number of units**
Engineering	24	53
Education	19	62
Health, Safety and Environment	13	52
Mining and Minerals	13	36
Language and Literature	7	20
Science (Chemistry, Physics) and Bioscience	7	16
Environmental Science	6	14
Recorded *too many units of study to name* *(Presumed each taught 8 units of study a year)*	4	32
Geography	3	20
Mathematics	3	13

Laboratory Practical	3	6
Art	2	20
Sociology	2	8
Computer Science	2	5
Occupational Therapy	1	5
Veterinary	1	4
Management	1	3
Speech Therapy	1	3
Hospitality	1	1
Did not write subject taught	8	
Total	121	371
	Number	**Percent**
Engineering	37	31%
Non-Engineering	84	69%
Country the Educator was teaching from		
Country	**Number**	**Percentage**
Australia	60	50%
China	1	1%
Croatia	2	2%
Czech Republic	3	3%
Ghana	2	2%
India	38	31%
Iran	1	1%
Lebanon	2	2%
Singapore	1	1%
Slovakia	4	3%
Taiwan	2	2%
USA	5	4%
Total	121	100%
Developed country	65	54%
Developing country	56	46%

Online teaching experience	Number	Percentage
≤ 3 years	77	64%
> 3 years	44	36%
Total Teaching Experience	**Number**	**Percentage**
≤ 3 years	23	20%
> 3 years	96	80%
Employment Position	**Number**	**Percentage**
Teaching Focused	58	48%
Teaching and Research	61	50%
Research Focused	2	2%
Permanency Status of the educator	**Number**	**Percentage**
Fixed Term	37	31%
Casual	41	34%
Ongoing	42	35%
Conduct their online teaching from	**Number**	**Percentage**
University Campus	27	23%
Outside of University Campus	93	77%

- *Gender* – The analysis showed that there were slightly more female than male participants.
- *Age* – The age distribution within three age defined age group categories were similar. Lower age group category aged from 25 up to 46 years had the highest number of participants with n=42, 35%, followed by the older age group above 55 years with n=41, 34%, with least numbers of educators from middle age group from 46 years to 55 years with n=38, 31%. No research participants reported being 24 years or younger.
- *Country* – A greater number (n=65, 54%) of participants were from developed countries while developing countries had 46% (n=56) of the participants in this study.
- *Employment Status* – Although the most common employment type for participating educators who conducted online teaching was 'ongoing' employment with 35%, rest 65% of the respondents did not have the security of continuing employment as they were working for a fixed term, such as one semester, or only casually when work was available.

➢ *Employment Type* – Around half of the participant educators (n=61, 50%) were 'teaching and research focused' followed by Teaching Focused (n=58, 48%) and 2 (2%), were research focused staff.

➢ *Total Teaching Experience* – Only 19% (n=23) had less than or equal to 3 years of teaching experience while 79% (n=96) participants had more than 3 years of tertiary education teaching experience.

➢ *Online Teaching Experience* – 64% of respondents (n=77) had been teaching online for 3 or fewer years and 36% (n=44) had been teaching online for more than 3 years. This indicates online teaching has become more common in the last three years. The survey was conducted at the end of 2022. According to a UNESCO report in December of 2019, Coronavirus (COVID-19) started to rapidly spread worldwide (Ali, 2020). Consequently, countries began introducing school closures as a strategy to reduce the spread of this virus. By the 12th of March 2020 forty-six countries in five different continents had announced school and university closures and shifted from face-to-face teaching to online teaching as an infection control measure to prevent the spread of the COVID-19 virus (Huang et al., 2020).

➢ *Conduct online teaching* – Online teaching work can be performed from anywhere. Some educators had allotted office space in which to do their teaching, while other educators, especially casual or sessional staff, were not generally provided with an office space at the university, so they worked outside of the university. Other educators had a choice of using their university office or working from home. The most-reported place where online teaching was conducted was outside the university office e.g., at home.

5.2.4.2. Likert Scale data analysis.

There were 50 Likert scale type questions. These questions were categorised into five groups: Online Teaching (11); Physical and Environmental Ergonomic Factors (4); Organisational Ergonomic factors (9); Cognitive Ergonomic Factors (16); Social Ergonomic Factors (7) and Online Research Supervision (3). The 5-point Likert scale ranged from 'Strongly Agree=1, Agree=2, Neither Agree nor Disagree = 3, Disagree =4, and Strongly Disagree=5'. The participants answers were recorded to identify the number and percentage of participants answers in Table 19 Factor Analysis Results for Likert Scale Questionnaires. Table 19 is located in Appendix 23.

For 121 participants responses the highest agreement score was for ‘Some online students are good communicators, engage well with the educator and other students to promote online discussion and student subject learning (84%). The highest disagreement score (68%) was that ‘At times there is inadequate ventilation in my work environment’ indicating that there was good workplace ventilation.

The Factor Analysis showed that there were 6 main factors in the answers to this part of the questionnaire. The factors were (1) Online teaching facilitating factors, (2) Technology (3) Cognitive ergonomic factors, (4) Organisational ergonomic factors, (5) Physical and environmental ergonomic factors and (6) Social ergonomic factors. Under themes the questions in which there was a major difference between the agree and disagree number and percentage are further described below.

Online teaching facilitating factors.

Online teaching and learning were perceived as being university core functions and integrated into the university’s educational structure by 73% of the respondents. However, 12% of the online educators disagreed. The *flexibility* of online teaching was appreciated by the educators as 49% agreed that they prefer teaching online due to its flexibility (29% disagreed), 52% agreed that they could avoid/minimise travel time (27% disagreed) and 65% agreed that they were more able to balance work and personal commitments while teaching online (23% disagreed). Having their teaching online did allow the educators more flexibility in how they spent their work time.

Half of the online educators agreed that they had no problems with online teaching while 30% disagreed as they had online teaching problems. Benefits of online teaching were reported as being able to use a variety of strategies to assess a student (52% agreed, while 27% disagreed) and teaching online enabled educators to use innovative student learning assessment practices (51% agreed, 18% disagreed). It was reported by 84% of online educators that some online students were good communicators and engage well with the educator and other students to promote online discussions and student subject learning. There was minimal disagreement with this statement.

Time provided for online teaching preparation was important as 75% of educators wrote that online teaching methods needed to be adapted to meet the needs of culturally and intellectually diverse student groups. There was minimal disagreement with this statement. Online teachers were reported by 79% to have the responsibility to be aware of their students' online skills; for example, mature aged students who are new to studying online at a university. As online students become more culturally diverse 64% agreed that the teacher's job became increasingly challenging and time consuming. There were not always adequate resources available for supervising research students who were off campus and studying online according to 51% of the research supervisors, however 31% did report having enough resources.

Some of the difficulties with online teaching were reported as language barriers affecting the educators' ability to interact with students who did not have English as their first language (55% agreed while 22% disagreed). The Blackboard system was documented by about half of the respondents to enhance their sense of isolation from students and co-workers. Other problems documented by 72% of the online educators were that it was hard to motivate and engage students in an online teaching platform and the absence of face-to-face interaction with students was reported as a disadvantage by 73% of online educators. These were also social ergonomic problems. There was a close connection between online teaching and social ergonomics.

Technology

Most of the online educators (83%) agreed that they had adequate computer skills to successfully manage online teaching. There was minimal disagreement with this statement. The use of technology helped to improve online teaching as 67% of the participants reported looking for new technology to enable online teaching innovations, while 12% did not. More than half of the respondents agreed that the prerequisite for having technical skills was not clearly identified before beginning their online teaching with 52% of the participants documenting that the technologies involved in online teaching can sometimes be confusing, so they did not use unfamiliar technology when teaching online but 31% were willing to use unfamiliar technology.

The use of technology is important in the online teaching environment and 58% of the participants reported that at their university support was **not** provided by the university during and after the adoption of new technology for online teaching, while 22% reported receiving university support. A barrier to online teaching was reported by 48% of respondents who agreed that sometimes it is very challenging to cope with the constant change/upgrading of the software, but 31% did not have this problem.

Sometimes there were problems with technology as 79% of educators reported that it was very stressful when there was a computer software failure during class. There was minimal disagreement with this. Fifty two percent of online educators reported encountering unstable internet access during class time, but 29% did not have this problem. Some students did not have adequate technological skills that were required for studying online according to 65% of the respondents however 23% did not find this barrier. It was found to be challenging when university students, enrolled to study online and did not have the technology to use for online learning by 63% of the respondents while 11% reported not finding this a challenge. For online teaching the answers indicated that it was important to have appropriate technology that worked and the skills to use this technology.

Cognitive ergonomic factors.

A cognitive ergonomic problem experienced by 45% of the educators was that there was not enough training and assistance available for the teachers who were transitioning from classroom (face-to-face) teaching to online teaching. There was little or no opportunity to observe other educators using technology for online teaching prior to committing to teach online according to 67% of the online educators. However, 41% agreed that their university had an active peer-mentoring program for online university teaching and using online technology but 32% disagreed with this. That the university offered software education before adoption of each new online software was agreed to by 44% but disagreed with by 33%. In some areas Universities did provide good online teaching education, but not in other areas, such as when educators had to transition from face to face to online teaching.

Generally, there was a good understanding of the students' online communication as 48% of the respondents disagreed with the statement 'when dealing with students I sometimes

misinterpret different communication styles as behaviour problems' however 25% did misinterpret. For online educators who were supervising research students 62% reported that miscommunication is more likely to occur when supervising research students who are off campus and studying online than when supervising research students studying on campus, while 21% disagreed with this. For students who were doing their research education online this indicated that it was easier for many of the educators to communicate with their students face to face than online as then there was less misunderstandings.

Organisational ergonomic factors.

The main theme that came through from questions related to organisational ergonomics was that online educators were expected to do more work in less, or with inadequate, time. Fifty five percent of the online educators reported that the allotted time was not adequate to develop a new online course or unit of study (25% disagreed) and 55% documented that there was inadequate time and university support to learn about new technologies available for online teaching (21% disagreed). Another problem related to work time provided to the online educators was that 55% agreed that some online students required a lot of explanation to understand simple concepts and they were not provided with enough work time to be able to teach at this level (22% disagreed with this statement).

Physical and environmental ergonomics.

In general, the research participants agreed that the physical and environmental ergonomic conditions were satisfactory. As the online educators came from different universities from a variety of countries, and taught a variety of different subjects, it was clear from the above results that there were differences in online teaching problems, barriers, and facilitators at different universities, but that there were also similarities for the question answers with high agreement and high disagreement scores.

Social ergonomic factors

Some of the difficulties with online teaching were reported as language barriers affecting the educators' ability to interact with students who did not have English as their first language (55% agreed while 22% disagreed). The Blackboard system was documented by about half of the respondents to enhance their sense of isolation from students and co-workers. Other problems documented by 72% of the online educators were that it was hard

to motivate and engage students in an online teaching platform and the absence of face-to-face interaction with students was reported as a disadvantage by 73% of online educators. These were also social ergonomic problems. There was a close connection between online teaching and social ergonomics.

5.2.4.3. Relationship between demographic factors and ergonomic factors

A Chi-square analysis was carried out to find the relations of each ergonomic questions with Gender of the participant educator (Male=0, and Female=1), Subject (Engineering = 0, and Non engineering =1), Country (Developed country = 0, and Developing country = 1), Permanency (Fixed term employment = 0, and Ongoing = 2), Permanency (Casual = 1, and Ongoing = 2). The p-value for identifying the significance and Odds Ratio (OR) was used for finding the odds for each factor against each question on specific ergonomic factors.

The physical ergonomic section had seven main questions which were a combination of 17 sub-questions. A Chi-square analysis was performed, and the results are described in Table 20.

Table 20
Demographic factors vs physical ergonomic factors

	Non-Adjustable seat	Inappropriate seat surface size	Inadequate Lumbar support	Seat front not rounded	Worksurface not with the level of elbow	Inadequate worksurface area
Male Academic	1.70	1.0	1.7	1.1	**0.3[c]**	0.6
Teaching Engineering Subjects	0.8	0.9	1.6	1.1	0.9	1.2
Developed Country	0.5	0.6	0.7	0.8	0.4	**0.3[b]**
Lower age gr. in comparison to old age group	1.1	1.0	1.5	1.1	1.0	2.5
Middle age gr. in comparison to old age group	1.1	3.3	1.1	1.6	1.1	3.4
Fixed term Educators vs. Ongoing Educators	1.5	**3.9[c]**	1.2	1.3	**4.6[c]**	1.7
Casual Educators vs. Ongoing Educators	**0.3[c]**	0.75	**0.3[b]**	0.5	3.2	1.3

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

Table 20 Continued

	Inadequate height clearance of workstation	Inadequate width of worksurface	Inadequate availability of leg space	Not using Sit-to-stand desk	Inadequate accessibility to the resources	Inadequate resource storage space
Male Academic	1.9	1.0	2.1	1.2	1.3	1.5
Teaching Engineering Subjects	2.5	1.6	1.2	1.2	0.7	0.4
Developed Country	1.1	0.6	0.7	1.6	0.4	0.4
Lower age gr. in comparison to old age group	0.7	1.2	0.2	0.8	3.3	1.0
Middle age gr. in comparison to old age group	1.4	1.6	0.6	1.4	2.3	0.9
Fixed term Educators vs. Ongoing Educators	3.8	0.6	1.1	0.6	**5.3**[c]	1.1
Casual Educators vs. Ongoing Educators	2.2	0.4	1.0	1.1	1.0	0.4

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

Table 20 Continued

	Not able to look straight to the monitor	Elbows not next to the body while using keyboard	Uncomfortable posture of the fingers while typing	Uncomfortable feeling while using mouse	No recommendation given to improve
Male Academic	0.5	1.0	1.0	1.1	1.0
Teaching Engineering Subjects	0.5	0.7	0.5	0.5	0.8
Developed Country	0.9	1.8	0.7	0.7	0.8
Lower age gr. in comparison to old age group	2.9	1.4	2.5	1.7	1.5
Middle age gr. in comparison to old age group	3.3	2.2	2.5	2.9	1.9
Fixed term Educators vs. Ongoing Educators	1.8	1.4	1.0	1.4	1.0
Casual Educators vs. Ongoing Educators	1.0	1.5	0.7	0.8	0.5

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

The data in table 20 above shows that the male educators had an odds ratio of (0.34) at p≤0.05 confirming that in comparison with female educators more male educators' worksurfaces were at the level of elbow. Standard desk heights used globally for online workers are around 28 and 30 inches (TAHPI, 2015). This size of desk generally is suitable for individuals with a height between 5'8" and 5'10". The standard height of females, especially females from Asian background, is less. This verified that a greater number of

female educators' worksurface were not at the level of their elbow and they were not able to look straight at their monitor.

Educators from developed countries had an odds ratio of (0.34) at $p \leq 0.01$which showed that the worksurface area was inappropriate for a greater number of educators from developing country than the educators from developed country. The multifactional nature of developing muscular skeletal disorders from physical and psychosocial workplace factors were described in various frameworks (National Research Council, 2001; Bongers et al., 2006; Karsh, 2006). The majority of these frameworks were established in developed countries. The developed countries had formalised insurance and compensation schemes in place and considerable efforts have been made to reduce the large numbers of muscular skeletal disorders during the last two decades. Developing countries in general have fewer formal workers' compensation systems (Maakip et al., 2016) providing a reason for educators from developing countries using workstation with inadequate surface area. Another reason may be lack of finance to suitable work desks.

The educators with 'fixed term employment' had an odds ratio of 3.9 at $p \leq 0.05$, indicating a greater number of educators with fixed term employment were using seats with inappropriate seat surface size than the educators with ongoing employment. The educators with fixed term employment had an odds ratio 4.6 at $p \leq 0.05$, showing that a greater number of educators with fixed term employment were using a workstation of inadequate height i.e., the worksurface was not with the level of elbow. The educators with fixed term employment had an odds ratio 5.3 at $p \leq 0.05$ indicating that a greater number of educators with fixed term employment did not have easy accessibility to resources compared to educators with ongoing employment.

Educators with 'casual employment' had an odds ratio of 0.3 at $p \leq 0.05$, identifying that more educators with casual employment were using a fully adjustable seat than the educators with ongoing employment. The educators with casual employment had an odds ratio of 0.3 at $p \leq 0.01$ showing that a more educators with casual employment were using seats with adequate lumbar support than the educators with ongoing employment. Educators with casual employees generally work only when required. Some participating casual academic employees were working for multiple universities at same time. As they used their own set up to perform the online teaching, they could arrange their workstation

with a fully adjustable chair and ergonomic desk. This may be the reason for a greater number of educators with casual employment using an adjustable or correct height chair and workstation in comparison to educators with fixed term and ongoing employment.

The next section describes the relation between demographic factors against environmental ergonomic factors. There were seven main environmental ergonomic questions which were a combination of 13 sub-questions asked in this section. A Chi-square analysis was performed, and the results are described in table 21.

Table 21

Demographic Factors vs Environmental Ergonomic Factors

	Not enough natural Light	No lighting control device	No glare effect of the monitors	Not using glare reducing method	Movable task or desk light not available	Not matt finish worksurface
Male Academic	1.1	1.1	0.8	1.9	0.9	0.8
Teaching Engineering Subjects	0.6	**0.4[b]**	0.5	0.8	0.7	0.8
Developed Country	0.5	0.6	0.8	1.1	0.5	0.6
Lower age gr. in comparison to old age group	2.5	**3.0[c]**	0.7	0.9	1.0	1.3
Middle age gr. in comparison to old age group	1.2	2.0	1.4	0.8	0.7	1.4
Fixed term Educators vs. Ongoing Educators	2.2	0.9	0.9	0.6	1.4	1.2
Casual Educators vs. Ongoing Educators	1.0	0.6	0.6	1.1	0.6	0.8

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

Table 21 Continued

	Negative effect of shared office place	Not distracted by surrounding noise.	Room Temperature not hot	Room Temperature not cold	Inadequate room air circulation	Inadequate room air quality	Inadequate humidity of the room
Male Academic	1.3	1.1	1.0	0.9	1.5	1.7	1.5
Teaching Engineering Subjects	1.2	1.2	1.2	1.1	1.3	1.3	1.0
Developed Country	1.1	1.3	0.8	0.5	0.7	1.0	0.8
Lower age gr. in comparison to old age group	0.6	**0.2[b]**	0.9	0.6	2.0	2.5	**0.2[b]**

Middle age gr. in comparison to old age group	1.7	0.4	1.2	1.3	0.9	2.1	**0.2**[c]
Fixed term Educators vs. Ongoing Educators	0.4	0.4	0.8	1.5	0.8	0.9	0.9
Casual Educators vs. Ongoing Educators	0.3	0.9	1.3	1.6	0.7	1.0	1.0

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

The educators teaching 'engineering subjects' had an odds ratio of 0.4 at p≤0.05 indicating that a greater number of educators teaching engineering subjects had lighting control device than the educators teaching other subjects. 82% of educators teaching other subjects reported that they teach from outside of university e.g., home, whereas only 62% of educators teaching engineering reported teaching online from outside of their university. Generally, the university offices had lighting control devices and more people teaching engineering subjects online did their work at their university.

The educators with lower age group category had an odds ratio of 3.0 at p≤0.05 indicates that a greater number of educators from lower age group in comparison with educators from old age group category had no lighting control device; odds ratio of 0.2 at p≤0.01 and odds ratio of 0.2 at p≤0.01 indicates that a lower number of educators from lower age group were experiencing distraction due to surrounding noise and experiencing inadequate humidity at their working area than the educators from the older age group category.

A Chi-square analysis was performed, to identify the relation between demographic factors and organisational ergonomic factors (table 22). A total of seven main organisational ergonomic questions, which were a combination of 8 sub-questions, were asked in this section.

Table 22
Demographic Factors vs Organisational Ergonomic Factors

	No clear policies and procedures	Inadequate time provided for				
		Online teaching	Communicating with students	Marking and providing feedback	Supervising and assisting co-workers	Marking moderation work.
Male Academic	0.9	1.1	0.8	**0.4**[c]	0.9	0.6
Teaching Engineering Subjects	1.1	0.8	0.7	**0.4**[c]	0.5	0.7
Developed Country	1.1	**2.5**[c]	2.3	**3.5**[a]	1.3	**2.1**[c]

	No clear policies and procedures	Inadequate time provided for				
		Online teaching	Communicating with students	Marking and providing feedback	Supervising and assisting co-workers	Marking moderation work.
Lower age gr. in comparison to old age group	1.0	1.1	1.1	1.1	1.0	0.9
Middle age gr. in comparison to old age group	1.1	1.4	1.4	1.3	1.9	1.0
Fixed term Educators vs. Ongoing Educators	0.6	1.0	1.0	1.2	1.5	1.0
Casual Educators vs. Ongoing Educators	0.4	**3.2[c]**	**3.2[c]**	**4.3[a]**	3.5	3.1

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

Table 22 Continued

	Not enough time for developing new online unit	Not enough time for teaching preparation	Not enough time for updating existing unit	Rarely experiencing technological issues	Not receiving adequate resources	No other organisational factor affects online teaching
Male Academic	0.9	0.7	0.4	0.6	0.9	0.8
Teaching Engineering Subjects	0.6	**0.4[c]**	**0.2[a]**	0.5	1.2	0.9
Developed Country	1.7	1.6	1.7	1.5	1.2	0.8
Lower age gr. in comparison to old age group	0.7	1.3	1.4	1.4	1.5	1.2
Middle age gr. in comparison to old age group	1.2	1.6	1.7	1.0	1.4	1.2
Fixed term Educators vs. Ongoing Educators	1.1	1.2	1.0	2.1	2.3	2.3
Casual Educators vs. Ongoing Educators	2.6	2.3	2.1	1.2	1.4	2.1

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

The ‘male’ educators had an odds ratio of 0.4 at p≤0.05 showing that more male educators identified that they did receive enough time for marking and providing feedback than the female educators.

Within the 68 female participants 46 (68%) online educators had less than three years of online teaching experience, of which 15 (22%) had less than one year of online teaching experience. Within 51 male participants 28 (55%) participants had less than three years of teaching experience. 45% of male educators had more than 3 years online teaching experience while only 33% of female educators had more than 3 years online teaching experience. 15 (22%) of the female educators had less than 1-year online teaching

experience while only 1 male educator had less than 1-year online teaching experience. So, it could be said that though the analysis shows male educators require less work time than female educators, it may be experience which determined this, not gender.

The educators teaching 'engineering subjects' had an odds ratio of 0.2 at $p \leq 0.01$ indicating that a fewer number of educators teaching engineering subjects identified that they did not receive enough time for marking and providing feedback than educators teaching other subjects. The engineering subjects were mainly calculation oriented, but other subjects might have had long descriptive essay assignments. Checking and providing feedback for long descriptive assignments is more time consuming than mathematical based assignments. Thus, educators teaching engineering subjects did not feel a shortage of allotted time for marking and providing feedback.

The educators teaching 'engineering subjects' had an odds ratio of 0.4 at $p \leq 0.05$ showing that a greater number of educators teaching engineering subjects identified that they received enough time for teaching preparation than the educators teaching other subjects. This indicates that either engineering subjects take less teaching preparation time, or that educators teaching engineering subjects are provided with more teaching preparation time than educators teaching other subjects.

The educators teaching 'engineering subjects' had an odds ratio of 0.2 at $p \leq 0.001$ indicating that a greater number of educators teaching engineering subjects identified that they receive enough time for updating existing units of study than the educators teaching other subjects. Preparing online courses or updating existing courses online requires digital fluency. This might be a reason that the educators teaching engineering subjects were able to manage preparing course material and updating existing course within allotted time. Another reason could be that engineering educators were provided with more time for updating their units of study than educators teaching other subjects.

The educators with 'casual employment' had an odds ratio of 4.3 at $p \leq 0.001$ signifying that a greater number of educators with casual employment did not receive enough time for marking and providing feedback than the educators with ongoing employment. And with an odds ratio of 3.2 at $p \leq 0.05$ indicates that a greater number of educators with casual employment were struggling with adequate allotted time for both communicating with

students and for online teaching preparation. Ryan et al. (2017) in previous studies performed on the challenges faced by Australian casual academics concluded that casual academics were underpaid and/or provided with payment of limited time for preparing course material, marking, and providing feedback to the students (Brown et al., 2010; Jensen & Morgan, 2009a).

The educators from developed country had an odds ratio of 2.5 at $p \leq 0.05$, 3.5 at $p \leq 0.001$ and 2.1 at $p \leq 0.05$ indicates that a greater number of educators from developed country were experiencing lack of allotted time to complete online teaching related work, marking, and providing feedback and marking moderation work respectively in comparison with the educators from developing countries.

A Chi-square analysis was performed to identify the relationship between demographic factors and cognitive ergonomic factors (table 23) . A total of eight cognitive ergonomic questions were asked in this section.

Table 23

Demographic Factors vs Cognitive Ergonomic Factors

	Policies and procedures related training not provided	Understandability of related documents were hard	No training provided for existing and new technologies	Hard to locate related information related to online teaching
Male Academic	0.5	1.3	0.7	1.0
Teaching Engineering Subjects	0.5	1.4	0.7	1.0
Developed Country	0.4	0.7	0.6	1.5
Lower age gr. in comparison to old age group	1.1	1.1	1.5	1.1
Middle age gr. in comparison to old age group	1.0	**0.4**[c]	0.9	0.5
Fixed term Educators vs. Ongoing Educators	1.5	1.0	2.8	1.5
Casual Educators vs. Ongoing Educators	1.2	1.3	1.5	1.2

[a]$p \leq 0.001$, [b]$p \leq 0.01$, [c]$p \leq 0.05$

Table 23 Continued

	Did not understand how to use online teaching related technology	Not working more than 60 minutes without break with computer	Did not receive any information related to decision making and problem solving.	No other cognitive ergonomic factors affect effectiveness of online teaching
Male Academic	**0.4**[c]	1.3	0.6	1.3
Teaching Engineering Subjects	0.5	0.5	1.0	0.7
Developed Country	**0.4**[b]	1.0	0.6	1.9
Lower age gr. in comparison to old age group	2.0	1.9	0.9	1.4
Middle age gr. in comparison to old age group	1.7	1.4	0.8	0.6
Fixed term Educators vs. Ongoing Educators	3.1	2.0	1.2	0.6
Casual Educators vs. Ongoing Educators	1.8	1.6	0.6	3.3

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

The 'male educators' had an odds ratio of 0.4 at p≤0.05 indicating that a greater number of male educators identified that they understand how to use online teaching related technology than female educators. There were no other significant factors. The educators with 'middle age group' category had an odds ratio of 0.4 at p≤0.05 indicates that a greater number of educators from older age group in comparison with educators from middle age group category had difficulty in understanding the online teaching related documents.

The educators from 'developed country' had an odds ratio of 0.4 at p≤0.01 signifies that a greater number of educators from developing country had trouble in understanding how to use the online teaching related technologies than the educators from developed countries.

The next section analyses the relationship of demographic factors against social ergonomic factors. There was a total of nine social ergonomic questions asked for this section. The Chi-square analysis results are described in table 24.

Table 24

Demographic Factors vs Social Ergonomic Factors

	Working alone is most ineffective	Did not receive sufficient support and guidance	Did not participate in teamwork	Language barrier did not affect the ability to communicate
Male Academic	1.3	1.4	0.5	1.1
Teaching Engineering Subjects	0.9	1.8	0.5	1.1
Developed Country	0.8	**0.4**[b]	0.9	0.9

Lower age gr. in comparison to old age group	0.5	2.1	1.6	1.5
Middle age gr. in comparison to old age group	1.1	0.8	1.9	1.8
Fixed term Educators vs. Ongoing Educators	1.9	1.5	0.7	1.4
Casual Educators vs. Ongoing Educators	2.1	0.5	0.7	2.6

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

Table 24 Continued

	Did not have audio-visual contact through the internet with students	Technical infrastructure required for online teaching were not in place	Did not feel isolated	Cultural differences did not affect the efficiency of online teaching	Working alone is most ineffective.
Male Academic	1.1	0.7	1.0	0.8	1.6
Teaching Engineering Subjects	**0.3[b]**	0.8	0.6	0.8	0.8
Developed Country	0.7	0.6	1.5	0.5	0.9
Lower age gr. in comparison to old age group	0.6	1.7	0.7	1.5	0.6
Middle age gr. in comparison to old age group	1.0	2.0	1.0	1.0	0.8
Fixed term Educators vs. Ongoing Educators	1.5	1.3	1.1	2.3	1.7
Casual Educators vs. Ongoing Educators	1.6	0.8	2.8	2.5	1.5

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

The educators teaching 'engineering subjects' had an odds ratio of 0.3 at p≤0.01 showing that a greater number of educators teaching engineering subjects identified that they had audio-visual contact through the internet with students while teaching online than the educators teaching other subjects. Educators teaching engineering may have been more digitally fluent in using the tools and technology required for connecting with students' audio-visually than educators teaching other subjects. Reasons could also have been that engineering subjects are more difficult for students to understand than other subjects, so students needed to attend classes, rather than reviewing the lecture at their convenience, or that if engineering students did not attend online classes and communicate with the lecturer, they failed the unit of study.

Educators from 'developed country' had an odds ratio of 0.4 at $p \leq 0.01$ indicating that a greater number of educators from developed country received sufficient support and guidance than the educators from developing country. Online teaching and learning were a popular and well accepted mode of education before the COVID-19 pandemic outbreak in developed countries so, on-line teaching related policies and procedures were already available in many developed country universities, and many of the educators were already conducting online teaching. In contrast online teaching was not that common in developing countries (Hassan et al., 2020). In developing countries, the most important factor affecting online teaching was the technological skills of educators and students. Many educators were struggling to teach online and some of them chose to use easier tools which were not very versatile to maintain the connection with their students. Teachers were experiencing technical issues while creating e-content and instructions for online delivery (Hassan et al., 2020). A study performed by Hassan et al. (2020) identified that the educators found that their lack of computer skills needed for online teaching, such as creating digitised course materials and using different software tools to deliver the class, were challenging and they required effective guidelines and training. Due to the emergency shift to online teaching delivery the availability of support and guidance were underdeveloped in developing countries.

5.2.4.4. Years of experience in online teaching

Relationship between online teaching years of experience and other demographic factors

The next section focused on identifying any relationship with online teaching experience and the demographic factors of the participants and any of the items examined within the five ergonomic factors. Chi-square and Bivariate logistic regression analysis were performed to identify the risk factors for all the factors as independent variable with dependent variables 'online teaching experience' of the respondents. Age was categorised into three groups such as Lower age group (below 46 years), Middle age group (46 to 55 years) and Older age group (above 56years) and permanency category of online educators categorised into three groups such as (Fixed term / Casual / Ongoing employment). Online teaching experience was the dependent variable with categories of $1 \geq 3$ years and $0 \leq 3$ years of online teaching experience, and subjects taught as categories of 1 = Engineering and 0 = Other subjects.

Table 25 describes the significance of 'Years of online teaching experience' of the participant educators and all other demographic factors for the participants. To evaluate the effect of various factors on both online teaching experience and academic type, crude odds ratios (CORs) and their 95% confidence intervals were calculated. Then, adjusted odds ratios (AORs) and 95% confidence intervals were calculated by using the multivariate logistic regression analysis. All the analyses were carried out by using the SPSS statistical software (SPSS Statistics v29). Forty-four of the participants had more than 3 years online teaching experience while 77 had 3 years or less online teaching experience.

Table 25

Relationships between various factors and Online Teaching Experience

	ODDs Ratio and 95% CI			ODDs Ratio and 95% CI		
	COR	**Lower (Ln)**	**Upper (Ln)**	**AOR**	**Lower (Ln)**	**Upper (Ln)**
Engineering Subject Taught Engineering=0 Non-engineering=1*	0.9	-1.1	0.8	1.4	-1.8	2.6
Gender of the Academic Male=0* Female=1	0.6	-1.2	0.3	0.9	-1.9	1.8
Age						
Lower age gr. in comparison to old age group ≤ 46 years=0* ≥ 56 years = 2	**4.9**[a]	0.6	2.6	**2.8**[c]	0.01	2.0
Middle age gr. in comparison to old age group 46years to 56 years=1* ≥56years=2	1.8	-0.3	1.47	**1.8**[b]	1.0	2.6
Countries the Educators from Developed=0 Developing=1*	**7.1**[a]	1.1	2.85	8.3	0.6	3.6
Academic Type Teaching Focused=0 Teaching and Research Focused=1*	0.6	-1.3	0.2	2.0	-1.2	2.5
Fixed term Academics in comparison to Casual Academics Fixed term=0* Ongoing =1	**4.4**[b]	0.4	2.6	**5.1**[b]	0.6	2.7
Ongoing vs Casual employment Casual=1* Ongoing=2	0.87	-1.0	0.7	**4.4**[b]	0.4	2.6
Total Teaching experience <3years=0*	**19.1**[a]	0.9	5.0	**67.2**[c]	1.0	7.4

	ODDs Ratio and 95% CI			ODDs Ratio and 95% CI		
	COR	**Lower (Ln)**	**Upper (Ln)**	**AOR**	**Lower (Ln)**	**Upper (Ln)**
>3years=1						
Online Teaching from University Environment From University=0 Outside of University=1*	**0.3**[b]	-2.3	-0.5	**27.0**[b]	1.2	5.4
Effectiveness of teaching depends on subjects taught Not depend on subjects=0 Depends on subjects=1*	0.5	-1.6	0.1	1.7	-1.0	2.1
Special method of teaching due to COVID No=0 Yes=1*	**7.5**[a]	1.1	2.9	**7.5**[a]	1.13	2.9
Extra support required due to COVID No=0* Yes=1	0.6	-1.3	0.2	1.2	-1.3	1.6
Caused depression, anxiety, or stress? No=0 Yes=1*	**7.6**[a]	1.0	3.1	**7.6**[a]	1.0	3.1

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05,

The crude odds ratio and adjusted odds ratios between 'Years of online teaching experience' of the participant educators and all other demographic factors are listed in table 25. The data shows that the educators with 'Lower age group, in comparison to older age group' had an odds ratio (4.9, 95% CI 0.6 to 2.6) at p≤0.001 and adjusted odds ratio (2.8, 95% CI 0.01 to 2.0) at p≤0.05 which confirms that the older aged educators had less online teaching experience in comparison with the lower age group. An adjusted odds ratio (1.8, 95% CI 1.00 to 2.6) at p≤0.01 for educators with 'Middle age group in comparison to older age group' indicates that a greater number of educators from middle age group has more online teaching experience. This result shows the older aged educators had overall less online teaching experience.

Educators from developing countries had an odds ratio (7.1, 95% CI 1.1 to 2.9) at p≤0.001 showing that educators from developing countries had more online teaching experience compared with developed countries. Some institutes, particularly in developing countries, were not equipped with the infrastructure required for fully online course delivery and most of the teachers were not fully trained/familiar with technology and/or pedagogy required to teach online before the pandemic (Sahu, 2020) yet the results of this research indicated

that it was the educators in the developing countries who had the most online teaching experience.

Educators with 'Fixed term employment' in comparison to 'Ongoing Academics' had an odds ratio (4.4, 95% CI 0.42 to 2.6) at $p \leq 0.01$ which indicated that a greater number of educators with fixed term employment status had more online teaching experience compared with academics with ongoing employment. The reason for this may be that academics with fixed term employment are more likely to be teaching focused only and spend more time teaching online than academics with ongoing employment who are teaching, and research focused.

Participants with 'less experienced in teaching' had an odds ratio (19.1, 95% CI 0.91 to 5) at $p \leq 0.001$ which showed that the number of educators with less experience in teaching had more online teaching experience compared with the educators that had more experienced in overall teaching. The 'Special method of teaching due to COVID' had an odds ratio (7.5, 95% CI 1.1 to 2.9) at $p \leq 0.001$ which confirmed that new online teaching of subjects was introduced due to COVID-19 pandemic requirement for home isolation when online teaching became mandatory for all stream of education from the first quarter of 2020.

Involvement with online teaching was a personal choice of the students before the COVID-19 outbreak but it became compulsory after home isolation requirements were introduced by the government of many countries, so some university educators, who had previously only taught students face to face on campus were required to adopt online teaching and learn to use new technology. Tertiary educators as adult learners are different from university students. Hung (2015) wrote that there were some limitations faced by the older adults adopting online teaching. On the other hand, some of the young educators started their teaching careers with online learning so they were more comfortable with digital platforms. In Australia in 1991 at Deakin University educators commenced online teaching. By 2000 online education was common at Australian Universities (Bossu et al., 2012), thus many of the experienced university educators in Australia were comfortable with online teaching before the COVID-19 pandemic.

The results for educators performing their 'online teaching from the university' had an odds ratio (0.3, 95% CI (-)2.3 to (-)0.5) at $p \leq 0.01$ identifying that fewer educators with more experience in online teaching want to teach online from the university and preferred to conduct their online teaching from their home. It also identified that the online teaching experience has a significant relation with 'online teaching from university environment' factor. Considering the association between ergonomics and sustainability, inadequate workplace design signifies a risk factor for individual and affects their well-being, due to their exposure to the uncomfortable working conditions (Ayyildiz & Taskin Gumus, 2021). Educators may be forced to use awkward body postures due to poor workstation design, which may result in developing musculoskeletal disorders (MSDs), thus proper design of educators' workstations benefits their work performance (Ayyildiz & Taskin Gumus, 2021).

Educators may lose work motivation while working away from their designated university office setup for various reasons, such as, not having a suitable working atmosphere, distracted by family members and friends, available entertainment options, or social media, etc. (Purwanto et al., 2020). Online teaching educators working from home are required to organize and pay for internet connection and other amenities but save travel costs and travelling time (Purwanto et al., 2020). When conducting online teaching from home there is a more flexibility in terms of time, of using any room of the home for teaching, being able to spend more time with family and friends which all contribute to increase the effectiveness of teaching and work satisfaction (Purwanto et al., 2020).

The factor, 'caused depression, anxiety, or stress?' had an odds ratio (7.6, 95% CI 1.0 to 3.1) at $p \leq 0.001$ indicating that online teaching did cause depression, anxiety, or stress for participant educators. Online teaching has been assessed as unsatisfactory and exhausting by many academics (Brookfield, 2015). In online teaching the course materials are generally prepared in isolation, and students participate in online education at a time when they would like to so may not be online at the same time as the educator (Perrotta & Bohan, 2020; Taverna et al., 2015). Hodges et al. (2020), argue that providing adequate support to educators can provide a satisfactory online teaching experience. Canty et al. (2020) stated that, the growing range of online technologies can support "high-quality distance learning that is engaging, interactive and increasingly personalised"(p. 3). Studies showed that, the major stressor for the educators were the pressure of learning virtual teaching methods

(Sokal et al., 2021). The stresses generated from becoming used to working from home full-time as well as implementing new online teaching technologies were intensified with taking care of their family members at the same time (Cipriano & Brackett, 2020). Constant stress at work, and not receiving any, or receiving less support and resources, can cause professional burnout or feeling of inefficacy (Maslach et al., 2001). Stress and exhaustion are related to numerous undesirable consequences, including reduced teaching efficiency, inferior relation quality with students, etc. (Baker, et.al., 2021; Robinson, et al., 2023).

The relationship between each ergonomic factors against years of experience in online teaching

Tables 26, 28, 29, 30 and 31 show the relationship *(Crude ratios, adjusted ratios and 95% confidence intervals)* between online teaching experience and physical, environmental, organisational, cognitive, and social ergonomic factors respectively for the 121 research participants.

Table 26

Physical ergonomic factors and Online Teaching Experience

Physical Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Adjustable Seat *No = 0** *Yes = 1*	1.6	-0.3	1.3	1.2	-1.1	1.4
Appropriate seat surface size *No = 0** *Yes = 1*	2.3	-0.3	2.0	0.6	0.3	8.7
Lumbar support *No = 0** *Yes = 1*	1.6	-0.3	1.3	1.4	0.5	1.5
Seat fronts rounded *No = 0** *Yes = 1*	1.4	-0.5	1.1	1.1	-1.4	1.5
Position of worksurface *Not with the level of elbow =0** *Level of elbow =1*	1.2	-0.8	1.2	1.8	-0.7	1.9
Surface area of workspace *Not appropriate = 0** *Appropriate = 1*	1.2	-0.9	1.3	1.5	-1.3	2.1
Height of clearance of workstation *Not enough = 0** *Enough = 1*	1.9	-0.7	2.0	2.4	-0.9	2.7

Physical Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Width of the work surface *No = 0** *Yes = 1*	0.9	-1.1	0.9	0.6	-2.3	1.4
Available enough leg space *No = 0** *Yes = 1*	1.2	-1.0	1.3	0.7	-2.1	1.3
Using Sit-to-stand desk *No = 0** *Yes = 1*	1.0	-0.8	0.9	1.0	-1.0	0.9
Easy accessibility to the resources *No = 0** *Yes = 1*	**7.5**[c]	-0.1	4.1	2.6	-1.7	3.6
Enough resource storage space *Not available = 0** *Available = 1*	**5.3**[c]	0.1	3.2	3.2	-1.4	3.7
Able to look straight to the monitor *No = 0** *Yes = 1*	-0.1	2.1	1.9	-0.8	2.1	-0.1
Elbows are next to body while using keyboard and mouse *No = 0** *Yes = 1*	-1.5	0.4	0.1	-5.5	-0.3	-1.5
Posture of fingers while typing *Uncomfortable = 0** *Comfortable =1*	-0.6	1.5	3.4	-1.2	3.7	-0.6
Comfortably using mouse *No = 0** *Yes = 1*	-0.4	2.3	2.5	-1.7	3.5	-0.4
Recommendation for improving any other factors *No = 0** *Yes = 1*	-0.9	0.6	0.9	-1.2	0.9	-0.9

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05, * *Reference category*

The crude odds ratio and adjusted odds ratios between 'Online teaching experience' of the participant educators and effect of physical ergonomic factors are listed in table 26. The data show that the physical ergonomic factor 'Easy accessibility to the resources' had an odds ratio (7.5, 95% CI (-) 0.1 to 4.1) at p≤0.05 which indicates that the educators with more online teaching experiences had less access to the resources. 'Enough resource storage space' had an odds ratio (5.3, 95% CI 0.1 to 3.2) at p≤0.05 which showed that the educators with more online teaching experiences had less space for storing resources. None

of the other factors considered had significant adjusted odds ratios with $p \leq 0.001$, $p \leq 0.01$ and $p \leq 0.05$.

The workstation width for placement of related accessories and availability of enough space to work and store resources are important to prevent musculoskeletal discomfort symptoms. According to Hedge et al. (1995), intracarpal tunnel pressure increased when the wrist was in floating posture rather than when it was supported. Grandjean and Kroemer (1997) suggested that the keyboard should be placed at a distance ranging from 10 to 26 cm between the desk edge and the home row of keys. Having the keyboard more than 12 cm distance from the edge of the desk had been linked with a lower risk of hand arm symptoms and disorders (Marcus et al., 2002; Woo et al., 2016). The ergonomic standards for work surface area were established for different countries and some are listed in the following table 27 (Woo et al., 2016) as people in different countries may have different anthropometric measurements and this influences e information in the Standards.

Table 27

Work surface area ergonomic specification for different countries

Australia	Canada	United States of America	Europe
Australian Standard AS-3590.2	Canadian Standards Association CAN/CSAZ412-M89	American National Standards Institute ANSI/HFES-100	International Organization for Standardization ISO-9241
Minimum width of 1200 mm and depth of 900 mm (for sole tasks: keyboard work)	Minimum width of 760 mm, depth of 610 mm (for books and papers) and 900 mm (for computer printouts and large drawings)	Minimum width of 700 mm and depth of 500 mm	Minimum width 760mm, and minimum depth is 900 mm.

Note: Adapted from "Ergonomics standards and guidelines for computer workstation design and the impact on users' health – a review", by E. H. C. W00, P. White, and C.W.K. Lai, 2016, *Ergonomics, 59(3), 464-475.* (https://doi:10.1080/00140139.2015.1076528) Copyright 2015 Taylor & Francis Group.

Setting up online teaching and learning in developing countries was quite challenging for both students and educators (Gumasing et al., 2022). Though there was information about workstation design found, there was very little published literature on the design of workstations based on online educators' perspectives and experiences (Gumasing et al., 2022).

Table 28

Environmental ergonomic factors vs years of Online Teaching Experience

Environmental Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Natural Light *Not enough = 0** *Enough = 1*	2.6	-0.4	2.3	1.9	-0.9	2.2
Lighting control device *Not available = 0** *Available = 1*	1.9	-0.1	1.4	1.7	-0.4	1.4
Position of monitor *No glare = 0** *Glare = 1*	1.1	-0.8	0.9	0.7	-1.4	0.6
Using glare reducing method *No = 0** *Yes = 1*	1.3	-0.5	1.0	1.4	-0.5	1.2
Movable task or desk light *Not available = 0** *Available = 1*	1.7	-0.2	1.3	1.1	-0.8	1.0
Matt finish worksurface *No = 0** *Yes = 1*	2.0	-0.1	1.5	1.36	-0.6	1.3
Shared office place affects *Negatively = 0** *Positively = 1*	0.6	-1.3	0.3	1.15	-0.8	1.1
Distracted by surrounding noise *No = 0* *Yes = 1**	**3.4**[b]	0.3	2.0	**3.2**[b]	0.3	2.0
Room Temperature hot *No = 0** *Yes = 1*	1.0	-0.8	0.7	0.9	-1.3	1.0
Room Temperature cold *No = 0** *Yes = 1*	1.0	-0.8	0.7	1.2	-0.9	1.3
Room air circulation	1.5	-0.7	1.5	0.3	-3.4	0.8

Environmental Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Inadequate = 0 *Adequate = 1*[*]						
Room air quality *Not good = 0*[*] *Good = 1*	2.7	-0.2	2.2	6.4	-0.3	4.0
Humidity of room *Inadequate = 0*[*] *Adequate = 1*	1.0	-0.9	0.8	2.2	-0.4	1.9

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05 [*]*Reference category*

The crude odds ratio and adjusted odds ratios between 'online teaching experience' of the participant educators and effect of environmental ergonomic factors are listed in Table 28. This data shows that the environmental ergonomic factor 'Distracted by surrounding noise' with odds ratio (3.2, 95% CI 1.4 to 2.0) at p≤0.01 indicated that more experienced online educators were distracted by the surrounding noise than those who were less experienced. Studies show that an unsatisfactory environment is major challenge for the educators teaching online (Agustina et al., 2020). The most common examples of noise distractions from the surrounding environment can be neighbours playing loud music, noise generated from aircraft or road traffic or children playing (Opuku, 2021). According to Opuku (2021), within various environmental background noise distractions the most annoying one was traffic noises, followed by construction, aircraft, neighbouring and industrial noise.

Table 29

Organisational ergonomic factors vs years of Online Teaching Experience

Organisational Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Have clear policies and procedures *No = 0*[*] *Yes = 1*	0.9	0.9	-0.8	0.7	1.0	-0.9
Time allotted for online teaching *Inadequate = 0*[*] *Adequate = 1*	0.2	0.6	-1.3	0.3	1.2	-0.9
Time allotted for communicating with students *Inadequate = 0*[*] *Adequate = 1*	0.7	-1.2	0.4	1.0	-1.1	1.1
Time allotted for marking and providing feedback *Inadequate = 0* *Adequate = 1*[*]	**2.5**[c]	0.2	1.7	**2.5**[c]	0.2	1.7

Organisational Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Time allotted for supervising and assisting co-workers *Inadequate = 0** *Adequate = 1*	0.62	-1.2	0.3	1.1	-1.0	1.2
Time allotted for marking moderation work. *Inadequate = 0** *Adequate = 1*	0.6	-1.3	0.2	1.1	-1.1	1.3
Time allotted for developing new online unit *Inadequate = 0** *Adequate = 1*	0.6	-1.3	0.2	0.7	-1.4	0.7
Time allotted for teaching preparation *Inadequate = 0** *Adequate = 1*	0.7	-1.1	0.4	1.1	-1.0	1.2
Time allotted for updating existing online unit *Inadequate = 0** *Adequate = 1*	0.7	-1.1	0.4	1.0	-1.0	1.0
Experiencing technological issues *Rarely = 0** *Often = 1*	1.1	-0.6	0.7	1.3	-0.6	1.1
Receiving adequate resources *No = 0** *Yes = 1*	2.0	-0.3	1.7	2.5	-0.2	2.0
Any other organisational factor *No = 0** *Yes = 1*	0.7	-1.2	0.3	0.5	-1.5	0.2

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05
**Reference category*

The crude odds ratio and adjusted odds ratios between 'Online teaching experience' of the participant educators and effect of organisational ergonomic factors are listed in table 29. None of the organisational ergonomic factors appeared significant with p≤0.001 or p≤0.01. The organisational ergonomic factor 'Time allotted for marking and providing feedback' had an odds ratio (2.5, 95% CI 0.2 to 1.7) at p≤0.05 indicating that a greater number of more experienced educators had adequate time for marking and providing feedback. The reason for this might be the experience helps the educators work faster and more effectively than the less experienced educators.

None of the factors considered had a significant adjusted odds ratios with p≤0.001 or p≤0.01 level of significance. Only the factor 'Time allotted for marking and providing feedback' was significant with an adjusted odds ratio (2.5, 95% CI 0.2 to 1.7) at p≤0.05.

Designing and planning online courses are very challenging and time consuming for less experienced educators, as all the course contents, objectives, assessments, and activities required to be redesigned as per online teaching requirements (Martin, Ritzhaupt, Kumar & Budhrani, 2019). Varvel, (2007), reported that experienced or competent educators can perform the online teaching task without disturbing their other commitments due to having adequate time-management skills. Darabi et al. (2006), considered that evaluating students' achievement of learning objectives, providing feedback, creating questions to improve thinking and problem-solving skill, and providing instructions for assignments were the top-five tasks that online educators spent most of their time doing. Online educators are required to aid struggling students to understand the topic and answer questions related to technology, etc. (Napier et al., 2011). Educators are required to provide appropriate, timely fast feedback. Communication between educators and students, can include rules and regulations, due dates of assignments, cyber etiquette, course expectations, ethical requirements, the code of conduct, policies for the course, and information regarding accessibility, privacy, and copyright (Coppola et al., 2002; Darabi et al., 2006; Ko & Rossen, 2001; Varvel, 2007).

Table 30

Cognitive ergonomic factors vs years of Online Teaching Experience

Cognitive Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Policies and procedures related training *Not provided = 0** *Provided =1*	**3.1[b]**	0.3	2.0	**3.2[c]**	0.1	2.3
Understandability of related documents *Hard = 0** *Easy =1*	**2.3[c]**	-0.01	1.7	2.3	-0.1	1.8
Training for existing and new technologies *Not provided = 0** *Provided =1*	0.2	1.7	-0.3	1.3	0.7	-1.5
Easy to locate related information *No = 0** *Yes = 1*	0.84	1.1	-0.7	0.9	0.7	-1.4
How to use related technology *Not understand = 0** *Understand = 1*	0.2	1.7	-0.2	1.30	1.2	3.1
Working more than 60 minutes without break with computer *No = 0** *Yes = 1*	0.7	1.2	-0.6	0.9	1.5	-0.5

Cognitive Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Receiving information regarding decision making and problem solving *No = 0** *Yes = 1*	0.2	1.7	-0.3	1.4	1.4	-0.8
Any other cognitive ergonomic factors affect effectiveness *No = 0** *Yes = 1*	0.3	0.6	-1.4	0.4	0.6	-1.5

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05
**Reference category*

The crude odds ratio and adjusted odds ratios between 'Online teaching experience' of the participant educators and effect of cognitive ergonomic factors are listed in table 30. None of the cognitive ergonomic factors appeared significant with p≤0.001. The cognitive ergonomic factor 'Policies and procedures related training' had an odds ratio (3.1, 95% CI 0.3 to 2.0) at p≤0.01, and 'Understandability of related documents' with odd ratio (2.3, 95%CI -0.01 to 1.7) at p≤0.05 detecting that a greater number of more experienced online educators had not received training on the policies, procedures and did not always understand the documents. This indicated that the more experienced educators received less training on workplace policies and procedures.

None of the other factors considered had significant adjusted odds ratios with p≤0.001 and p≤0.01. Only the factor 'Policies and procedures related training' was significant adjusted odds ratio (3.2, 95% CI 0.1 to 2.3) at p≤0.05. The policies and procedures of the institution plays an important role as policies tell people what to do and procedures describe how to perform a task in a step-by-step way. Creating a supportive culture through training and development should be included in institutional policies. It is important to provide university policies and procedures related training and development to university online teachers (Dittmar & McCracken, 2012; González-Sanmamed al., 2014). In addition, full-time staff, adjunct and casual staff should also be considered for the training and development (Hammond et al., 2018).

Table 31

Social ergonomic factors vs years of Online Teaching Experience

Social Ergonomic Factor	Crude odds ratio and 95% Confidence interval			Adjusted Odds Ratio and 95% Confidence interval		
	COR	Lower (Ln)	Upper (Ln)	AOR	Lower (Ln)	Upper (Ln)
Working alone is most effective *No = 0** *Yes = 1*	0.7	-1.4	0.7	0.5	-1.9	0.5
Sufficient support and guidance received *No = 0** *Yes = 1*	**2.9[b]**	0.2	1.9	**2.9[c]**	0.08	2.1
Participate in teamwork *No = 0** *Yes = 1*	**2.6[c]**	0.04	1.8	2.3	-0.2	1.8
Ability to communicate are affected by Language barriers. *No = 0** *Yes = 1*	0.5	-1.7	0.2	0.4	1.3	0.4
Have audio-visual contact through the internet with students *No = 0** *Yes = 1*	1.2	-0.7	1.0	1.3	-0.7	1.2
Necessary technical infrastructure is in place *No = 0** *Yes = 1*	1.8	-0.4	1.5	1.0	-1.1	1.1
Feeling isolated *No = 0** *Yes = 1*	0.8	-1.0	0.5	1.1	-0.8	1.0
Affected by cultural differences. *No = 0** *Yes = 1*	1.2	-0.6	1.0	1.9	-0.4	1.7
Any other social ergonomic factor. *No = 0** *Yes = 1*	1.1	-0.8	1.0	1.1	-1.0	1.2

[a]p≤0.001, [b]p≤0.01, [c]p≤0.05

**Reference category*

The crude odds ratio and adjusted odds ratios between 'Online teaching experience' of the participant educators and effect of social ergonomic factors are listed in table 31. None of the social ergonomic factors appeared significant at p≤0.001. The social ergonomic factor 'Sufficient support and guidance received' had an odds ratio (2.9, 95% CI 0.2 to 1.9) at p≤0.01 identifying that a greater number of experienced online educators reported not receiving enough support and guidance than less experienced online educators; 'Participate in teamwork' with odds ratio (2.6, 95%CI 0.04 to 1.8) at p≤0.05 showed that a greater number of experienced online educators reported a lack of ability to participate in teamwork than less experienced educators. This may have been because the less

experienced educators were required more organisational support and involvement in teamwork due to their lack of experience in online teaching.

None of the factors considered had significant adjusted odds ratios with $p \leq 0.001$ or $p \leq 0.01$. Significant adjusted odds ratio with $p \leq 0.05$, for social ergonomic factor 'Sufficient support and guidance received' had an odds ratio (2.9, CI 0.08 to 2.1) at $p \leq 0.05$ indicated that more experienced online educators reported not receiving enough support and guidance than less experienced online educators. Verma et al. (2020), stated that many educators working in institutions did not have adequate skill to conduct online classes remotely and struggled to accept the transition. The research conducted by Sun and Chen, (2016), identified that the online educators in tertiary education have not been receiving sufficient support from their respective institutions. Online teaching requires more technology than traditional face-to-face teaching, especially for the educators who are new to online teaching. Due to the emergency transition from traditional to online teaching to deal with the COVID-19 pandemic some of the educators were inadequately trained or supported to effectively operate on online teaching platform, it is very important to receive support from the university and from the co-workers to get full understandability of the objectives, having proper knowledge of the framework and teaching activities for their respective class (Bao, 2020).

5.2.5. Section Summary

Quantitative analysis between all the five ergonomic factors with the demographic factors including gender, subjects taught, country they were teaching from, and the permanency status of the educators and online teaching experience were carried out in this section to identify any significance between these factors. The main areas identified were the inadequate seating and workstation set up, noise and lighting options, inadequate time allocation for online teaching related work, inadequate training and understandability of policies and procedure, technology related issues, support and guidance received from the respective institutions. Results confirmed that demographic factors and experience in online teaching did affect the educator.

5.3. Qualitative Data Analysis

5.3.1. Introduction

To achieve research Objectives 1 (ergonomic factors that were perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering academics), 2 (ergonomic factors that were perceived by university educators to be a barrier to providing online teaching), and 4 (relationship of the five ergonomic factors towards experience in online teaching) questions were included in the survey to help the researcher to obtain an in-depth knowledge to achieve these objectives. For the qualitative data analysis NVivo 12 software was used to create nodes, sub nodes, themes, and word clouds to analyse the qualitative answers collected through questionnaire survey. Quotes from research participants were included to highlight important information related to the research objectives achievement.

5.3.2. Online teaching

The 3rd part of the questionnaire included 6 questions with a yes or no answer and room to provide comments on why the answer was yes or no and included 17 sub questions and one open ended question on physical ergonomic factors related to online teaching work. This was followed by asking 9 yes/no questions and room to provide comments on why the answer was yes or no and included 15 sub questions and 82 open ended question on environmental ergonomic factors related to online teaching work. Organisational ergonomics had 6 yes/no questions and room to provide comments on why the answer was yes or no and included 8 sub questions. Cognitive ergonomics had 8 yes/no questions and room to provide comments on why the answer was yes or no, included 1 sub question and one open ended question. Social ergonomics had 9 yes/no questions and room to provide comments on why the answer was yes or no. The final question for this section was to rank the 5 ergonomic factors in order of importance. The last section of the questionnaire included 7 open ended questions to assist with answering the research aim and objectives. Questions related to online teaching in the 1st section of the survey in which the participants had the opportunity to provide an explanation were also analysed qualitatively.

Descriptive statistical analysis was conducted to identify the number and percentage of each ‘yes’ or ‘no’ answer. Qualitative analysis was carried out to analyse the comments made by the participants to support their ‘yes’ or ‘no’ answer. Thematic analysis of the

answer received for the comments and the open-ended sections was conducted using NVivo 12 software.

5.3.2.1. The effectiveness of online teaching related to subject taught.

Question 13 from the 1st section of the survey asked respondents "Do you think effectiveness of online teaching depends on the subject you teach online? Yes/No. Please explain". Seventy two percent (87) reported that the effectiveness of online teaching depended on the subject taught while 28% (34) educators indicated no. The explanations were grouped into following themes.

Online teaching is hard.

Within 114 comments provided by the respondents 34 educators indicated that online teaching was hard for some subjects and the most common response was that online teaching is hard. Three respondents commented that subjects requiring group work are not easy to teach online as reported by P44, a female from Croatia,

> *Some subjects require more group work or practical assignments that can't be conducted online. Interaction between students and between students and teachers is better and more effective in the classroom, where it is easier to give feedback because the teacher has a better insight into students' work.*

Respondents identified that theoretical subjects were the easiest to teach online, while laboratory and fieldwork were more difficult to conduct as online classes. P23, a female from Australia, reported that,

> *I imagine that teaching skills labs would be difficult online – e.g., pathology where students need to learn to take blood.*

According to Cruickshank, (2020) and Sanger, (2020) face-to-face (F2F) teaching for theoretical topics can be effectively transformed into online courses with an interpretation of modified pedagogy to confirm continual student online commitment. It was suggested that using discussion boards and synchronous online conferencing increased educators' interaction with the students and with the integration of collaborative student assignments. These authors did not consider student learning and performing practical skills that required a physical interaction with people. Robinson et al., (2020), wrote that there were genuine worries about growing online teaching and learning demands, accessibility to the

technology for students, and the working conditions of the staff members. Finding the right method of facilitating interactive learning and providing active, meaningful assessment online without jeopardising a violation of academic integrity was one of the genuine concerns of some staff members (Sanger, 2020).

Easier to teach online.

Nine respondents indicated that they find some subjects are easier to teach online than others or that the effectiveness of online teaching does not depends on subject taught. P65, a female from Singapore, commented,

> *While some subjects may be easier to teach online than others, I think it is possible for most teaching to be done online. What is more important is the intention of the session. If it is content delivery-focused then online is fine. If there are practical elements such as the teaching of skills or techniques then face-to-face is preferred, but we have done it online too. Tutorials and discussion-focused sessions can be done online but require different structures to facilitate.*

P42, a male from Lebanon, explained that,

> *Theoretical courses are not as hard as applied courses to get across.*

Educators are required to change their mode of delivery from face-to-face to online teaching ensuring that the quality and the objectivity of the content are still present (Acosta-Tello, 2015). Using synchronous interactive online instruction, educators may be able to engage the students and improve the quality of teaching as educators find opportunities to explain, highlight, and facilitate difficult contents of the course (Moore et al, 2009). Educators may be able to overcome the limitations of space and distance by highlighting the complex portions of course content in an interactive teaching platform (Acosta-Tello, 2015).

Teaching technical subjects with laboratory work.

Thirty one comments made by educators indicated that the most preferred method for conducting laboratory classes was face-to-face teaching in a laboratory, as then the students were able to use the equipment to conduct experiments, generate their own results (instead of watching through videos someone else do the work) and students could ask questions and immediately receive clarification from the educator and/or from peers which helped to

improve their understanding of the laboratory work (Barbeau, et.al., 2013). P17, a female participant from Slovakia, recorded:

> *Laboratory subjects cannot be taught online.*

P6, male a from USA wrote,

> *In highly technical subjects that require laboratory or field work, it has been difficult to do these courses on-line.*

Similarly, P96, a female from India reported that,

> *Lab based subjects need hand on demonstration not feasible via online as students themselves need to perform and experience themselves the same.*

The result of a study carried out by Stuckey-Mickell & Stuckey-Danner, (2007), comparing perceptions of online laboratories to face-to-face laboratories in an online biology course found that 86.9% of the students agreed, or strongly agreed, that face-to-face laboratory classes help to improve their understanding of the content more. Other studies showed that fully online laboratory courses are effective though there are some limitations related to communication that may exist. (Barbeau, et.al., 2013). Practical courses are substantially important in connecting theory with practice and this connection enhances the academic and practical skills of the student. Students can receive more hands-on experience related to the subject through practical and laboratory classes, than only attending online lectures. Practical courses help the students in developing aptitudes that affect their mindsets (Walkington et al., 1994). Teaching practical courses online, including medical, engineering, health, gastronomy and languages without practical work creates a challenge for educators, universities, and institutions (Elhaty, et al., 2020).

Non responsiveness of students and motivation.

Six of the respondents commented on student non-responsiveness and three comments were received on motivation. Comments received from P39, male from Australia, were that

> *Online teaching is often quite didactic. Even though you may want it to be interactive, it very often isn't because students are reluctant to speak online. The most useful aspect of online teaching/learning is one to one, or small group, tutorials in which students come with issues important to them.*

As an explanation of the problems, she faced Australian P51, reported,

> *I taught Anatomy and physiology online last year and when we were in shut down this year and I volunteer to teach refugees overseas online. The medium is difficult to engage students in group situations or to have discussions. Students do not use video unless requested and prefer to remain faceless. This enables a few students to dominate the class. It becomes more difficult to determine where conceptual problems occur.*

Lack of student engagement or non-responsiveness is a very common barrier in online learning (Stott, 2016).

P103, a female from Australia commented,

> *The online teaching program will be effective when students have strong inner motivation. The online teaching provides them with autonomy to study on their own path.*

In comparison a male participant from India P55, commented that,

> *While it may appear that subjects that require illustrations in the classroom are difficult to teach online, this notion has been addressed by the ICT and related technologies. However, two-way seamless interaction is a challenge still. So, as courses requiring a lot of interaction may have issues with online teaching effectiveness. But even this can be addressed through appropriate instructional approaches.*

Sometimes the online classes become boring and unengaging to both the students and the educator (Dhawan, 2020). Individual attention is an enormous challenge in online teaching and learning platform. Having too much flexibility sometimes pose a challenge in completing the work on time (Song et al., 2004). It is difficult always to get two-way interaction, which results in a feeling of isolation. The major barriers are feeling a lack of community, problems with technology, and struggling to understand the instructional objective (Song et al., 2004).

Availability of technology resources.

Five comments focused on availability of technology resources. The following comment was received from P86, a female from India,

> *I teach Bengali language and literature to undergraduate students. In online mode I had to face mostly two difficulties. Firstly, most of my students belong to economically underprivileged background who can't afford online education as they can't afford the tools and technology. Secondly Most of the text and reference*

books (written in a regional language) of their curriculum are not available online.

A similar comment about lack of resources was made by P14, a male from Ghana.

Online mode of delivery depends on availability of resources such as internet, computers, teaching aids, and conduciveness environment and ability to use internet.

Poor engagement of students may result from poor internet connectivity (Stott, 2016). Stott (2016) reported receiving student emails directly related to navigation within the learning management system, mainly when students were trying to obtain off-campus access to the system, or when students had a lack of computer skills, or when they faced technical difficulties. In some countries, such as Lebanon, there may only be electricity provided to the home or university for one hour a day, if at all, which limits the amount of time that online learning can be conducted.

Educators' knowledge, training, and skills

The effectiveness of online teaching work can depend on educators' teaching skills/training in online teaching as commented on by 8 of the respondents. Literature reviewed showed that the roles and competencies of online educators depended on the educators' competencies related to technology (Egan & Akdere, 2005; Martin, Budhrani, & Wang, 2019), online communication (Williams, 2003), and the type of student assessments provided to demonstrate student learning outcomes (Bağrıacık Yılmaz, & Karataş, 2022; Baran et al., 2011; Bilgiç & Tuzun, 2020). As reported by P25, a female educator from Australia that,

It depends on the teacher's own knowledge of the online teaching pedagogies.

Having lack of online teaching experience due to being new to online teaching required more time and practice than usual as did facing technological difficulties with having access to high-speed internet (Arasaratnam-Smith & Northcote, 2017; Claywell et al., 2016; Sun & Chen, 2016). Numerous studies show that the interaction between educators and students can considerably impact the perception of students' online learning and the reliability in designing courses (Swan et al., 2000). With good interaction the educators should be capable of promoting the students' critical thinking ability and information processing (Duffy et al., 1998; Hay et. al., 2004; Picciano, 2002).

The educators who teach online were required to overcome the potential barriers posed by technology, time, and place and make decisions on how to use the online tools to create efficient, effective, and appealing online courses. Thus, online educators may be required to have roles and competencies slightly different to traditional teaching (Moore et al., 2001; Prestera & Moller 2001; Spector & de la Teja, 2001; Williams, 2003). Researchers described the roles of online teachers as advisor/counsellor, process facilitator, content facilitator, assessor, researcher, designer, technologist, and manager/administrator (Baran et. al., 2011; Goodyear et al., 2001). Research studies have shown that higher interactivity between students and educators can result from more discussions (Townsend et al., 2002), participating and getting involved in online lectures, and case studies (Smith & Winking-Diaz, 2004).

5.3.2.2. COVID-19 pandemic effect on method of teaching.

Another question from the 1st section of the questionnaire was 'Has the COVID-19 pandemic affected your method of teaching (online or on campus)? Yes/No. Please provide comment.' Results indicated that 28.1% (34) of the university educators did not feel that the COVID-19 pandemic outbreak had any impact on their method of teaching, as they were already teaching online before this pandemic. However, 71.9% (87) respondents felt that the outbreak did impact their method of teaching.

Altogether, 114 comments were received related to the effect of the COVID-19 pandemic. The comments were grouped into five main themes and some sub-themes as below:

Started teaching online due to the COVID-19 pandemic.

The forced change from face-to-face teaching to online teaching due to the outbreak of the COVID 19 pandemic affected some educators, as well as the students, positively and some negatively. The educators who were forced to change their mode of teaching from in a classroom to online faced many challenges at the time of the transition as it was very abrupt. For example, P38, an Australian male, reported,

> *I was required to convert a face-to-face course to be fully online within a matter of weeks when the pandemic hit.*

Not having sufficient time sufficient time to develop online teaching was one of the problems described. Similarly, P117, an Australian female wrote that,

> *It has forced units online that had not been previously. The Unit Co-ordinator had always previously said they would never teach online and would never work for Open Universities Australia.*

As described above the response to the pandemic also forced educators who did not want to teach online to be required to do this by their university managers.

In relation the changes in university teaching due to the COVID-19 pandemic different countries, systems, and institutions were posed with different challenges due to isolation requirements (Heng & Sol, 2021). A study conducted by Adedoyin and Soykan (2023), revealed various distinct challenges instigated by the sudden transformation of classroom teaching to online during the outbreak of the COVID-19 pandemic. The main challenges were associated with technological infrastructure and digital expertise, socio-economic factors, assessment and supervision, high workload, and compatibility within different subjects such as physical education courses that require physical interaction. This study identified similar problems.

Pedagogy.

To cope with the unexpected change from face-to-face to online teaching the educators' main concerns were to be able to engage the students in in the same way as face-to-face teaching (Jegede, 2020; Ratten, 2020; Mahaye, 2020). The educators (P14, P16, P18, P38, P39, P49, P50, P51, P79, P98) implemented alternative plans, including instructional methods to ensure that the educator was able to make the content understandable as well as interesting to engage the students in the online learning platform.

> *More and frequent assignments are given to students. Teaching aids such sketches and videos are largely employed. (P14)*

> *My teaching method is primarily based on board work for derivations and explanations. During the pandemic, preparing the whole content as a PowerPoint presentation is quite difficult and also does not carry all the necessary information that I want to convey to the students. It becomes more like a seminar! (P79)*

Educators reported facing challenges to convert specific courses (numerical and practical) teaching to online teaching (Joshi et al., 2020). Educators were uncomfortable teaching some courses online specially subjects which involve numerical, experiments and personal interaction (Mahajan, 2020). Participants P18, P61, P63 raised similar issues.

I had to look for suitable and new ways of approaching the problem in technical subjects where a calculation procedure and practical examples of solutions are required. (P18)

All the units I teach are suitable for face-to-face teaching as they are numerical, software related and lab-based units. I don't feel comfortable in teaching these units online. It seems I am not giving my best to the students. I cannot understand the facial expression of the students. It is not as interactive as face-to-face one. (61)

Change in role.

The changing role of the educators was another major challenge related to online teaching (Kebritchi et al., 2017) as the role of online educators transformed from a knowledge communication mediator to an online expert to lead students' learning process (Juan et al., 2011). Additionally, the educators were expected to be available to provide student feedback, direct the educational tools (managerial or administrative), and enable student-to-student engagement (social relationships).

I became more of a director to ensure we moved through the material. Previously I could move around the class and discuss problems with small groups. I could eye-ball students and they felt more confident asking me questions about their understanding. (P51)

Already involved in online teaching.

Respondents' answers showed that 21% (23) educators out of 121 respondents were involved with online teaching prior to outbreak of the COVID-19 pandemic. The educators who were already involved in online teaching before the outbreak of COVID-19 did not encounter as many challenges with this transition. P31 was involved with online teaching from 2017.

I developed a fully online, interactive, and engaging online course in 2016, and enhanced it in 2017. (P31)

The responses of P24, P56 confirmed that some educators were already involved in online teaching, so this sudden shift did not make any difference for them.

Online teaching in COVID made no difference in Western Australia. More students were engaged in online learning and to that extent, it became more

acceptable for students to accept online teaching - and many were pleasantly surprised. (P24)

I have been always teaching online sessions either in normal mode or flipped mode. So, there is no effect. (P56)

Affected

Approximately one third 31% (36) respondent educators felt that their method of teaching was affected by sudden change of instructional platform i.e., online from face-to-face teaching to online. The majority of the educators described various aspects of their concerns while teaching online, which includes accessibility to resources (P86), interaction (P102), lack of connectivity (P84), unavailability of highspeed internet (P88), extra workload (P62, P97, P104), effect on personal life (P42), etc.

Azman and Abdullah (2021), claimed that the lack of good internet support such as access to high-speed internet was one of the main challenges for students and educators of developing countries.

For online teaching - participation of some of the students got affected due to their remote location and lack of connectivity. On Campus- it got affected as there were no students in the campus and at some point, of time the institute was also closed down. (P84)

The abrupt change to online teaching produced an unexpectedly high workload in building e-platforms and incorporating peripheral applications into their system on time (Adedoyin & Soykan, 2023). Training educators on how to use the new system and platforms also posed challenges. Some educators experienced extra workload as they transformed course content, teaching resources, and assessments to online and because of the urgent necessity, this workload triggered stress and anxiety (MacIntyre et al., 2020; Winthrop, 2020). P62, P86 and P78 provided their explanations about their challenges.

More online. Less in person teaching. More students studying because of extra payments and therefore units became very large without warning and this extra workload was not accounted for. (P62)

Due to COVID-19 online teaching, access to library and books, examination system has severely suffered. (P86)

> *Being unable to observe the eyes of the shy students in the class, the teacher is unable to judge whether a particular topic requires to be reiterated or not, which remains a lacuna and affects the whole course. Also, the expression of the students when they follow a certain topic act as an award to the teacher, and so the class becomes drab. (P78)*

The sudden shift to online education generated more stress, frustration, and isolation for some students and educators due to a lack of opportunities for interactions between student-educator, student-student, co-workers/colleagues (Daniel, 2020; Gillett-Swan, 2017). This frustration was explained by P100.

> *Interaction with students is an important aspect of teaching, which is negligible on the online platform. It becomes really difficult to make students understand topics on art history. (P100)*

Similarly, participants P44 and P55 described challenge they were faced to keep the balance between personal and professional roles, as teaching shifted to working-at-home to maintain social distancing.

> *By all means, my lifestyle has drastically changed! (P44, P55)*

5.3.2.3. Provision of online teaching support to students.

The next question asked 'Did you need to provide any extra online teaching support to students during the COVID-19 pandemic? For this question 66.1% (80) participants agreed that the COVID-19 pandemic outbreak did result in more time being required to provide extra support to the students in online teaching, whereas 32.2% (39) participants disagreed. Comments were provided by 77 respondents to explain their answer. These responses were divided into four themes as discussed below.

More consultation and support time required.

Of the 80 participants who stated that online teachers needed to provide extra support 48 participants reported that online teaching requires 'more consultation and support time' to provide extra study materials that were required for online teaching and to help students to deal with their stress arising from the COVID-19 restrictions. Respondents wrote that there were changes in the role of the educator as besides delivering the course content online, they were required to have more communication with students related to technology, coursework, or personal issues. Another challenge was the demand on educators' time, as

online teaching requires time to prepare, plan, and teach as online teaching requires twice the time to prepare online course content in comparison with time taken to prepare the course content for face-to-face classes (Kebritchi et al., 2017). For example, P13, P41 and P86 described spending extra time to support their students by providing resources.

> *We needed to provide students with extra worksheets, E-text books and materials. (P13)*

> *In addition to online classes and materials, I provided additional time outside of scheduled activities for students to discuss content, questions, issues, etc.(P41)*

> *I often had to scan voluminous books to provide my student's study materials as book shops and libraries were completely shut. Due to poor internet connectivity courses took much more time to get completed. I often had to reschedule/restructure online classes as per my student's requirement. (P86)*

It was suggested by Kebritchi et al., (2017), that for online teaching and student learning support educators should try to use several e-learning approaches including active presentations, tutorials, theoretical discussions, interaction, and collaboration with students to support their knowledge development, activity, and assessment but providing all of this took extra time that was not allowed for in the university work time allocation to the educators.

Participants P1 and P38 described allowing students time in class to obtain help with problems arising due to the pandemic and how they provided extra support to students who required this.

> *Allowed non recorded time for online classes at the end of class for students to discuss any problems that they had and helped to provide advice for problem solutions. (P1)*

> *I had to organise online sessions to help students during the pandemic and provide extra support to several students who were going through difficult times during the pandemic. (P38)*

Rotas and Cahapay (2021), in a qualitative study with 32 purposively sampled Filipino university students who were studying online because of the COVID-19 pandemic, found that the students were messaging their lecturer about their poor internet connection that was making it difficult for them to study online. Students were also reported phoning their

lecturer for additional help as they were finding it difficult to study online or they had problems which were making it difficult for them to study. To deal with this extra need for support virtual mentoring was implemented as a way of providing advice and guidance to the students who were new to online learning, for students who were having difficulty with online learning, and for students who had problems related to the pandemic.

Laboratory classes

Laboratory classes in real laboratories were not possible during the pandemic isolation time so virtual labs, remote controlled labs or video-based labs were introduced (Gamage, et al., 2020). The following are examples of some of the problems identified by the online educators in relation to laboratory work.

> *Had to find a substitute for laboratory experiences in three lab courses. (P4)*

> *We were not able to have face-to-face practical classes, so I arranged for industry professionals to deliver lectures on actual projects they had recently undertaken. I then developed quiz questions to test the student's understanding of the presentations. (P114)*

Gamage, et al., (2020), reported that virtual laboratories were useful but there was still a major need during the pandemic to be present in the laboratories to do most of the teaching and student practical work effectively.

Internet/Software.

"Technology adoption" was identified as a barrier in online teaching. According to Verma et al. (2020), many institutes did not have educators experienced in online teaching (Joshi et al., 2020). P11 described the education provided.

> *The start of teaching in the Microsoft Teams environment was started with a two-hour course for teachers on how to use MS Teams correctly. The university did not provide other educational activities. There was also no technical and material support for teaching from home, which I consider to be a problem. (P11)*

> *Many students faced problems with interrupted internet connections. Even many students inform that do not have sufficient data balance as well as gadgets available during the class duration every day. (P96)*

In some cases, slow and unreliable network connections affect the quality of online teaching and learning (Bean et al., 2019). Inadequate internet access, including poor

internet connection and low speed discouraged the implementation of online education (Sinha & Bagarukayo, 2019). Other issues that surfaced in relation to more educational support time required from the participants' comments were lack of technological training for the educators including errors while downloading, installation issues, problems with login, audio/video related issues and more (Kebritchi et al., 2017). The requirement for technology related training was identified by P16 and 53:

> *I would welcome some training on the use of TEAMS and how to use its functions effectively and easily. Secondly, I would need some methodological support on how to teach online, especially on the types of suitable activities or tasks for students. (P16)*

> *Proper training is needed. Also training on platform we are using. (P53)*

Educators were expected to effectively integrate technology into their online educational platform though they were continually struggling to keep up with new technology and pedagogical innovations (Tarus, et al., 2015; Voet and De Wever, 2017). Technology was required for preparing online course material and as the medium of delivery of instructions, but some educators did not have adequate skills and competencies to design and implement effective technology into their online teaching (Munyengabe et al., 2017; Munyengabe et al., 2019).

Stress.

Debbarma and Durai (2021) reported that educators and students can become emotionally unstable due to the threat of catching the COVID-19 virus, or due to the lack of speed, or lack of connectivity to the internet for online education. To provide support to the affected students some educators went beyond their normal responsibility of only teaching to spend time (P42) to refer students to mental health support (P97) and other support. For example, P97 wrote:

> *Mental health support and referrals provided. Students in lockdown have significant barriers to assessment in terms of resources (such as laptops or acquiring texts). It takes a lot of realisation to be prepared to study in lockdown and not all students realised the extent of the required preparation. (P97)*

> *Extra hours were provided to students who were personally affected by COVID-19. (P42)*

> *I respond to many more emails because of the COVID impact. Stress levels are high with impacted students so there is a need to be extra supportive and caring at this time. (P99)*

Due to the sudden outbreak of COVID-19 pandemic the students were asked to leave studying on campus at their university on short notice and required to study online. Some students and staff lost their paid jobs and felt insure and concerned about their own as well as family's wellbeing (Brown & Kafka, 2020). Coping or dealing with stress can be described as a process of responding to the stressors with the use of one or more tactics or techniques (Talbot & Mercer, 2018; Tikkanen et al., 2020).

5.3.2.4. Educators experiencing depression, anxiety, or stress due to conducting online teaching during the pandemic.

The next question asked the online educators completing the questionnaire 'Did having to conduct online teaching during the pandemic cause you to be depressed, anxious or stressed? 'Yes/No'. Please provide a comment.' The majority [64.5% (78)] of the participating educators did not think that the COVID-19 pandemic caused them depression, anxiety, or stress but approximately one-third [33.1% (40)] reported being adversely affected. Seventy-two of the participants provided comments to explain their yes or no answer. All the comments were grouped into following themes.

Stressed or Anxious.

MacIntyre et al. (2020), recorded that university educators were required to deal with stressors due to the pandemic including concerns about catching the virus themselves and other people becoming ill due to the COVID-19 virus, isolation requirements. This resulted in having to work from home rather than in a classroom, threats to job security of self and other family members, new extended domestic responsibilities, and to being confined inside the home and not able to go out or socialise. Another challenge for educators was to keep the balance between personal and professional roles, as teaching shifted to working-from-home to maintain social distancing. In some instances, the educators were required to share the working space with their other members of the family, or their young child/children who needed attention as they were at home (MacIntyre et al., 2020). For example, P5 and P 83 reported balancing teaching responsibilities while caring for young children.

> *The steep learning curve for online teaching, plus suddenly home schooling my kids, plus worrying about certain students falling away. (P5)*

> *Moreover, having a toddler at home while conducting online classes can be quite challenging. (P83)*

Some educators who were not involved with online teaching prior to the outbreak of the pandemic found online teaching very daunting as it required, learning new technology, getting used to a different method of teaching and working from home. Extra stress occurred from the fear, lockdown, and uncertainty. Also, the severity of the impact of the pandemic and the helplessness was a reason for elevated stress for some educators. This was reflected in the comment made by P99:

> *In 2020 the pandemic did cause fear and uncertainty. This year there is still a lot of extra pressure to support COVID impacted Open University Australia students, however, I do not feel anxious anymore, I just see my role as the need to be supportive. I am now immunised so not as worried as last year. (P99)*

The global pandemic affected some people psychologically due to health concerns for immediate family members (P5, P83), especially the elderly members, social and physical distancing, travel restrictions, closed borders, unavailability of daily supplies, restricted services, and mostly the uncertainty of life becoming normal again (P99) (MacIntyre et al., 2020).

More Work.

According to MacIntyre et al. (2020) and P103 the role of online educators can be very stressful due to intense workload, the demand for time management and juggling between different roles. P39 acknowledged that though there was an increase of workload, it did not make him stressed.

> *Not depressed or stressed, but it did increase my workload and working hours, resulting in profound tiredness. (P39)*

However, P103 did experienced stress due to the elevated workload.

> *The number of emails increases significantly, which results in my need to spend more time dealing with administrative work, and this is truly time and energy consuming. (P103)*

New environment.

The COVID-19 pandemic isolation requirements impacted both teachers and students. Some educators started teaching online amid COVID-19 pandemic, so this environment was new to them (Mishra et al., 2020). P2 said he got stressed due to the sudden shift of teaching method.

> *We were given 1 week to make the shift to all online teaching. (P2)*

While P60 did learn a new method of teaching he did not feel stressed.

> *Learned new methods to engage students, reached out to individuals through My class interface using Polls. (P60)*

Isolation.

Seven educators expressed their feeling of isolation while teaching online.

> *Being stuck in a single room all day long was by itself a nerve-racking experience. (P42)*

> *The lack of classroom atmosphere and social interaction with students makes online teaching quite monotonous and depressing. (P83)*

Feeling of isolation were identified as a major barrier in online teaching. Some study participants reported missing the physical interaction with students and colleagues due to sudden shift to online teaching. Van der Spoel et al. (2020), research findings were that the lack of interaction was the main negative feature in online teaching as this requirement resulted in a lack of physical, temporal, and/or psychological activity with co-workers. Another factor that caused stress for the educators in online teaching was internet or software issues, which are discussed below.

Internet/Technical Issues.

Online classes cannot be performed without having access to electricity and internet connection. Some of the educators complained about the internet or technical issues they encounter while teaching online. Participants P48 and P9 stated that they and their students sometimes faced problems related to electricity and/or internet connection. A study performed by Gurung (2021), concluded that, the most significant challenge faced by

online teachers are to teach students live in remote areas due to lack of availability of strong internet access or who have an absence of continuous electricity supply.

> *Bad connection, electricity outage, voice problems and disconnection were quite nerve-wracking during the online sessions. (P48)*

> *And sometimes technologies may fail (PC), internet, electricity etc. (P9)*

The comments from P48 and P9 support the feeling of discomfort experienced by the educators resulting from poor internet facilities and lack of technology knowledge. The following section focuses on the educators who were already involved with online teaching before COVID-19 outbreak.

Already teaching online.

Thirty-four of the respondents were already involved with online teaching prior to COVID-19, so they did not encounter any change. Most of the comments received from the educators who had been teaching online before COVID-19 were that there was no change in their teaching or stress levels, so prior online teaching experience was identified as being a stress reducer for some educators as evidenced by the quotes below:

> *It is my main form of teaching. I was fortunate to be in this situation as I kept my job and got extra work teaching other teachers who had no experience in online teaching. (P24)*

> *We have taught online to a degree for a long time. It was at times frustrating but not more so than any other aspect of our work. (P41)*

> *I am an experienced online practitioner. I did not need to change any of my teaching practices during COVID. (P73)*

The comments received from the educators who were involved with online teaching prior to the sudden shift identified that due to their previous experience in online platform this sudden shift did not affect them. The next section describes the ergonomic factors that pose a barrier to online teaching.

5.3.3. Physical Ergonomic Factors in Online Teaching

5.3.3.1. Introduction

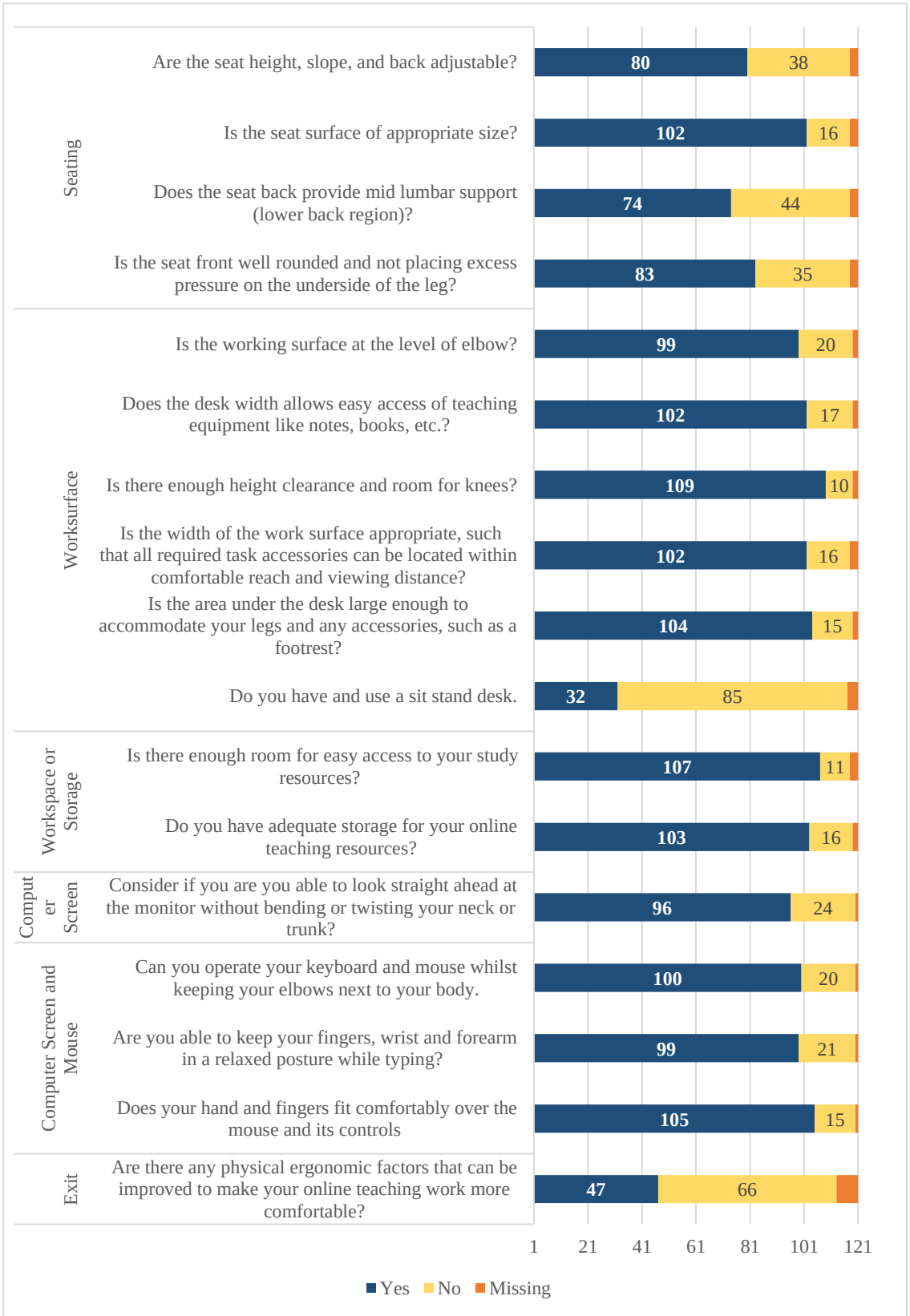
The following questions explored the educators' perceptions of physical ergonomic factors in their online teaching environment including their seating, workplace, desk design, computer, mouse, and keyboard setup. As well as answering yes or no to each of the questions on physical ergonomics the educators had the opportunity to provide comments about their answer to explain their 'yes' or 'no' answer.

Educators involved in teaching online courses may be frequent computer users, and be required to spend long hours sitting on a chair working at computer workstations, keying text, scrolling through electronic documents, etc. (Meidert et al., 2016). Educators who teach online units of study might be exposed to static muscle loading that can result in musculoskeletal stress in the upper extremities, back, shoulders, arms, and hands as prolonged hours doing computer work can entail a static posture of the upper body. Studies show that sitting has a detrimental health effect if prolonged and is associated with various illnesses including diabetes and cardiovascular disease (Dunstan et al., 2012). The flexibility to change one's position by sitting, standing, and walking, while working is better than continuously sitting with 90-degree angles in knees and hips (Chandra et al., 2009).

Physical ergonomic risk factors influence the efficiency of the worker. The key physical ergonomic risk factors for work related musculoskeletal disorders are awkward posture, extreme physical load, repetitive movement of any body part, and extent of movement and vibration (Lasota, 2020). According to many researchers the work-related muscular skeletal disorders caused by physical ergonomic factors can cause reduced productivity and efficiency as well as, and increase absenteeism (Lasota, 2020). and medical/insurance costs (Lasota, 2020). There is some evidence that using alternative/ergonomic keyboards and/or mice may lower the pain in upper extremity and neck of the users (Lasota, 2020).

The following section describes the 7 questions with sub-questions related to physical ergonomic factors. Figure 54 Shows the number of positive and negative answers of the participants while answering the physical ergonomic related questionnaire.

Figure 54
Physical ergonomic considerations



5.3.3.2. Seating

This section of the questionnaire focused on the type of seating options available for the educators while teaching online. The question on seating was dived into four sub-questions to provide better understanding of ergonomic factors related to seating. Table 32 lists comment which were grouped according to their themes.

Table 32

Availability of seating options of the educators while teaching online

Stressors	***Participant number + employment type***	***Gender***	***Country***
Using fully adjustable chair	P52, P56, P60, P65, P12, P112 (Ongoing). P26, P84, P95, P98, P115, P119 (Casual)	5M. 7F.	Australia 7 India 3 Singapore 1 Taiwan 1
Not using adjustable chair	P2, P14, P44, P53, (Ongoing). P78, P8, P90, (Fixed-Term). P115, P19, P21, P25, P32, P49, P51, P104 (Casual)	4M, 11F.	Australia 8 USA 1 India 3 Ghana 1 Croatia 1 Czech Republic 1
Appropriate size of seat surface with well- rounded front	P25, P84, P98, P115 (Casual). P60 (Ongoing). P90 (Fixed-Term)	3M. 3F.	Australia 3 India 3
Inappropriate size of seat surface without well- rounded front	P19 (Casual). P12, P112, P114 (Ongoing). P78 (Fixed-Term)	2M. 3F.	Australia 3 India 1 Taiwan 1
Seat back provide mid lumbar support	P12, P60 (Ongoing). P90 (Fixed-Term). P98 (Casual)	2M, 2F	Australia 1 India 2 Taiwan 1
Seat back do not provide mid lumbar support	P19, P25, P51, P84, P115 (Casual),	1M, 4F	Australia 4 India 1

Adjustable seat height, slope and back.

Figure 54 shows that 66% (80) participants were using fully adjustable chairs while teaching online but that 31.4% (38) participants did not use an adjustable chair. Extended sitting at a sub-optimal workstation including the office chair has been linked with musculoskeletal symptoms such as discomfort and muscle tension in the cervical, shoulder, and lumbar regions (van Niekerk et al, 2012).

Using fully adjustable chair.

After studying the comments, it was identified that 12 educators who used fully adjustable chairs or ergonomically supported seating arrangements, were either conversant with

ergonomics, or they obtained help from an ergonomic expert while setting up their working area. For example:

> *I have an OT degree so am totally aware of the complexities of sound seating and workspaces. (P26)*

> *I am cognisant of ergonomic principles and sought a high-quality chair for my home office. (P52)*

Participants P26 and P52 understood physical ergonomics so used their knowledge to set up their work area so that it was ergonomically suitable for their online teaching. Another participant used an expert to assist with office chair selection and reported that the:

> *Office chair selected for me by ergonomic expert. (98)*

Other participants (P56, P60, P65, P95, P119) also reported having a fully adjustable chair. For example:

> *I have an office chair and can adjust the height and backrest position. (P56)*

Studies show that an adjustable chair can reduce muscle activity in the neck, shoulder, and back. Also, the ability to adjust the seat pan height and depth according to with user's body size reduces intervertebral disc pressure and spinal discomfort (Underwood & Sims, 2019). Other research participants did not have fully adjustable chairs to use when developing their teaching materials and teaching online.

Not using adjustable chair.

Fifteen comments were received from respondents who were not using a fully adjustable chair. Four participants were using a chair which was broken. P32, expressed that though she is aware that the chair she uses for her online teaching work is not suitable, she is not able to buy a new chair due to financial constraints. The participants not using a fully adjustable chair were mostly casual academics who did not seem to be provided with the same ergonomic workplace setting up advantages as provided to academics with ongoing employment. For example, it was reported:

> *I use an old office chair as I cannot afford to get a specifically designed one if I am not permanently working from home. (P32)*

Other academics reported having a partially adjustable office chair for their teaching work. For example:

Height yes, slope no. (P49)

Prolonged sitting in an improper chair led to inappropriate sitting positions resulting acute psychological stresses and affect performance of any individual (Ansari et al., 2018; Aryaie et al., 2017). Three participants (P2, P78, P115) used alternative seating arrangements as to reduce their risk of static muscle loading and improve their comfort. For example, one participant wrote:

Mostly I sit on my bed during the online class. (P78)

Another participant recorded:

I use a yoga ball instead of a chair. (P115)

Flexible seating includes many types of seating options other than the traditional desk and chair. Some seating options might involve a physical component such as a stability ball, cushion seats for wiggling, and stationary pedals. Other seating options may include a change in height like sitting table, standing desk, or high-top table. There are other comfortable options such as beanbag chairs, couches, or big chairs (Burgeson, 2017).

Seat size and shape.

Regarding of having appropriate size of the seat surface Figure 54 showed that 84.3% (102) said yes to having a correct seat, 13.20% (16) did not have a chair with a proper seat surface; 68.6% (83) of the participant educator reported 'yes' and 28.93% (35) said 'no' to having a seat with a well-rounded front. Appropriately cushioned rounded edge seat pan helps to reduce the pressure on the backs of user' legs (Woo et al., 2016).

Inappropriate size of seat surface without well- rounded front.

While most of the participants said that their seat surface is well-rounded, five participants commented that either their seat size is inappropriate, or seat front is not well rounded and comfortable. For example:

The seats were a bit too big. (P12)

Having too big i.e., too wide, and deep, seat pan of the working chair may prevent the user from using the armrests and the backrest (Woo et al., 2016). The adjustable seat height and depth of the chair helps to provide a range from the 5th percentile female (at the lowest setting) to the 95th percentile male (at the highest setting) of the anticipated user populace (Woo et al., 2016). If seats are of an incorrect size this can result in a pressure problem, as described by P114.

> *Sometimes I have to sit for too long and this results in the chair leaning down and too much pressure on the underside of my legs.*

Chair with mid-lumbar support.

For this question, Figure 54 indicated that 61.2% (74) participants said that the chair they use for working does provide mid lumbar support and that 36.4% (44) reported not having proper lumbar support. An explanation of the answer was provided by P51 who documented:

> *I am very short and sit at the front of the seat.*

As an explanation of the effects of lumbar support P12 wrote

> *It does, but as the recorder prolonged, it was tiring to sit.*

Indicating that there were still problems due to the length of time spent sitting, even when there was good mid lumbar support. Sufficient lumbar support and buttocks clearance should be provided by the backrest of the chair used with an adjustable height and inclination of the chair to support the back of the user in various sitting postures (Occupational Safety and Health Administration, 2008). Having an adequately tall and wide backrests has been suggested by previous studies as being important for back support (Woo et al., 2016).

5.3.3.3. Workstation design to use for online teaching work

Factors impacting workstations included layout of the workstation, method of working, tools used to complete the job and their design (Lasota, 2020), also the workers anthropometric characteristics (Sumpor, et al. 2015). The Table 33 describes the comments received.

Table 33
Workstation related comments.

	Participant number + employment type	***Gender***	***Country***
Height and width of the workstation	P2, P65, P112, (Ongoing) P25, P84 (Casual)	2M. 3F.	Australia 2 India 1 USA 1 Singapore 1
Area under the workstation	P9, P23, P84 (Casual) P57, P78 (Fixed-Term) P12, P47, P114 (Ongoing)	2M. 5F.	Australia 3 India 2 Czech Republic 2
Using Sit-to-stand desk	P12, (Ongoing) P31 (Fixed term) P119 (Casual)	1M, 2F	Australia 2 Taiwan 1
Not using Sit-to-stand desk	P25, P49 (Casual), P58, P114 (Ongoing)	2M, 2F	Australia 4

Appropriate design and space for the work surface is crucial to avoid musculoskeletal disorders related to the elbows, shoulders, hands, and wrists (Sumpor, et al. 2015).

Height and width of the workstation.

Figure 54 showed that 81.8% (99) participants had a working surface at the level of their elbow. For both sub-questions of having enough room on the workstation and having appropriate depth of their desk for better accessibility to teaching accessories, 84.3% (102) participants reported 'yes' to both sub-question 1 and 3. For sub-questions 2 and four, 13.2% participants reported 'no' to each, while 8.26% (10) participants reported that their workstation height was not adequate. If the work surface is too high the user must raise their arms and shoulder, resulting to exhaustion or soreness. On the contrary, a too low work surface will influence the user to lean forward, putting all the stress on the arms and back (Woo et al., 2016). Preferably, work surface and seat height should be adjustable individually to permit the user to achieve both adequate computer keyboard-to-forearm distance and ample space available for leg (Sauter and Arndt 1984).

The comments provided from the participants indicated that the reason behind opting 'no' as the answer to these questions was due to having inadequate chair/ chair height, [*I previously had knee ache for a short period due to prolonged sitting. I needed to adjust the seat height* (P57) (P25)], *height of table* (P78), or *too small a desk*. For example, P114 and P84 wrote:

I need a camera to share documents and drawings on paper. No room for this. (P114)

Not adequate for task accessories within manageable distance. (P84)

Area under the workstation.

Fifteen (12.4%) of participants reported not having enough space under their desk for their legs. Most educators reported having enough height clearance and room for knees and for a footrest but if the educators did not need it, they did not use a footrest as a footrest was only required if the person's feet did not reach the ground when sitting on their chair. One participant did have a problem with the footrest and explained:

But the footrest damages my wall and the chair rolls around too much and I can't stop it. (P23)

Using a sit-to-stand desk.

Thirty-two (27%) of the participants had and used a sit and stand desk. In some cases, the desk was purchased by the educator. For example, participant 119 wrote:

I purchased an electric sit-stand desk for teaching.

In other cases, the educator was given a choice of having a sit to stand desk provided by the university that the participant worked for. For example, participant 12 documented:

I chose to use a standing desk. The standing desk was decent in size. I was standing. (P12)

Prolonged sitting while teaching online could elevate persistent exposure to sedentary behaviour (Buckley et al., 2014). This can be defined as an independent risk factor for obesity, diabetes, few types of cancers and death from any of these cause (Straker et al., 2013) and is recognised as a growing health and safety issue for workers in Australia (Straker et al., 2016). Introducing a sit-stand workstation (SSW) for workers working spending long hours in sitting position has resulted in a steady reduction in lengthy sitting time (Shrestha et al., 2018), reduce short-term musculoskeletal discomfort and enhance cardiovascular results (Agarwal, Steinmaus, & Harris-Adamson, 2018; Chambers et al., 2019) and prolonged use of sit-stand workstations (more than 3 months) benefit cardio-

metabolic risk statistics (Alkhajah et al., 2012; Healy et al., 2013) and work efficiency (Chu et al., 2016; Gao et al., 2018; MacEwen et al., 2015; Peterman et al., 2019; Sui et al., 2019). In Australia, the reports published by the Occupational Health and Safety (OHS) Regulators (Straker et al., 2016; Workplace Health and Safety Queensland, 2017), and other circumstantial observation suggests that a rapid uptake in Sit and Stand workstations (SSWs) across desk-based organisations. The integration of sit-to-stand workstations (SSW) is a useful approach for reducing sitting time at work and allowing for the educator to change posture as desired to avoid static muscle loading.

It was reported by 70.2% (85) educators that they did not have a sit to stand desk to enable a change of working posture during their working day. The comments received related to not having or using sit-to-stand desk varied from it's very expensive (*Too expensive to outfit*. P25), medical reasons (*Cannot use due to medical reasons.* P49) and individual preference (*Prefer not to have one.* P58).

5.3.3.4. Adequate workspace and storage space available for online teaching work.

Figure 50 identified that 85.1% (103) respondents had enough room for easy access to their study resources while 13.2% (16) did not. For having adequate storage for online teaching resources 88.4% (107) participants agreed while 9.1% (11) participants did not. Seven participants provided comments to explain their yes or no answers. Some online teachers were preferred to use online resources for their teaching which they stored digitally. For example, P25 wrote:

> *Books and files are to the side and have trays and whiteboard for additional information. Use Google Drive. (P25)*

Some educators did have adequate space for storage (P60); or have enough space on their desk.

> *One rooms has been earmarked for online teaching resources storage. (P60)*

Educator P32 chose to use the area had better lights as her working area, though that area did not have enough storage options.

> *A small study space in the entry of the house is the space with the best light so it is where I work. There is some space but given the number of units I work in the books and materials are extensive. (P32)*

The following section relates to the Computer Monitor, screen, keyboard, and mouse.

5.3.3.5. Computer monitor, screen, keyboard and mouse.

Able to look straight ahead at the monitor without bending or twisting neck or trunk.

Ninety-six (79.3%) respondents stated that they were able to look straight ahead at the monitor while working on a computer. Only 20% (24) respondents answered no to this question. Four comments explained that the participant educators were able to look straight at the monitor as stated by P83.

> *My seat is well adjusted with height of the monitor.*

Seven participants provided comments about why they were unable to look straight at the monitor. For example, P3 and P44 used laptop computers and not all educators knew the recommended height for computer monitors as stated by P21.

> *I don't know what the best height is to adjust it.*

Correct placement of the computer monitor is vital to avoid neck and eye strain (Kibria & Md. Rafiquzzaman, 2019). Majority of the guidelines suggests that the computer monitor should be positioned parallelly or below eye level to retain a relaxed angle to view and distance to the screen (Labour Department 2010) and it should also be directly in front of the user if the screen is viewed continuously or frequently (CSA 1989, 2000). A range of viewing angles and distances have been written in ergonomics standards, though, there is some dispute on the monitor positioning. For example, AS-3590.2 – 1990 (the latest Australian Standard published for screen-based work) recommended a low monitor position that is between 32° and 45° below horizontal eye level (Standards Australia, 1990); whereas ANSI/HFES-100 (American National Standard for Human Factors) recommends a mid-position that is between 15° and 25° (ANSI 1988).

More than one monitor.

Four participants (P24, P25, P41, P73) wrote that they were using more than one monitor.

> *Have two screens though, so the one to the right needs to turn neck. (P25)*

> *I have 3 monitors, so 1 is central the others require movement to see, however there is room to move my chair position rather than my neck or truck. (P41)*

As described by the participants it is difficult not to turn the head when focusing on more than one screen. CSA (1989, 2000), wrote that the computer monitor should be placed directly in front of the individual, if they are working with computer for prolonged time and view the screen continuously or frequently, which cannot be possible while working with more than one monitor. Improper positioning of the computer monitor can cause and elevate neck and eye strain (CSA, 2000).

5.3.3.6. Computer (or other electronic device) keyboard and mouse are comfortable to use for online teaching work.

One hundred (82.6%) participants reported that they could operate their keyboard and mouse keeping their elbows next to their body while 17.4% (20) could not. Ninety-nine (81.8%) wrote that they could work with relaxed finger, arm and wrist but 18.2% (21) could not. One hundred and five (86.8%) participants reported having a mouse which could be used comfortably, while 13.2% (15) participants did not. This indicates that most participants had a mouse and keyboard that was satisfactory.

Correct setting of computer keyboard and mouse.

Habibi et al. (2016), reported that the use of an ergonomic keyboard and mouse may reduce upper extremity and neck pain experienced by users. Participants P25 and P57 used an ergonomic keyboard to minimize this risk.

> *Have ergonomic keyboard with the curve, wrist rest and mouse rest with ergo mouse too. (P25)*

> *I had to change to an ergonomic mouse as previously an ordinary mouse became uncomfortable for my right index finger. (P57)*

Incorrect setting of computer keyboard and mouse.

Prolonged hours working on a computer may cause musculoskeletal disorders due to persistent repetitive and extensive vigorous use of hand, arm and finger motion, awkward postures, and positions (Lasota, 2020). P5, P74 and P121 reported having computer use problems.

> *Working from home on a laptop, the worst! (P5)*

I type with two fingers. (P74)

I use a laptop with a keypad built in. Need to have elbows on the table. No mouse. Only a trackpad. (P121)

It has become common to use a laptop computer for online teaching and preparation work when working from home for flexibility (Arshad et al., 2020). As the screen and keyboard of a laptop are attached, it is not easy to have the correct positioning to obtain a comfortable posture for both the keyboard and viewing the monitor as either the keyboard position is higher, or the screen height is lower than the recommended (Chandra et al., 2009).

5.3.3.7. Other physical ergonomic factors that help to make the online teaching work comfortable.

The important themes in answer to this question were workstation and equipment. The educators' explanations for the physical ergonomic factors that made their online teaching work comfortable are listed below. Total 57 responses were received, and the comments were grouped in to 6 groups as listed below in Table 34:

Table 34
Which Physical ergonomic factors help online teaching work comfort

Factors	***Participant number + employment type***	***Gender***	***Country***
Suitable Workstation and seat	P2, P3, P60, P105 (Ongoing). P9, P16, P18, P57, P76 (Fixed-Term). P71, P72, P84, P99(Casual)	6M. 7F.	Australia 5 India 3 USA 1 Iran 1 Slovakia 2 Czech Republic 1
Sit-to-stand desk	P31, P89 (Fixed-Term). P35, P55, P65, P73 (Ongoing). P72 (Casual)	2M. 5F.	Australia 5 India 1 Singapore 1
Improvement required	P9, P11, P111 (Fixed-Term). P22, P23, P32, P51, P62, P69, P71, P95, P121 (Casual). P41, P43, P47, P48, P50, P55, P58, P61, P63, P65, P66 (Ongoing)	10M. 13F	Australia 13 India 4 Czech Republic 2 Singapore 1 Croatia 1 Slovakia 1 Lebanon 1
Using multiple monitors	P98, (Casual). P12, P58, P61, P74 (Ongoing)	2M. 3F	Australia 4 Taiwan 1

Suitable Workstation and seat.

Thirty-five participants from nine different countries said that they were using comfortable seats / ergonomic adjustable workstation / reasonable headsets to help working with more than one monitor.

> *A large desk with easily mobile chair that can provide comfort in a range of positions. (P41)*

> *Large desk, modifiable desk chair, air conditioning, large screen on a screen raiser, sloped keyboard rest, large mousepad (iMac), good quality non reflective coated glasses. (P97)*

Environmental Factors and Summary.

Seven participants emphasised having good environmental conditions like less noise (P48), good lighting (P52, P56), good air quality (P104) despite being asked about physical ergonomic factors. P57 explained:

> *I am a safety practitioner so ergonomic set up important - including ventilation, temperature, noise levels, etc. (P57)*

Other comments received for physical ergonomics included liking the flexibility of being able to work from home.

> *I am in my own home so can set my area up in whatever way I like. (P22).*

> *My own office at home with everything I need and no one to interrupt me. (P50).*

> *Wearing flexible clothing, in my own home. (P62).*

> *At home a lovely office with a lovely view and the flexibility to get up and move around. (P95).*

The detailed study of the comments written by the respondents revealed that the most preferred options for making the online teaching comfortable were having an adjustable workstation, preferably a sit to stand desk, fully adjustable and comfortable chair, having an ergonomic keyboard and mouse. Working from home has become increasingly common for online educators. The main challenge of flexible online teaching is to balance their work and leisure by designing their own work tasks and conditions according to work demand (Tims & Bakker, 2010). Several countries have passed legislation involving the design of

VDU (visual display unit) worksurfaces to prevent health damages and stress for online educators and provided detailed guidelines for the design of an ergonomic work environment. If the working environment is not ergonomically designed then the online educators are in danger of spending long hours in an environment which might result in adverse health effects (Janneck et al., 2018).

5.3.3.8. Any other physical ergonomic factors that can be improved to make online teaching work more comfortable?

Forty-seven (38.84%) of the respondents answered yes. Thirty-seven who answered yes provided comments to describe their suggestions on opportunities for improvements. The responses were grouped into five main themes, which were seating (11), workstation and keyboard (15), miscellaneous (4), complaint/suggestion (8), and no issues (2) as described in the following table 35.

Table 35

Comments received for physical ergonomic factors that require improvement

Stressor	***Participant number + employment type***	***Gender***	***Country***
Seating	P47 (Ongoing). P57 (Fixed-Term). P19, P23, P25, P32, P49, P97, P104, P117, P119 (Casual)	2M. 9F.	Australia 10 Czech Republic 1
Workstation, Keyboard	P2, P5, P59, P61, P63, (Ongoing). P10, P33, P34, P88 (Fixed-Term). P19, P21, P22, P62, P103, P84 (Casual)	8M. 7F.	Australia 9 India 3 USA 3
Other suggestions	P14, P39, P65, P56, P60, P48, P114 (Ongoing). P9 (Fixed-Term). P97, P104 (Casual)	7M. 5F.	Australia 6 India 2 Lebanon 1 USA 1 Czech Republic 1 Singapore 1 Ghana 1

Seating.

Eleven responses, mainly from Australia, were received which were focused on seating arrangements. Some participants expressed their need to get a new chair as they were not happy with their current seating options (P24, P25, P32, P97, P104, P117). For example,

> *Lumbar support requires review - sloping shoulders from sitting at desk for long hours - foot rest required as I get swelling of the ankles and lower legs from sitting*

for long hours. Timers/apps to remind me to get up and move as much as possible. (P97)

Prolonged sitting while teaching or marking was problematic for P57 and P119. P49 complained about the chair she uses while working at the university.

Work from home mostly but when on campus, the chairs are awful. Additionally, we have a tiny, tiny window, affects light and air quality. (P49)

P23 wanted an ergonomic assessment of the home office area to be initiated by the university.

The university has not assessed homework stations. There was some form of self-assessment but without knowing how this should really look it is difficult to judge. (P23)

The above comments show that the respondents were aware of the benefit of using fully adjustable chair or sit-to-stand chair, as better lumbar support can be provided by these chairs to reduce MSD due to the demand of working long hours in seating position while preparing teaching materials and when teaching online.

Workstation, Keyboard.

Fifteen comments were received related to workstation height, width, keyboard, or monitor. P59, P61, P63 and P84 said that the desk they used was not adequate.

Desk is not adjustable. (P59)

P19 and P103 were thinking of getting a new setup and P103 wrote that there was a need for the university to

Invest money on the workforce furniture. (P103)

P21 expressed that she was feeling uncomfortable when working at the desk due to her height.

I am short so I would like the monitor to be adjusted for my height as I am the family member who uses the home office computer the most. I would also like a stand-up desk. (P21)

The comments reveal that respondent educators were interested of having an ergonomic keyboard and mouse. It was suggested that having an adjustable desk would provide the

flexibility of being able to adjust the keyboard height or the position of the monitor according to the educator's requirements.

Other suggestions.

Three participants suggested that having an individual office space at university or having access to a separate room for conducting online teaching would help to improve their online teaching work. For example, participants P39, 65 and 14 wrote:

> *We work in an open plan office. So online teaching has to be done in a small room, that is also used for meetings. The air conditioning is poor. The desk space is inadequate, and the technology works erratically, causing frustration and stress, especially if teaching is 'after hours' when there is no technical support. It is far easier to do online teaching from home, where I have space. I have natural light and can open a window if I need to. I also have reliable technology, albeit server interruptions can occur, but that may be due to government failure to properly invest in a network for the 21st Century. (P39)*

> *In the workplace we need more small office spaces to make online teaching possible. (P65)*

> *The university should establish studios for online lectures. (P14)*

P9 was seeking suggestions on new ideas for improving posture and other factors while teaching online.

> *Maybe some ideas how to relax during lessons, how to find new ways of teaching interesting, changing the office place at home. (P9)*

P88 thought that better internet support also plays a vital role in improving the comfortability and effectiveness of online teaching.

Under suggestions for improvements some participants wrote that they did not have any issues related to physical ergonomic factor. For example,

> *I set up my workstation and I am an ergonomist. (P2)*

> *An actual ergonomic assessment by a professional as was done when I was a permanent academic on-site. (P69)*

The educators who were ergonomist and educators well conversant in ergonomics assessed their home workplace set up and did not experience any discomfort related to physical

ergonomics, while educators with lack of physical ergonomic related knowledge, were using existing furniture without any ergonomic assessment and reported suffered from physical discomfort.

Some comments were received which were not related to physical ergonomic factor, but they were related to other ergonomic factors, like environmental ergonomic factors. For example, problems were documented as needing:

> *Good lighting and air-conditioning. (P56)*

> *In Lebanon, we face a constant problem of noise pollution, as it is quite common to blow car horns, shout out loud. (P48)*

> *Noise of fans or air conditioning impacts all work, not just online. (P114)*

One respondent commented about the eye strain and vision problems that resulted from using digital devices for too many hours without a break.

> *Eye strain and vision problems caused by extended computer or digital device use. Online teaching work causes eye discomfort and blurry vision, headaches, etc. (P111)*

The data identified that some online educators were experiencing neck and shoulder discomfort and eye strain due to not using fully adjustable chairs and desk height and working long hours in sitting position without changing the postures.

5.3.3.9. Section Summary

Figure 55
Physical Ergonomics related responses word cloud

The above word cloud shows the most common word as ‘Chair’ then office, work home, desk and adjustable. The comments received from the participants revealed that for the educators teaching online, using an ergonomically designed chair and workstation are the most important physical ergonomic factors as teaching online requires extensive amount of time sitting while working with computer. The differences are because the general population in each of these countries has different anthropometric measurements and because ergonomic standards and guidelines are more developed in Australia and less developed in India.

The data received indicated that not all physical ergonomic factors were met for the majority of the educators. Some educators, through their ergonomic knowledge (14 of the participants taught workplace health and safety subjects) organized their working area so that physical ergonomic factors were considered. Other participants reported having an ergonomic specialist to set up their workstation so that they could work comfortably. However, some educators did not have any idea about physical ergonomic requirements and these educators either answered no to the questions related to physical ergonomics or they chose not to answer.

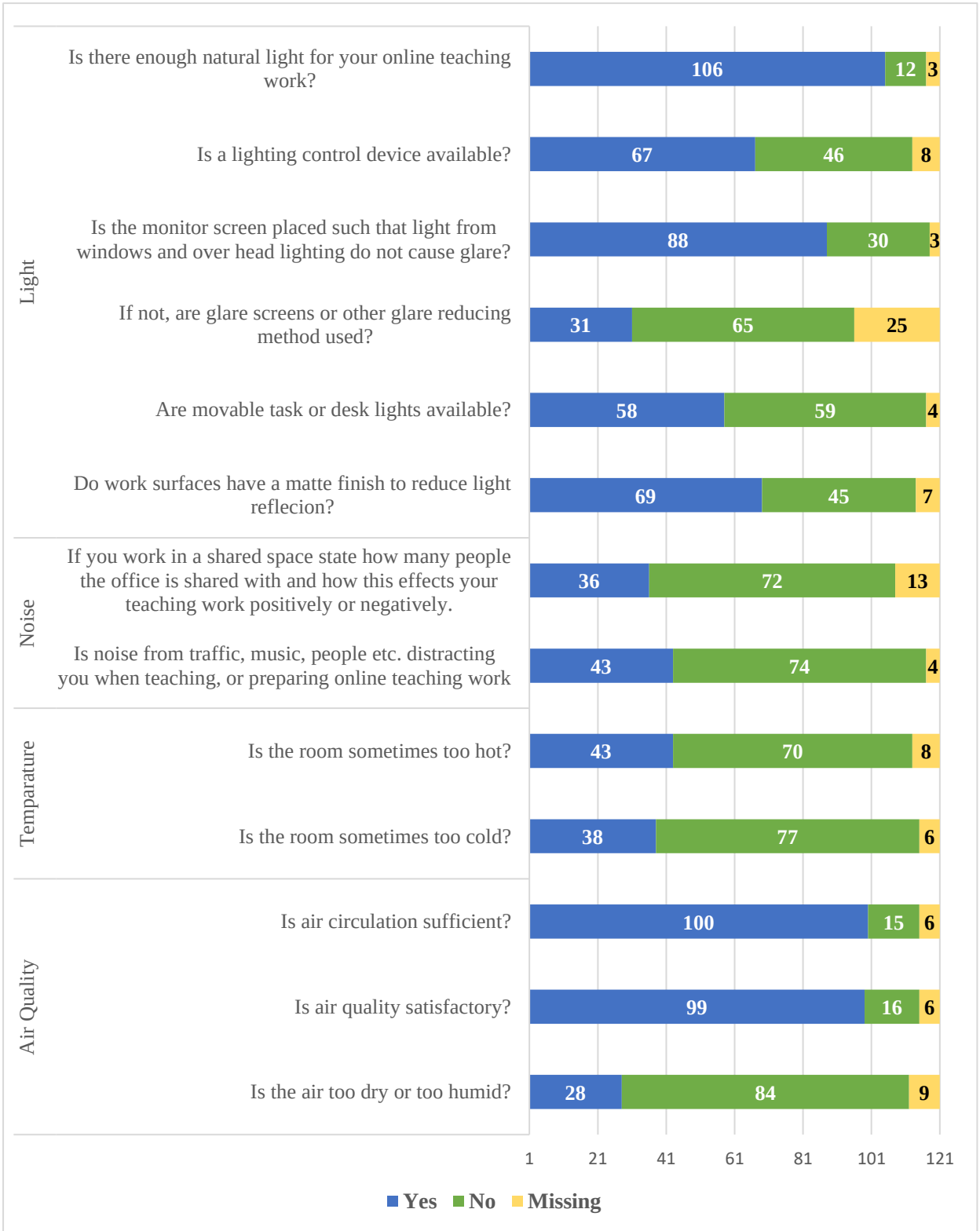
The advantages and issues related to environmental ergonomic factors for online teaching work are discussed in the next section.

5.3.4. Environmental Ergonomics in Online Teaching

5.3.4.1. Introduction

The following questions explored the educators' perceptions of environmental ergonomic factors that may affect their online teaching work including lighting, noise, temperature, and air quality. Studies have proven that the ambient conditions of the workspace, have positive and negative effects on both worker morale and productivity (Brill & Weideman, 2001; Fisk, 2000; McCoy & Evans, 2005; Monk, 1997; Vischer & Fischer, 2005). There were 13 questions on these environmental areas. The questions had yes/no answers with the options of writing a comment to explain the yes or no answer. Figure 56 shows the number of participants who answered yes or no to each question.

Figure 56
Environmental ergonomic considerations



It was reported by 69.42% (84) educators that the humidity in the room that they were working in was uncomfortable. Seventy-seven (63.63%) complained of feeling cold while 57.9% (70) reported the room temperature as too hot. The participants were also concerned about working in shared office situations 59.50% (72) and noise 61.16% (74).

5.3.4.2. Lighting

This question asked about the lighting condition in the area that the educators usually conduct their online work and had two sub questions.

Natural light available for online teaching work.

In relation to lighting conditions, figure 56 showed that 87.6% (106) online teaching educators agreed that they have enough natural lighting in the area they conduct their online teaching from, 9.9% (12) reported that they did not have access to natural light and 2.5% (3) participants chose not to answer this question. This data revealed that 61 (89.7%) female and 42 (82.4%) male participants had enough natural lights; and 7 (10.3%) female and 5 (9.8%) male participants reported having inadequate natural light in their work area. Seven participants provided comments to explain their 'yes' or 'no' answer. Comments included the following.

> *The room light is ok, but I have added an additional desk light to improve it and I have positioned the desk near the front door and window for natural light. (P32).*

> *This happens at home so I can control it. My workplace is variable. (P65)*

The above comments shows that these participants were aware of the lighting conditions and how to position their monitors to get best outcomes to have adequate light to work in. The second comment revealed that the educators teaching online do not just have one place to work.

In contrast P5, P25 and P84 documented concerns with the lighting conditions they had in the area from where they conducted their online teaching work. Concerns included:

> *The afternoon sun is very bright, and glare is a problem. (P5)*

> *North facing windows, so great natural light when the sun shining. The lighting in the room is still a little dim. (P25)*

Natural lighting is not much. (P84)

P97 was not happy with the brightness of the existing lighting option.

Require brighter lighting to effectively view teaching materials (in physical space) (P97).

The above comments indicated that natural light sources were an issue for some educators. Educators who depended on natural light can have issues like change of brightness throughout the day or glare. Using both natural and artificial light was reported as being the best. Natural sunlight provides a better light environment than white cool electric light or fluorescent light as natural light differs widely throughout the day, season, latitude, and other weather conditions unlike the artificial light which is always constant (Edwards & Torcellini, 2002). Vischer and Wifi, (2017), reported that presence of daylight motivates and makes the employees happier.

Access to a lighting control device.

A lighting control device helps the user to regulate the light level to suit the task and the preference of the individual. Figure 56 shows that 55.37% of participants wrote that they had a lighting control device for their work area while 38.02% said that no lighting control device was available. 10 participants commented to explain their 'yes' or 'no' answer. Types of lighting devices reported were a circular light (P60), blinds (P66) and 'on/off' switches (without dimmer option) (P41). P117 wrote:

Numerous lights to turn on or off as needed and large window with curtains.

The basic method of lighting controls used were the person operated manual on/off light switch and curtains which are generally used in most the homes and workplaces to control the illuminance and glare effect of light and to provide light when there is inadequate sunlight. The next question asked about glare on the monitor screen.

5.3.4.3. Glare.

Glare can be defined as the contrast reducing effect within a visual field due to the existence of bright light sources and has been studied and quantified using various indicators. Figure 56 shows that 72.7% of the questionnaire participants confirmed that their monitor is placed in such a way that there was no glare from light coming through windows and/or from

overhead lights, 24.8% reported encountering glare on their monitor screen and 2.5% participants chose not to answer this question. While referring to the questions regarding having antiglare monitor screen or having any other method to reduce glare 25.6% confirmed that they had glare reducing facility available for their monitor screen, 53.7% did not have any glare reducing method available, and the rest of the participants chose not to answer this question.

Seventeen comments were received to explain their yes or no answer in relation to glare on their monitor screen.

No Glare.

Participants provided an explanation about how they mitigated glare as described below.

> *My computer is perpendicular to the window, and I have diffused lighting in my office. (P2)*
>
> *Back to window. (P25)*
>
> *I work with a laptop! So, I can place it accordingly to avoid the problems. (P79)*
>
> *Seating position has been made to reduce such effects. (P84)*
>
> *Had glasses adjusted lens wise. (P105)*
>
> *Close curtains and use lights when appropriate. (P117)*

Appropriate lighting in the workplace improves visual comfort and work performance of the user by reducing eye irritation and visual fatigue. Appropriate lighting, anti-glare filters, ergonomic positioning of computer monitor, and regular work breaks may help to reduce adverse glare effect (Blehm et al., 2005). Window blinds, window coverings, or window tinting were some of the features which could be used to reduce excessive window lighting. Modifying the position of the workstation to a more favourable position might be an alternative option to be used to reduce the glare effect (Blehm et al., 2005).

Disturbed by glare.

Major difficulties reported by visual display unit (VDU) users are eye discomfort and musculoskeletal illness (Aarås et al., 2000). P53 and P120 identified that occasionally they

experienced issues with glare, but they did not mention implementing any anti-glare method to reduce the effect. The reason may because they were not aware of the adverse health effect related to exposer to glare for prolonged periods of time. The next question was related to availability of movable task or desk lights.

Movable task or desk lights.

A desk lamp can be described as a transferrable task light that generally placed on a desk or table to provide targeted illumination for achieving jobs such as working with computer, reading, writing, drafting, etc. Adjustable illuminations are provided by the desk lamps to ensure task visibility and ergonomic comfort. Figure 56 shows that 47.93% respondents confirmed that movable task or desk lights was available while 48.76% participants wrote that they did not have either. Five comments were received explaining the type of light fittings the educators were using to minimize glare.

> *Overhead lamp in hutch. (P41)*
>
> *When working from home a desk light is available for additional light when needed. (P57)*

The advantages of having a movable desk light were that it could be adjusted in a way to get maximum illuminance where needed and an individual could have the control over their lighting appropriately to completing their task (Shah & Jarzabkowski, 2013).

Inadequate quality of lighting affects any individual both physically and mentally (Agarwal, Gupta, Barman & Mitra, 2018). Though vision may not be impossible due to insufficient lighting conditions, it can affect the eyes to send the signals resulting interpretation related problems, and difficulty in concentration which might lead to poor performance (Konstantzos et al., 2020). It might also result awkward posture to be able to get better lighting (Mashige, 2014). To avoid these negative effects, it was recommended by Chandra et al. (2009) to avoid any disturbing reflections within the normal view area, and to consider other visual settings such as, the correct light brightness, placement of accessories in accordance with the workstation, implementing glare reducing methods, contrast, colour interpretation and colour temperature, avoiding factors related to reflection, flickering, and others.

In relation to the desk light P97 expressed:

These are insufficient and require review due to the colour and clarity. Yellow glare rather than an opaque white light. (P97)

This participant explanation highlights the importance of the light colour temperature. A warm white light measures between 2,000K-3,000K on the Kelvin scale and emits a light that has a yellow orange glow. This is a warm colour and is not a suitable work light. Most natural warm-coloured light sources emit significant infrared radiation. A cool white light measures between 3,100K-4,500K on the Kelvin scale and can be used for task lighting. The best workplace light is daylight which measures between 4,600K-6,500K on the Kelvin scale (Tetlow, 2007).

Matte finished worksurface.

Figure 56 showed that 57.02% participants reported having a matte finished work surface to reduce light reflection while 37.19% of the online educators wrote that they did not. There were no comments provided to explain the yes or no answers and no significant differences were identified in the responses between countries, gender, or employment type. However, P97 wrote that she did not know that having a glossy worksurface could be a problem.

Glossy desk. Never thought of this as a barrier! (P97)

The standards for lighting in workplace were developed assuming that an individual will be working from large office space. The average brightness level for big office space and other issues related to glare from light fixtures and other sources were considered while developing the standard. Employees were exposed to moderately uniform level of brightness throughout the day in contrast, in a home office an individual might have a higher level of exposure to natural light from windows for most of the day, and using artificial light at the time when outdoor light levels became insufficient. Daylight varies in brightness or light spectrum throughout the day and time of the year. So, it is very important to have implement correct lighting conditions either in the online educator's home office or university classroom (McKee & Hedge, 2022). The next question was related to effect of noise in online teaching work.

5.3.4.4. Working in a shared office.

Figure 56 showed that 29.75% of respondents reported working in shared office spaces, while 59.50% wrote that they did not use shared office space. One hundred and eight participants answered the yes/no part of this question, and 40 respondents provided a comment (Table 36) to explain their yes or no answer. The comments were grouped into themes.

Table 36
Comments made by the respondents regarding working in shared office.

	Participant number + employment type	***Gender***	***Country***
Problem with noise	P39, P43, P65, P112 (Ongoing), P1, P89 (Fixed-Term), P25, P117 (Casual)	1M. 7F.	Australia 6 Singapore 1 Croatia 1
No problems	P8 (Fixed-Term), P14, P20, P27, P29, P47, P52 (Ongoing), P21, P23, P68, P99, P118, P120 (Casual)	3M. 10F.	Australia 9 Ghana 1 China 1 Czech Republic 2
Not working in a shared office space	P49, P51, P70, P79, P98 (Casual), P5, P6, P12, P55, P56, P59, P63 (Ongoing) P4, P10, P31, P33, P44 P80, P90 (Fixed-Term)	9M. 10F.	Australia 7 Croatia 1 India 6 USA 4 Taiwan 1

Problem with noise.

The first theme identified was the need to deal with noise in a shared office, particularly when conducting online teaching. Educators working in a shared office used different strategies to avoid background noise so that the students could hear what was being said. For example,

> *Office has workstations for 7 staff members, but all are not in the office at the same time. We try to leave the office when someone is doing online teaching as any noise made can be heard by the students so online teaching is difficult. (P1)*

Other educators reported having to leave their office and find another space to do their online teaching as described below.

> *Over twenty in a large office space. It means I have to use a small meeting room to teach online. The place can be noisy with people talking. (P39)*

> *There are around 20 people in the office. It makes online teaching impossible in this space. We do it from home or find a small room if on campus. (P65)*

Ambient noise levels should not be higher than 55 decibels (dBA). Noise generated from discussion between colleagues, students and/or telephone conversations while working from a shared office was the leading source of distractions in online teaching. Crowded open-plan arrangements can cause distractions due to noise, and job performance can be affected by inadequate visual and noise privacy (Haapakangas, 2017). Distractions in place of work may decrease employee productivity by up to 40% and increase errors by 27% (Ajala, 2012; Vischer & Wifi, 2017).

No problems.

Thirteen participants said that they did not experience any adverse effect while working from shared office and P120 reported that there were benefits of working in a shared office.

> *Can't answer yes or no. When I work from the office (at the university) there are 8 people in my area. At times a negative impact - noise. At times positive impact – collegiality. When I work from home... No one else and all is quiet. (P120)*

Open-plan or shared workspace can provide more equality in space allocation and more opportunities for communication and collaboration (Morrison & Smollan, 2020; Mubex, 2010). Studies shows that a shared office or open-plan office environment promotes reciprocal assistance behaviours, encourages teamwork and commitment towards co-workers (Ajala, 2012; O'Neil, 2008;Mubex, 2010).

Five educators reported working from home to avoid working in a shared office when teaching online (P44, P51, P70, P79, P98) as described below.

> *It's 2 of us in the office, but when I need to give an online lecture, I work from home. (P44)*

> *Work from home for any on-line teaching. (P51)*

The next question was asked to identify whether the noise from traffic, music, people etc. distracted the educators while they were involved with online teaching related work.

Noise in the workplace.

Figure 56 shows that 35.54% of participants were distracted by noise while doing online teaching work while 61.16% participants were not. Within the 117 participant who

answered ‘yes or no’ to this question 21 provided additional information to explain their answer. Comments were divided into three categories as listed below.

Eleven participants wrote comments about the background noise that affected them. Two sources of noise experienced when online educators were working from home were traffic and family.

> *There is too much traffic noise at times. (P83)*

> *Family around especially in afterhours time when I have to teach. (P106)*

Noise irritation can be regarded as a complicated stress reaction which involves individual emotional, physiological, cognitive, and behavioural responses (Guski et al., 2017). Presence of background noise has also shown to be a significant effect modifier for the risk of hypertension (Babisch et al., 2013) and can result in a lower level of physical activity (Foraster et al., 2016), which may act as a sign of elevated cardiovascular disease risks in the long run.

Other participants found ways to screen out the background noise by using headphones (P23, P39) or worked in a quieter area (P24).

> *Sometimes it is impossible to concentrate with people talking. So, I often listen to music through headphones to block out the noise. (P39)*

> *My home is in a very quiet street, so I work from home. (P24)*

In summary some educators did feel distracted and disturbed by the noise arising from working in a shared office, background noise from children playing, lawn mowing, or other unwanted sounds. However, ten participants wrote comments stating that they did not face any problem with background noise. The next question asked about climatic conditions experienced when working.

5.3.4.5. Room temperature

The following section was focused on the temperature comfortability of the room from where the educators perform their online teaching. The following themes emerged from the participants answers.

The room is sometimes too hot.

Figure 56 showed that 35.54% of respondents recorded that the room they are conducting their online teaching in was sometimes too hot while 57.85% wrote that it's not. Sixteen respondents provided further information to explain their yes or no answers. One of the problems described was the outside temperature. For example,

> *Living in Singapore it is always hot. (P65)*

Some participants used air conditioners to maintain the air at a comfortable temperature.

> *Only one air conditioner for entire home. It is adequate but not ideal. (P97)*

However, when air conditioning was centrally controlled, like at a university, the temperature was not always comfortable for all educators as described by P32 and P41.

> *It is an old house. Sometimes the temperature is less than ideal, but it is much better than on-campus where the teaching rooms are always overheated, and you cannot open a window or manually adjust the temperature. (P32)*

> *The heating/cooling occasionally allows the room to get too warm. (P41)*

The Australian Standard AS 1837 – 1976 recommends a temperature range of 21-24 degrees Celsius for both offices and factories in summer. The preferred winter temperature is usually about two degrees lower than in summer. Good thermal condition increases productivity and decreases stress in workers (Al-Omari & Okasheh, 2017). Elevated temperatures can affect the performance of employees, especially responsibilities involved on cognitive, physical, and perceptual duties (Al-Omari & Okasheh, 2017).

The room is sometimes too cold.

Figure 56 shows that 31.40% of participants reported that the room they are conducting their online teaching in was too cold while 63.64% documented that was not too cold. Eight participants provided comments to further explain their yes or no answer, for example,

> *Office can sometimes be cold due to air con. (P65)*

This was similar to the reason given for feeling too hot, because air conditioners in most universities cannot be adjusted to suit individual needs. Participants reported ways that they overcame feeling too cold. In their home they could use a personal heater.

The heating is insufficient in the building I am currently in; however, I have a small space heater. (P41)

At a university this was not allowed so the option to keep warm was to *Just wear more clothing.* (P52). The next section reports on the quality of the air in the work area the educators used.

5.3.4.6. Room ventilation type.

The participants were asked to provide information on what type of ventilation system they were using while conducting their online teaching. Eighty-three comments were received from 121 participants. The comments indicated that 31.33% of the participants used fully natural ventilation, 27.71% depended completely on mechanical ventilation while 40.96% reported switching between both natural and mechanical ventilation according to their requirements.

Table 37 *Room Ventilation related comments*

	Participant number + employment type	***Gender***	***Country***
Natural	P5, P14, P52, p53, P59, P73, P112, P114 (Ongoing), P8, P16, P17, P18, P80, P82, P88, P90, P100, P111 (Fixed term), P19, P24, P51, P69, P79, P94, P104, P106 Casual)	10M. 16F	Australia 12 India 8 USA 1 Czech Republic 1 Ghana 1 Slovakia 3
Mechanical	P3, P12, P20, P27, P39, P41, P54, P55, P56, P60, P61, P63, P65, P66, P74, P77 (Ongoing), P1, P10, P33, P57 (Fixed term), P97, P98, P119 (Casual)	15M. 8F	Australia 12 India 6 USA 1 China 1 Iran 1 Taiwan 1 Singapore 1
Both	P2, P6, P40, P42, P43, P47, P48, P50, P58, P83, P105 (Ongoing), P4, P7, P9, P31, P76, P96 (Fixed term), P13, P21, P22, P25, P26, P32, P49, P68, P71, P72, P95, P99, P115, P117, P118, P120, P121 (Casual)	8M. 25F Prefer not to say 1	Australia 20 India 3 USA 3 Czech Republic 3 Croatia 1 Taiwan 1 Lebanon 3

Natural ventilation.

Twenty-six educators reported using natural ventilation e.g., open windows (P24, P80), open doors, or living in a place with higher altitude (*Natural ventilation at 1000m above sea level.* P104). Having fresh air from the outdoor environment through adequate

ventilation, reduces the concentration of internal air pollutants and helps to achieve improved indoor air quality (IAQ). It has been proven that movement of fresh air increases the productivity (Heracleous & Michael, 2019).

Mechanical ventilation.

Twenty-three online educators reported using a mechanical (air-conditioner, e.g., *Air conditioning only. The windows do not open.* (P39) ventilation system, or ceiling fans and 34 respondents used both natural and mechanical ventilation system as per their requirements. Some respondents reported on both their office and homework environments. For example,

> *Window (home), university (air condition). (P9)*
>
> *University Ventilation: Central air conditioning which doesn't work well. At home: windows and heaters and air conditioning. (P120)*
>
> *HVAC - heating, ventilation, and air conditioning - for university office. Air conditioning at home office. (P57)*

Indoor Air Quality (IAQ) and thermal comfort are significantly affected by ventilation as indoor contaminants can be removed through ventilation and the occupants can have fresh air to improve indoor air quality (Jia, et al., 2021).

Both types of ventilation.

Thirty-four participants were using both natural and mechanical ventilation system and were able to choose the type of ventilation that they used to maintain a comfortable indoor temperature. Other participants did not have a choice.

> *Mechanical (Air Conditioning, fans) Natural (windows), I go with temperature outside as to what I use. (P4)*

In some settings, mechanical ventilation can be used to adjust the indoor air temperature and relative humidity. Heating, ventilation, and air-conditioning system (HVAC) (P57) help to provide comfortable thermal conditions and healthy indoor air (Jia et al., 2021). Aerodynamic circuits with fans and ductwork to circulate fresh air from outdoor and to remove contaminated air from the building are a feature of HVAC systems (Chenari et al.,

2016). The next question was focused on the comfortability of the educators' air circulation system.

Air circulation.

Figure 52 indicated that 82 participants (64%) were happy with their air circulation rate but 12.40% reported having insufficient air circulation. Five comments were received to explain the participants answers. The responses identified that P1 uses fan when air circulation is poor (*Use fan when insufficient air circulation.).* Air circulation was affected by hot weather (P47). Air circulation was also affected by the participant's location.

> *At work there is poor air flow. Home is fine. (P65)*

Like the problems with temperature, at home the individual was able to control the climate, including ventilation, to suit them but at work they were not because the windows were kept sealed shut.

Air quality.

Figure 52 shows that 81.82% of participants were satisfied with their existing air quality while 13.22% participants were not satisfied. Two participants provided a reason for experiencing issues with air quality. Reasons provided were:

> *Old air conditioner. (P44)*

> *At work: No windows... just air conditioning. (P120)*

These answers seem to indicate that the problem was poor air circulation. Air quality mainly depends on the ventilation system of the premises. Indoor air quality (IAQ) is important for an individual's quality of life as people, especially online educators, who spend the majority of their work time in the indoor environment (Mannan & Al-Ghamdi, 2021).

The room air is too dry or too humid.

Figure 52 showed that 23.14% of participants reported that the indoor air was either too dry or too humid while 69.42% participants were happy with the air quality. Eight participants provided comments to explain their 'yes or no' answer. The main causes described were the air being too dry (P3) or too moist (P5). Moisture level comfort also

depended on the season (P78), and the day (P79) with the summer heat being recorded as being stifling (P96, P97).

Individual productivity and performance are related with good thermal comfort and air quality (Theodosiou & Ordoumpozanis 2008; Wargocki & Wyon 2013). IAQ mainly depends on indoor air quality for both mechanically and/or naturally ventilated buildings (Kukadia & Palmer, 1998). Another indicator of IAQ is the relative humidity (RH) of indoor air (Woloszyn et al., 2009). According to Fisk (2000); Seppänen et al. (1999) and Wargocki et al. (2002a), the rate of some types of communicable respiratory diseases is higher under conditions with lower ventilation rates. The educators teaching online use a computer. Working with computers for extended amount of time may be responsible for reduced blink rate as it requires working with small visual symbols and maintaining close attention to detail (Wyon & Wargocki, 2006). Lower blink rate causes dry eyes, which are very sensitive to air borne particles and other pollution (Wyon & Wargocki, 2006).

5.3.4.7. Any other environmental ergonomic factors that affect online teaching.

Twenty-seven respondents provided an answer to this question. Nineteen participants wrote that there were no other environmental factors that affected their online teaching work. Eight participants provided more information on noise, ventilation, temperature, or air quality (pollution) with the only new environmental ergonomic theme emerging being insects. The additional information provided is described under the themes below.

Noise.

Four participants complained about the surrounding noise that included *Kids screaming right outside the door.* (P5) and

> *Recently at my home office there has been construction work next door, which has made it difficult. But there is always the option of taking a break or moving to another part of the home, which may not be possible in a traditional workplace. (P58)*

Air Quality.

Four participants working from their university office commented that they were encountering problems with inability to have fresh air in their work environment (P18, P20).

> *The aircon works fine and is locally adjustable to some extent. I would like to be able to open windows for fresh air but understand why we can't. (P20)*

This was a similar problem that other educators reported when answering a previous question.

P25 complained about dust as an air pollutant in the work environment while P61 reported that the workspace had an old carpet that was infested with ants and other insects. Two participants' comments were not related to environmental ergonomics. One (P39) complained about spending more time than paid for when doing online teaching work (an organisational ergonomic factor) and another (P117) said that she was experiencing neck and shoulder pain due to prolonged sitting (health effect of static posture).

Figure 57
Most common words used for Environmental Ergonomic factors

The above word cloud, figure 57, shows the most prominent word is 'air' indicating air quality, the next prominent words are 'window, natural, work, home' which indicates the participants were more likely prefer windows for having natural light and fresh air for ventilation. This word cloud indicates that air quality was the most written about factors within environmental ergonomics.

5.3.4.8. Section Summary

After analysing the responses received from the participant educators teaching online answers indicated that most online educators were satisfied with the lighting provided (87% had enough light), temperature (63% reported having a comfortable room temperature), air quality, humidity, and ventilation in the area in which they worked. Seventy four percent of the respondents documented that they had a problem with noise in their work environment. This was similar to the findings of Jansz et al. (2016) where noise from shared office space and environmental noise were a problem for the online educators. In this research the source of noise was due to working in a shared office, or noise coming from neighbourhood children, nearby construction work, from the students passing in the corridor, or from other sources.

Vischer and Wifi, (2017) study found that lighting, ventilation rates, access to natural light and the acoustic environment were significantly related to workers' satisfaction and productivity. Similarly, Naddeo et al. (2021), wrote that the environmental factors of light, sound, ventilation, and temperature could influence educators' teaching, attitude and performance during online teaching and preparation work due to their comfort or discomfort. Some educators reported that the room they were doing their teaching work in was too hot (36%) or too cold (31%), the humidity was uncomfortable (23%), and the ventilation was inadequate (12%). Some online educators, particularly those teaching workplace health, safety, and environment (14 respondents), had a good knowledge of environmental ergonomics while some other educators did not have any knowledge. The relevance of this section is that it has highlighted the environmental ergonomic factors that affect educators providing online teaching.

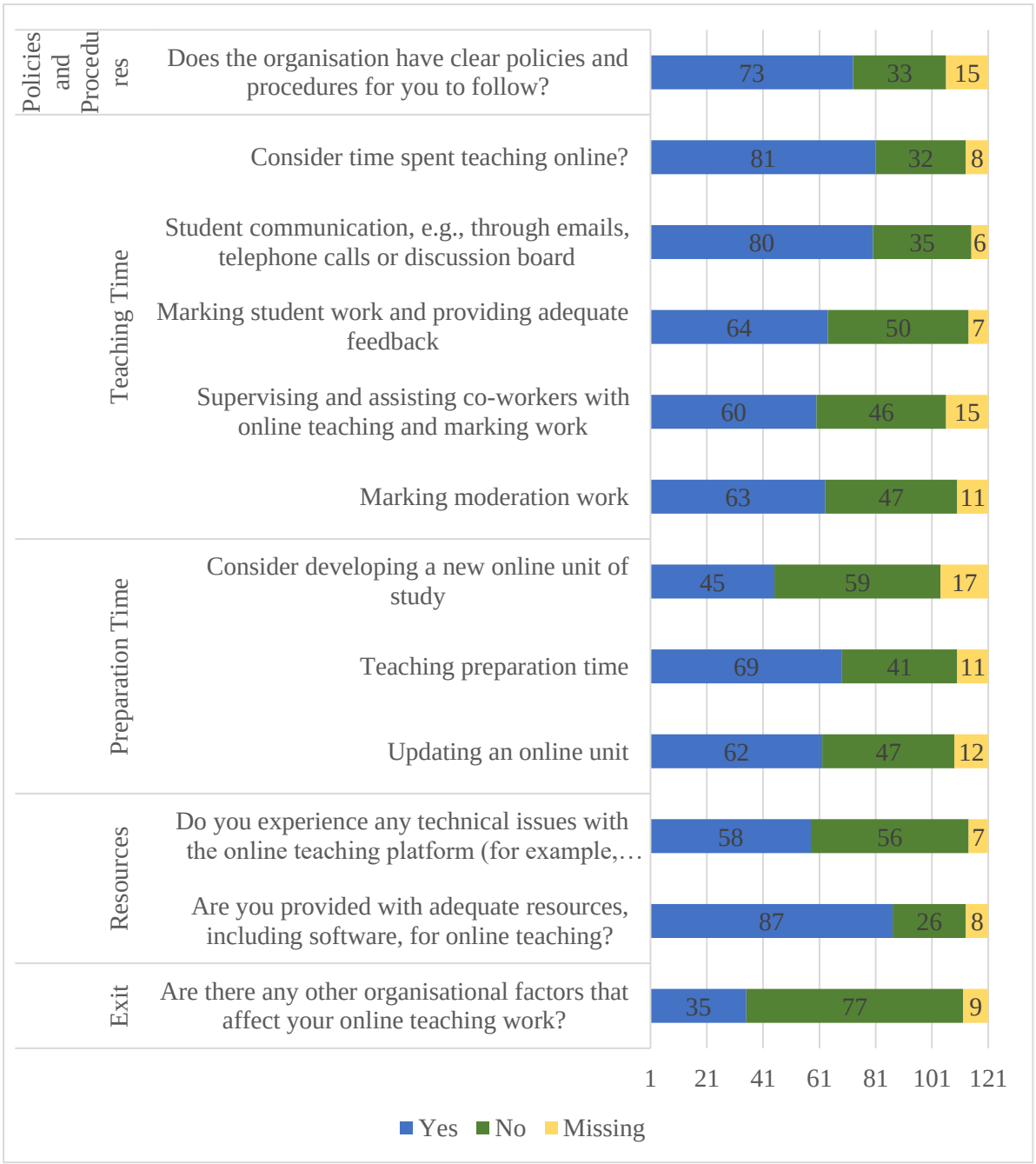
The next section reports on the organisational ergonomic factors which may affect online teaching educators.

5.3.5. Organisational Ergonomics in Online Teaching

5.3.5.1. Introduction.

There were 10 questions focused on organisational ergonomic. These questions had yes/no answers with an option of providing a comment to explain a yes or no answer. The following graph, figure 58, shows the number of participants who answered yes or no to each organisational ergonomic question.

Figure 58
Organisational ergonomic considerations



The answers related to organisational ergonomic factors that affect the work of online educators are discussed in this section.

5.3.5.2. Organisation policies and procedures.

Organisational policies and procedures are guidelines for decision making processes and the way that specific work should be carried out in that organisation. A policy tells people what to do. Procedures describe how to perform a task in a specific step by step-by-step way. The advantage of having clear, well-written policies and procedures is that they help to identify what people need to do in specific workplace and work process situations. When asked 'does the organisation have clear policies and procedures for you to follow' 60% of the participants said, 'yes' and 27% said 'no'. Comments were received from 44 participants to explain their 'yes or no' answer. The comments were grouped into three themes as described in the following table 38.

Table 38

Organisation has clear policies and procedures to follow

Stressors	***Participant number + employment type***	***Gender***	***Country***
Organisation does have clear policies and procedures	P35, P41, P42, P48, P52, P53, P73, P74, P83, P105, (Ongoing), P13, P26, P84, P97, P117, (Casual), P1, P76, P89, P96 (Fixed term)	7M. 2F.	Australia 9 India 5 Taiwan 1 Lebanon 2
Organisation does not have clear policies and procedures or known to the educators	P12, P63, (Ongoing), P4, P82 (Fixed-Term), P21, P64, P69, P120, P51, P79 (Casual)	5M, 5F.	Australia 5 India 3 Taiwan 1 USA 1
Misinterpretation	P19, P68, P119, P121 (Casual), P2, P20, P56, P61, P65, P74, P114 (Ongoing), P57, P76 (Fixed-Term)	6M. 7F.	Australia 9 India 2 USA 1 Singapore 1

Organisation does have clear policies and procedures.

The first theme identified was that the universities did have clear policies and procedures, and the educators were aware of them. Twenty-two participants provided comments that the university that they were working for had clear policies and procedures. The comments showed that some universities made the policies and procedures easily available (P84), but not everyone read or used the policies or procedures.

Organisational policies and procedures are available via the internet, but they are very rarely read or used. (P89)

There are policies, but no one seems to walk around and check they are used. (P73)

Other universities took measures to enforce the policies and procedures use and to help refresh this knowledge (P87).

There are clear policies and procedures outlined and consistently enforced. We are reminded of the availabilities of these policies regularly. (P87)

Bolliger & Wasilik, (2009), reported that studies show that the satisfaction of online educators can be enhanced when the institution has policies in place to support work, however heavy workload affects some online educators leaving them little time for finding and reading organisational policies.

Organisation does not have clear, known and used policies and procedures.

Several universities did have policies and procedures, but they were not very easy to locate so the educators were not aware of them or found them too hard to find.

Yes, but these are not always well communicated or easy to find. (P41)

Yes, but I am not familiar with them. (P35)

Even when they were available not all online educators knew the organisation's policies and procedures that were relevant to their work. For example:

We had to start the online lectures with very short notice, so we each had to figure out what works best for us. (P12)

Other educators reported not being aware of the organisation's policies and procedures or their university not having any.

Not that I am aware of as a casual staff member. (P51)

Not sure, no one has provided guidance. (P68)

No policy is framed. (P82)

Misinterpretation.

Thirteen participants misinterpreted the question as it was related to organisational policies and procedures rather than specific topic policies and procedures, so they wrote 'no' as their answer. For example:

> *Not sure how to answer this one - we have an OHS person who advises and reports regularly. (P20)*

> *Policy on ergonomics? Absolutely no idea. (P121)*

Answers related to the question, 'does the organisation have clear policies and procedures for you to follow?' were similar for Australia and India but not for other countries due to the small number of participants included from these countries. However, 60% of the participants did answer yes. It was noted that all participants with ongoing employment did provide a yes or no answer, but not all casual or fixed term employees did.

5.3.5.3. Time provided for Online Teaching, Communication and Assessment.

This section was divided into five sub questions related to specific areas.

Time spent on teaching online.

Figure 58 showed that 66.94% (81) participants reported having enough allocated time for teaching online, 26.45% (32) respondents indicated not having enough time allocated and 6.61% (8) did not answer this question. Out of 113 participants responses to 'yes/no' section 13 provided an explanation for their yes or no answer. For example:

> *Clearly meets paid hours. (P25)*

Eleven comments were received to explain why the time allocated by the institute for online teaching was not enough. The reason behind of not having enough time for online teaching were reported by the research participants (P31 and P44) as the increased workload in online teaching due to the requirement for increased interaction with the students, marking and providing feedback on their assignments, and responding to their questions through email, text, phone calls, or on blackboard platform.

> *There is a perception that online teaching is less time consuming than f2f teaching. This is not true. There are a lot of behind-the-scenes things that need to be done to present an online lecturer well. (P21)*

We have a very high teaching load. (P65)

Have to do the work, but don't get paid for the extra work I do. (P120)

The amount of time spent in online teaching is the combination of time spent in communicating with students online and the time spent for actual teaching online (Cavanaugh, 2020). One of the major barriers to the educators online teaching is believed to be increased time commitment (Berge, 2002; O'Quinn & Corry, 2002; Schifter 2000).

Time provided for student communication, e.g., through emails, telephone calls or discussion board.

Figure 58 indicates that 66.12% (80) educators thought that the allocation of time for student communication was enough, 28.93% (35) not enough and 4.96% (6) did not answer the question. Of the 115 responses 13 participants provided a comment to explain their yes or no answer. As the educators were the point of contact for the students in online environment, it takes more time than allocated to answer the students' questions (P21, P89, P97, P99), while some students require more time than others to clear their doubts (P25). All the comments received said that the communication with students does take the majority of their time.

You are often your students' point of contact, so if you want to engage your students it takes time to answer all their questions. If you have 75 students approx. 7 hrs/wk is hardly anything if you need to answer all their questions thoroughly. (P21)

This varies - some students create huge additional time needs that we have no way of claiming for or being supported for but is just 'part of our role.' (P25)

Student communication includes individual communication which means the educator is required to communicate with the students individually either through email, or phone or message. Online educators communicate with students through group discussions, chatroom questions and answers sessions (Conceição, 2016). The most time taken in online teaching is believed to be the communication (Conceição, 2016) but reducing time by limiting interactions may impact negatively on the quality of the course.

Time provided for marking student work and providing adequate feedback.

Figure 58 demonstrates that 52.89% (64) participants consider that the time allocated by the institution for marking and providing feedback was adequate, 41.32% (50) disagreed, and 5.79% (7) participants did not answer. P21 recorded that:

> *The allocated time for marking is unrealistic. I spend sometimes 2 or 3 times longer per assignment. It is unrealistic to expect lecturers to give meaningful feedback to 75 students with a 2-week turnaround time.*

Similarly, P89 wrote:

> *Workload time for feedback is inadequate so mainly having to use checklists for feedback. (P89)*

P68 said that she required extra time due to quality of the submitted work.

> *Sometimes work is of a poor quality and needs a lot of feedback which can take more time than allocated. (P68)*

For P105 workload increased due to the need for student engagement.

> *With ESL students need much more time now as online do not have those classroom connections either where we could catch up and students are less likely now to engage. (P105)*

Challenges of marking assignments online include keeping the balance between timely posting of the grades while providing detailed feedback respective to each individual student to help improve their performance (Davis et al., 2019). Challenges increase when there is a misconception of an assignment, trying to determine the best way to communicate feedback and grades, especially for assignments which do not have a 'right answer' and the educator must give more subjective grades (Bailie, 2015). Assignments with a 'right answer' may restrict the students from the opportunity to achieve proficiency in complicated topics which needed critical thinking and problem-solving skills to answer (Davis et al., 2019).

Time provided for supervising and assisting co-workers with online teaching and marking work.

The Figure 58 demonstrates that 60 (49.59%) participant educators were happy with the allocated time given by the institution for assisting co-workers and for supervising online

teaching and marking work, while 46 (38.02%) educators did not, and 15 (12.40%) did not answer this question, as they may have been educators without this responsibility. Of the 106 responses received 12 included comments to explain their yes or no answer. Comments received from the educators from Australia (P57, P64, P120), described why the time allocated for this work was not adequate.

> *Overall, Yes - but there's never enough time for 'Best Practice.' (P57)*

> *Woefully inadequate. (P64)*

Two participants with fixed term employment wrote,

> *Have to do the work, but don't get paid for the extra work I do. (P89 + P120)*

P89 said that she used her own time to help other staff.

> *If I am helping someone who is new to online teaching and marking students' work, I do this in my own time. (P89)*

Another eight comments received from educators from Australia (P21, P31, P32, P51, P118), USA (P5), India (P79) and Slovakia (P16) revealed that their role did not require supervising and assisting other educators.

Time provided for marking moderation work.

A challenge of any subject coordinator is to ensure consistency in marks and feedback provided if multiple people marking the same unit of study. Figure 58 shows that, 52.07% (63) participant educators had enough time for marking moderation, 38.84% (47) participants did not, and 9.09% (11) chose not to answer the question. About half or the participants recorded that they were provided with enough work time for marking moderation work within which only (P25) provided detailed comments to support the answer.

> *Clearly meets paid hours. (P25)*

According to P21 and P97 more time should be allocated for carrying out moderation work as this needed collaborating meetings to ensure maintaining the equity in the process.

> *There needs to be more time allocated for Collaborate meetings for moderation so to ensure equity in the process. Are lecturers even paid for the moderation process? (P21)*

> *Further time allocation is required to improve the quality of moderation, to ensure consistency across Tutor groups. (P97)*

Recognising the amount of time and effort required for a marking team to moderate marking must be understood by those who allocate work time (Jones & Gorra, 2013). Other problems included being an only teacher for the entire unit.

> *I am the only teacher in one unit and moderation is difficult. (P51)*

P97 suggested that to improve the quality of moderation and to ensure consistency more time should be allocated.

> *Further time allocation is required to improve the quality of moderation, to ensure consistency across Tutor groups. (P97)*

Some participants wrote that this was not in their scope of work so was not applicable.

There is no fixed method of marking, and each marker has their own way of marking (Yorke et al., 2000). The Tertiary Education Quality and Standards Agency (TEQSA), the accreditation organisation for higher education in Australia, emphasise on the validity and reliability of given marks for any assessment (Kuzich et al., 2010). Quality assurance poses a significant role in course design and assignment marking for higher education. Therefore, universities worldwide are expected to state the specifics of their moderation practices, declaring any differences that exist in the marking procedures and student groups for quality assurance purposes (TEQSA, 2018). Guaranteeing an efficient moderation process can help to improve reliability, as well as lower the marker favouritism, reduce the probability of becoming either a 'hard' or 'soft' marker, enhance student and staff trust in marking, as well improve of staff morale (Bloxham, 2009).

5.3.5.4. Time is provided to research information, develop, and update online study materials.

Some of the educators complained about the lack of availability of allocated time, but not all educators were required to prepare or update course material. This section had three sub-questions.

Time provided to develop a new online unit of study.

The Figure 58 shows that 45 (37.19%) participants reported having enough assigned time for developing new online study units, 59 (48.76%) educators documented that they did not have enough time allotted for developing new online units, and17 (14.05%) did not answer this question as they may not have developed an online unit of study. Involvement with developing course material is not compulsory for all the educators such as casual and sessional staff so this question was not applicable to everyone. P68, expressed her interest in being involved in course development processes as she had some innovative ideas.

> *As a sessional my ideas are not considered - certainly have some innovative ideas but unable to put them into practice. (P68)*

> *As a casual I do not do this anymore. (P99)*

Participants who did develop new online units of study commented that developing a new unit of study overall requires additional time for planning and managing. According to P60 he explored and used video clips or virtual labs to make the unit of study more interesting, whereas P52 stated that he was overloaded with too much work.

> *Overloaded with teaching allocation for Term 2 2020 and all of 2021. (P52)*

The online course development process requires a more interactive approach than face to face classroom teaching and 48.76% of the participants reported that not having enough time allocated when developing new units of online study decrease their effectiveness. Keeping providing an effective learning experience and focusing on conceptualisation of the course content should be the main goal if transforming the course and developing new units of online study rather than simply translating the lecture content to another mode of delivery, and this takes work time (Xu & Morris, 2007).

Teaching preparation time allotted.

Figure 58 showed that 69 (57.02%) of these educators had enough time to prepare online teaching, 41 (33.88%) educators reported struggling to accommodate their teaching preparation within the institution allocated time, and 11 (9.09%) respondents chose not to answer the question. Eight other participants included comments to explain their yes or no answer. For example:

Provided with realistic distribution of classes so that the preparation can be adequate. (P79)

Takes more time than allocated in workload hours, particularly if I have not taught the unit of study before. (P89)

According to P97 overlapping of existing and new SP (Supplementary assessment) creates extra workload.

More time before the start of a new SP is required. We are often finishing off the prior SP in the week leading up to the new SP. There is overlap and this creates extra work. There needs to be a gap between study periods of at least a week to ensure a high-quality engagement of the first week of new students. (P97)

Although 57.02% of participants reported having adequate online time to prepare their teaching resources publications suggests that the academics from around the world are reporting experiencing increased pressure and elevated work related stress, in conjunction with reduced self-determination over important parts of their work and a loss of power within their organisations (Altbach et al., 2009; Bexley et al., 2011; Bolden et al., 2012; Coates & Goedegebuure, 2010; Franco-Santos et al., 2014; Furlong, 2013; Kenny & Fluck, 2017; Kenway et al., 2004; Marginson, 2006; Roberts, 2013).

Time allotted for updating an online unit.

Figure 58 shows that 62 (51.24%) educators were satisfied with the time allocated to them for updating an online unit, 47 (38.84%) documented that more time should be provided to perform any update of an online unit, and 12 (9.92%) did not answer this question. Six participants wrote comments to explain their answer.

Continual updating of existing course material is very important in current rapidly changing fields. Changing a deeply integrated course material is really time consuming and complex task (P21 and P25) as changing one portion may require updating other parts with maintaining the internal cross-referencing (Weller, 2004).

Updating an online unit can sometimes take as long as redesigning a unit. (P21)

Having to add additional resources, fix links, find new videos, update PPTs, etc. is well beyond the scope given in online teaching work hours. (P25)

As stated by P89 and P117 that the time required for updating existing unit were not allotted by the university thus it stays unpaid.

Takes more time than allocated in workload hours. (P89)

Again, this is not something tutors are currently paid for. (P117)

A study performed by Nambiar (2020) identified that online educators found online teaching requires more time as online teaching includes more preparation and extra materials for the classes, and making sure that the students understand the subject and course content. Generally, educators are required to spend double the amount of time to prepare online course material compared with face-to-face class (Kebritchi et al., 2017). The next question was asked about the participants experience on issues related to technology in online teaching platform.

5.3.5.5. Experience of technical issues with online teaching.

Figure 58 showed that, 58 (48%) answered 'yes', 56 (46%) answered 'no', while 7 (6%) did not answer to the question regarding 'Do you experience any technical issues with the online teaching platform.' Fifty-one respondents provided an explanation for their yes or no answer as described in table 39.

Table 39

Technical issues related comments.

Stressors	***Participant number + employment type***	***Gender***	***Country***
No complain- good support received	P6, P52, P56, P60, P112 (Ongoing), P19P84, P97, P99, P104, (Casual), P1, (Fixed term)	5M, 6F.	Australia 7 India 3 USA 1
Minor Issues	P29, P41, P55, P42, P45, P74, (Ongoing), P22, P25, P68, P118 (Casual), P57, (Fixed term)	5M, 6F.	Australia 9 India 1 Lebanon 1
Internet issues	P50, P83, P105 (Ongoing), P13 (Casual), P8, P88(Fixed term)	6 F.	Australia 2 India 2 Czech Republic 1 Taiwan 1
Issues related to Software	P2, P5, P12, P14, (Ongoing), P21, P51, P98, P117, P120, P121, (Casual)	3M, 7F.	Australia 6 Taiwan 1 Ghana 1 USA 2
Miscellaneous technological issues	P63, P65 (Ongoing), P23, P30, P39, P53, P54, P61, P62 (Casual), P34, P76, P82, P89 (Fixed term)	8M, 5F.	Australia 8 India 4 Singapore 1

The comments received for this question identified the views of participants regarding technology related issues. The comments were grouped into main themes.

No complaints as good support is received.

Fifty-six participants wrote that they did not face any technological issues. Presence of a good support was identified as one of the main reasons of not encountering any issues with technology in online teaching.

> *Occasionally but ask for and receive help from online support staff when this happens. (P1)*

> *Occasional glitches which are easily rectified by our Technology and Service Assistance centre. (P52)*

In contrast to that, unavailability of information technology support on weekends was the main concern identified by P19.

> *Our IT support team do not work on weekends yet the courses we run do. (P19)*

Other three participants (P6, P84 and P104) wrote that they did not have enough technological knowledge to begin with, but that they were getting better with experience.

> *No such issues experienced. However, I feel that I am not being able to exploit fully all technical capabilities of the online teaching platform. (P84)*

Minor Issues.

Experiencing minor technological issues were described by eleven participants. Examples of minor technical issues experienced are as follows.

> *Occasionally problems arise, but not more than I'd expect for any platform. (P22)*

> *We had at the time of launch but post maturity no issues have been noticed. (P55)*

Internet issues.

Issues related to internet in online teaching emerged from the comments provided by six participants from four different countries. Poor internet connection was a problem faced by

P8, P13, P83 and P88, while issues faced by P105 were dependent on number of users at a particular timeframe. Examples of comments written are as follows.

> *Disconnected with the students or slow speed. (P13)*
>
> *Lack of uninterrupted internet facility. (P88)*
>
> *Depends on internet and volume of users. (P105)*

Software and other issues.

Seven participants described issues related to software including failing of software integration during a class conflicting with other existing systems.

> *Software fails, updates conflict with other systems, complex steps are needed to execute functionality and errors occur. (P2)*
>
> *It was harder to transition between different teaching instruments, such as video, writing, and power point. There was also copyright issue with some of the lecture materials. (P12)*
>
> *The university Blackboard site for education is too clunky. It takes too long to navigate it. It is not intuitive nor is it visually appealing. (P21)*
>
> *BB does not support the playing of ppts with animations or videos (TEDTalks, YouTube videos etc) cannot be heard on student end. Link to video is pasted into chat and students are asked to follow link. Being able to use PowerPoints with animations is important. (P117)*
>
> *Updates to Zoom and Canvas (our LMS) are not explained. (P5)*

Other problems were related to trying to record the session (P62), poor voice/video quality (P63), disrupted electricity supply (P82), issues with specific software (P23), speed (P30), limitations of certain software (P39), integration to new system in the middle of the semester (P54) and facing problems during practical classes (P82).

> *Blackboard, or the cheaper versions of it, are restrictive because of the very linear nature of the platform. Marking takes much longer online than when using hard copies. (P39)*
>
> *Moodle changes being completed during term. (P54)*

After studying answers provided by participants, it was concluded that the educators from Australia mainly experiences minor issues related to technology and those were quickly rectified by the information technology department. Educators from India and other countries experienced problems with internet speed, accessibility, and power-cut issues, which were beyond the scope of university control. According to Orlando and Attard (2016), "teaching with technology is not a one size fits all approach as it depends on the types of technology in use at the time and also the curriculum content being taught" (p. 119). In other words, the integration of technology helps to identify and consider teaching pedagogy and construction of learning experiences related factors (Gillett-Swan, 2017).

5.3.5.6. Adequate resources, including software, for online teaching.

Figure 58 showed that 87 (72%) answered yes, 26 (21%) answered no while 8 (7%) did not answer this question. Within 113 participants answering 'yes/no' part of this question, 27 provided comments to explain their 'yes/no' answer. The comments were grouped according to the theme of the comments.

Table 40 *Educators provided with adequate online teaching resources.*

Stressors	***Participant number + employment type***	***Gender***	***Country***
Adequate resources provided	P5, P48, P56, P112 (Ongoing), P70, P97, P120 (Casual), P89 (Fixed term)	3M, 5F.	Australia 5 India 1 USA 1 Lebanon 1
Inadequate resources provided	P12, P20, P43, P61, P63, P14, P65, P105 (Ongoing), P22, P62, P99, P117 (Casual), P34, P102 (Fixed term)	4M,10F.	Australia 8 Taiwan 1 Croatia 1 India 2 Singapore 1 Ghana 1
Miscellaneous	P2, P35 (Ongoing), P17, P76, P82 (Fixed term)	3M, 2F.	Australia 1 India 2 Slovakia 1 USA 1

Adequate resources provided.

Nine participants explained that they received adequate resources required for online teaching from their respective institutions. For example,

Proper guidelines on what might be encountered are provided by the universities. (P48)

We have LMS called Taxilla for uploading course material, conducting quiz and assignment. Training is given in advance along with a guide to help faculty. (P56)

The LTS team in the School of Education are amazing. No question is too difficult for them, and response time is excellent. (P70)

P5 from USA stated:

There are good resources, but they are only delivered in these extremely time intensive trainings, so I have not been able to take advantage of them with everything else that has been going on (teaching full time, research, and home schooling). (P5)

One hundred and twelve participants did not describe having adequate resources for online teaching.

Inadequate resources provided.

Various explanations were made by the participants to explain the unavailability of adequate resources including lack of training options, outdated (P20), using own resources (P14, P22, P62, P65, P99, P102, P105), no training (P34), sometimes training was reported as not being funded (P117), complicated software to be used (P61) and due to political or copyright issues (P12). Example explanations are included below.

Due to political reasons, some software was banned from use. It did restrict our choices of instruments. (P12)

I provide everything from my own salary with no financial help from institution. (P102)

Tutors are currently expected to seek training and explore new ideas and in most cases this is unpaid. (P117)

As well as having inadequate resources there were other organisational factors that affected their online teaching work.

5.3.5.7. Other organisational factors that affect online teaching work.

Figure 58 shows that 35 participants (28.93%) documented that there were organisational factors which affect their online teaching work. Comments received were grouped into themes as shown in table 41.

Table 41

Comments received for exit question for Organisational Ergonomic Factors.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Time	P41(Ongoing), P25 (Casual), P1, P89 (Fixed term)	1M, 3F.	Australia 4
Insufficient Staff	P39, P52 (Ongoing), P32 (Casual),	2M, 1F.	Australia 3
Job Insecurity	P22, P62, P71, P119 (Casual)	2M, 2F.	Australia 4
Lack of training and support	P19, P69 (Casual), P10 (Fixed term)	1M. 2F	Australia 2 USA 1
Miscellaneous	P2, P5, P14, P20, P58, P61, P63, P65, P105, (Ongoing), P21, P26, P97, P99, P115, P120 (Casual)P31, P34, P57, P102(Fixed term)	8M, 11F.	Australia 13 India 2 Singapore 1 USA 2 Ghana 1

Time.

Having insufficient times to complete the online teaching task was the main issue identified throughout the organisational ergonomic section as illustrated in the following comment.

> *Essentially time allocation and workload (general expectations) impede our ability to deliver the best teaching possible. (P41)*

Insufficient Staff.

Concerns about having insufficient staff were expressed by P32, P39 and P52 as higher student teacher ratios can impact on the work of the educators who required more time to provide feedback and answering questions as illustrated in the comment below.

> *Insufficient tutors per ratio of students, e.g., 1 tutor to between 75 - 140 students in Open Universities Australia. (P39)*

Job Insecurity.

Some respondents were concerned about their casual employment status which can be terminated within an hours' notice (P119), while P71, stated that extra mental stress was caused due to the uncertainty of job continuation after every 13 weeks.

> *Only that I have been doing the same job for 13 years and still need to wait for a placement every 13 weeks, very stressful. (71)*

> *Casualisation of the workforce means you often go above and beyond as you are only on a casual contract and could be let go with an hours' notice. (P119)*

Lack of training and support.

Lack of training and support provided by some universities was another area which educators complained about as commented below.

> *I believe the University needs to provide more training for online instructors and, in my opinion, Professors should not be allowed to teach online until they take an approved online teaching curriculum. (P10)*

> *Limited support in setting up the home office - left to my own devices. (P69)*

Miscellaneous.

Other issues raised included experiencing unavailability of adequate resources like devices and/or access to proper internet due to socio-economic constrains of some students (P14), compatibility issues (P2), restricted software access (P61), unhappy with upper management (P97, P105), less interaction from students in online classes (P21) and workload (P31, P115). There was also a disconnect between management and some online educators work as commented below.

> *Upper management is very much out of touch with ground dwellers doing the work i.e., teaching students. Many decisions made not ideal and SLOW. Not good at all and feel so sorry for students (and staff), whole new generation. (P105)*

> *The number of changes and policies affect my work. The blanket requirements for all people to do the same thing are difficult, such as all lectures online and all tutorials face-to-face do not allow for pedagogy-based decisions. It also causes issues with lack of room availability, so we are then asked to do sessions online. (P65)*

However, P58 commented on the positive aspect related to online work-related meetings.

> *The majority of meetings now have an online option, which has been a benefit of the pandemic. It caters for those who live far away from university and those interstates. It saves time without having to walk from building to building.*

The comments related to organisational ergonomics illustrate that there were both positive and negative organisational factors that affected online teaching.

5.3.5.8. Section Summary.

In this section the organisational ergonomic factors that affect the online educators' work have been identified. The main issues were inadequate time and excessive workload. These two words also showed up as the most frequently used words for the word cloud as shown in figure 59:

Figure 59

Word cloud for Organisational Ergonomic Factors for online Educators

The data received related to organisational ergonomic factors identified that the educators were experiencing issues related to inadequate time, workload, issues related to resources like software, hardware, training, and support provided by the university. Extra mental stress was caused due to job insecurity for casual educators. The focus of the next section is cognitive ergonomic factor that affect the work of the educators who teach online.

5.3.6. Cognitive Ergonomics in Online Teaching.

5.3.6.1. Introduction.

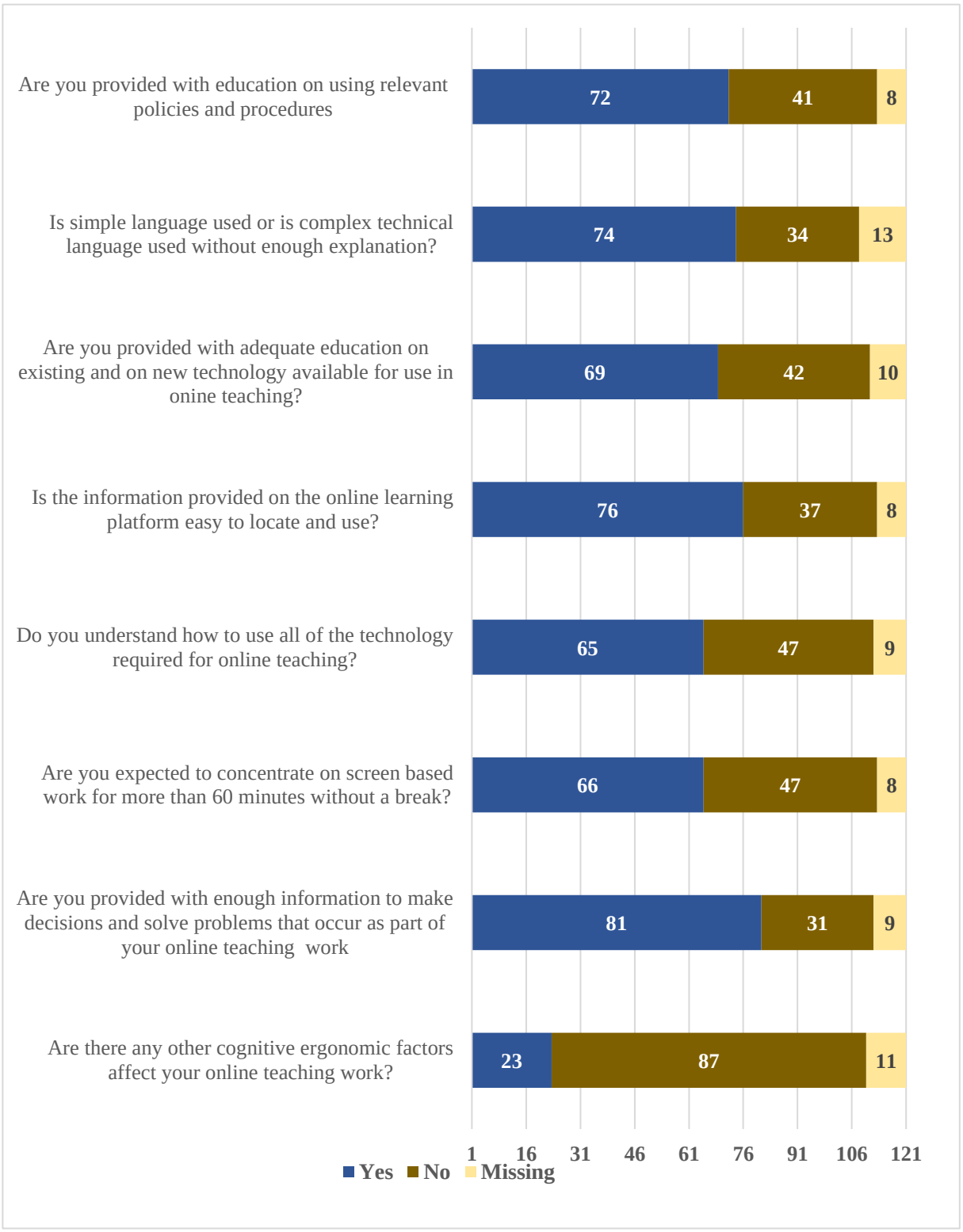
Cognitive ergonomics is fitting the work and products used to how people think, and process information. It considers how people learn, memory capabilities, attention span, problem solving abilities, their motivation and perception. Considering cognitive ergonomic factors in work design improves the productivity and effectiveness of online educators (Gurses et al., 2020; Karwowski 2021).

A set of sixteen questions were asked related to cognitive ergonomic factors that may affect the work of the educators teaching online. There were eight questions with yes or no

answers and others were asking for comments. The Figure 60 summarises the answers given by the participants to the yes/no questions.

Figure 60

Cognitive ergonomic considerations



The main problems identified were understanding how to use the online teaching technology and concentrating on screen-based work for long periods of time.

5.3.6.2. Educations on using relevant policies and procedures were provided.

Regarding being educated on using relevant policies and procedures 59.50% (72) of respondent educators confirmed that they received education on using relevant policies and procedures, while 33.88% (41) stated that they did not receive education on this. The comments were grouped as per their theme as listed in table 42.

Table 42
Receiving education on policies and procedures.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Adequate education received	P41, P48, P63, P83 (Ongoing), P19, P25, P70, P97, P98, P120 (Casual), P4 (Fixed term)	4M, 7F.	Australia 7 India 2 USA 1 Lebanon 1
Inadequate education received	P27, P39, P53, P65, P73, (Ongoing), P21, P32, P51, P62, P84, P121 (Casual), P89 P102 (Fixed term)	3M, 10F.	Australia 8 China 1 India 3 Singapore 1

Adequate education received.

Participants described different methods related to policies and procedures education, such as using available webinars or other digital platforms (P4, P70, P98), information session organised by the university (P41), regular notification/readily available (P25, P48, P83, P97) as demonstrated by some of the participant comments below.

> *My university offers webinars both from within the organisation and outside entities which I take advantage of frequently. (P4)*

> *Where there is significant change there are generally information sessions and support. (P41)*

> *Online study we have to do. Not paid or time. Over and above teaching time. (P120)*

Despite education being provided not all online educators used the university policies and procedures as stated by P19.

> *But not everyone sticks to them which makes it challenging.*

Inadequate education received.

The comments related to inadequate education included the timing and the quality of the training provided (P65), mode of delivery (P53), all the areas were not covered (P27, P32, P62, P89) and facing issues with time and accessibility (P39).

> *One online training was conducted. It is not helpful to me. I require training on campus. (P53)*

> *While training is helpful, it is not always done at the time when I need it. Just going through a new system out of context is not helpful. A brief overview perhaps but having help as I use the system is more helpful. (P65)*

> *Policies are available, but no one discusses why we need them or how to use them for teaching purposes etc. (P73)*

The above comments help to explain why not everyone uses the policies and procedures.

Understandability of work-related documents.

For the question, 'Are work related documents that affect online teaching easy to understand?' 61.16% (74) selected 'yes', 28.10% (34) ticked 'no' and 10.74% (13) participants did not answer. Some participants provided comments to explain their yes or no answer. Six participants commented that the documents related to their teaching work were easy to understand as they were written in simple language.

However, according to P2, P32, P62, P64, P79 the documents were very confusing, outdated and some were written with complex technical language. For example,

> *LMS procedures are very confusing when reading technical manuals. I'd rather attend hands-on training. (P2)*

> *Only had one document. It was vague and has not been updated in several years. It outlined time allocations for teaching and marking, etc. (P64)*

Some participants reported that face-to-face discussions works better for them to be able to understand and use the teaching related documents effectively.

> *I find having to read everything and email so much can be challenging at times, it is easier when you could have a conversation. (P99)*

P105 said that she did not have enough time to read rather she chose to skim through.

> *Sometimes ok, other times way too much so skim through, too much else to do.*

Just skimming through documents may not provide good understanding and follow on use of the document.

5.3.6.3. Education is provided on existing and new technology for online teaching.

Sixty-nine (57.0%) participants said that they did receive adequate education on technology used, while 34.7% (42) participants stated that they did not. Twenty-eight participants provided comments to explain their yes or no answer.

> *N/A. I haven't asked for it because I get great support from my other two universities. (P105)*

From this it can be concluded that some universities provided better support than others. According to P56 from India hands-on training was provided by the university.

> *Demonstration and hands-on training for any new tool is provided.*

Sixteen participants from five different countries commented that they received enough education on new or existing technologies required for online teaching, whereas some participants from Australia (P32, P57, P89 and P120) described a lack of time for attending the educational programs.

> *It is there... Of course... we are not paid extra for the time we spend... So, it just goes to eroding our hourly rate of pay. (Sessional make up an increasingly large proportion of teaching staff). (P120)*

Ten participants from four countries wrote they did not receive enough education as explained by P73 and P121.

> *Only have a very small learning and teaching unit who don't provide much staff development. (P73)*

> *Yes, except for Collaborate sessions. You really have to know how to access those. Not user friendly. (P121)*

The above comments showed that education related to new or existing online teaching technology was available in some universities but inadequate in others.

5.3.6.4. Ease of locating and using information.

Within 121 participants 62.81% (76) participants answered 'yes', 30.58% (37) participants wrote 'no' (table 43).

Table 43
Ease of locating and using information.

Stressors	*Participant number + employment*	*Gender*	*Country*
Easy to locate	P14, P41, P48, P63 (Ongoing), P68, P79, P99, P103, P106, P118, P121 (Casual), P9 (Fixed term)	5M, 7F.	Australia 7 India 2 Lebanon 1 Czech Republic 1 Ghana 1
Hard to locate	P43, P65, P73, P105 (Ongoing), P21, P22, P25, P64, P67, P115, P120 (Casual), P1, P76, P89 (Fixed term)	2M, 12F.	Australia 11 India 1 Croatia 1 Singapore 1

Easy to locate.

Twelve participants provided comments to explain their yes answer. Two explanations on why the information was easy to locate were as follows, but these explanations said that it was not easy for everyone.

> *Mostly but not always, it is harder I think for older staff who are not as computer literate. (P99)*

> *Yes, except for Collaborate sessions. You really have to know how to access those. Not user friendly. (P121)*

Hard to locate.

The comments made by the educators who said 'no' to the question demonstrates experiencing mixed issues including, feeling that the resources cannot be located easily (P65), sometimes need clarification as they seems confusing (P64), some platforms were harder than others (depends on an individual level of understanding) (P89), it's hard to locate many resources, all the required information is not in same place (P25, P73), thus

it's hard and time consuming to find proper required information. Some explanations why are below.

> *There is a large amount of information, and it is not always possible to easily locate it. (P65)*

> *Sometimes it is very confusing. (P64)*

It is important that documents can be understood for them to be used effectively.

5.3.6.5. Understandability of technology.

To answer this question 65 (53.72%) participants said yes, while 38.84% (47) answered no. Thirty-three of the participants included a comment to explain their yes or no answer as shown in table 44.

Table 44
Understand how to use all the technology required for online teaching.

Stressors	***Participant number + employment***	***Gender***	***Country***
Have good understanding on related technologies	P40, P48 (Ongoing), P25, P68, P97, P103, P121 (Casual), P9 (Fixed term)	2M, 6F	Australia 5 Lebanon 2 Czech Republic 1
Do not have good understanding on related technologies	P2, P12, P14, P41, P43, P52, P53, P63, P65 P73 (Ongoing), P24, P32, P79, P84, P98, P115, P120 (Casual), P1, P18, P57, P76, P89, P111, (Fixed term)	12M, 13F.	Australia 12 USA 1 India 7 Ghana 1 Croatia 1 Slovakia 1 Singapore 1 Taiwan 1

Have good understanding.

The comments received from eight participants identified that they had a good knowledge. According to (P68, P103) training and support were provided by the university. Some comments explaining why they had a good understanding are below.

> *Given my technological background, I have no problem with new technologies. (P48)*

> *Yes, for those required but I haven't had time to look at other technologies that may enhance my online teaching. (P41)*

If, not I find out. Always lots of tutorials available. When I need to know I find out. (P68)

Do not have good understanding.

Comments related to inadequate understanding were that some of the participants knew some technology but not all (P2, P24). According to P32 it was hard to know all the technologies as there were too many. Time constraints were another issue faced by the participants (P12, P41, P57, P64). Other comments related to understanding included the following.

I am not paid as a sessional to get adequate tech training! but they do pay for me to get training on diversity and similar 'soft' skills and knowledge. (P64)

The basic LMS only, none of the other recommended tools such as proctoring software or Wooclapp, or others. (P2)

I don't think anyone would know about all technology. I know the ones I work with frequently and I would find out about others if needed. (P65)

Inadequate usability of software and human-computer user interface increases mental fatigue and mental which affect the workers' performance (Kazemi & Smith, 2023).

5.3.6.6. Screen-based-work.

While answering about concentrating on screen-based work for more than 60 minutes without a break, 53.7% (65) participants said 'yes', while 39.7% (48) participants wrote no. Thirty-six participants chose to provide an explanation for their 'yes' or 'no' answer.

Table 45

Concentrate on screen-based work for more than 60 minutes without a break.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Concentrate on screen-based work for more than 60 minutes without a break	P3, P14, P20, P29, P41, P59, P65, P73, P105 (Ongoing), P21, P23, P24, P25, P26, P51, P79, P97, P104, P117, P120 (Casual), P1, P57, P89 (Fixed term)	8M, 15F.	Australia 18 India 2 Iran 1 Singapore 1 Ghana 1
Take intermittent break on screen-based work for more than 60 minutes	P12, P42, P58, P59, P60, P63 (Ongoing), P64, P70, P99, P121 (Casual), P4, P7, P76 (Fixed term)	7M, 6F.	Australia 6 USA 1 India 3 Lebanon 1 Czech Republic 1 Taiwan 1

Twenty-three participants, eighteen from Australia and five from other four countries, commented that educators teaching online mostly conducted screen-based work for more than 60 mins due to either the length of their classes which were more than 60 minutes (P1, P89, P21, P29, P51) or they had to perform other teaching related work before and after the class (P117), so they ended up spending more hours. P21, P25 and P26 and others said that online teaching work included long hours.

> *Collaborates, marking, emails, discussion boards – some days it might be in short bursts, but mostly it is sitting for hours doing this. (P25)*

> *I guess the expectations from an ergonomic point of view is No – but in reality, it is necessary to exceed this to achieve the workload. (P57)*

> *Marking and moderating assessments take hours at a time. (P97)*

Thirteen participants commented that they did not spend more than 60 mins without a break. Their comments identified that sometimes it's the educators' decision to spend longer times working on the computer without break. P4 and P121 reported setting their own schedule as they were working from home. P12 took intermittent break every ten minutes. P24 and P41 said that normally they didn't work with a computer screen for more than 60 minutes without a break, but while marking they had to do.

> *There is no expectation, but it often occurs. (P41)*

P60 wrote that use of video clips or other activities during the lecture helped him get break from continuous screen time.

> *Intermittent use of Polls, video clips etc allow to have short breaks required. (P60)*

According to Rochmayani and Cahyaningsih (2021), "Exposure to computer screens with a higher frequency and duration is a risk factor for Computer Vision Syndrome (CVS)" (p66). The American Optometric Association stated that, CVS is a close work-related compound eye problem that an individual is exposed while working with computer. Using computers for expanded hours and in higher frequency may cause uneasiness such as eye strain and fatigue, burning sensation, irritation, redness, blurred vision, dry eyes, which are generally symptoms of CVS.

5.3.6.7. Information for decisions and problem solving.

In answer to the question 'Are you provided with enough information to make decisions and solve problems that occur as part of your online teaching work?' 81 (66.94%) participants wrote 'yes', while 25.62% (31) participants chose 'no'. Fifteen of the participants provided a comment to explain their yes or no answer. Nine participants reported having a very supportive IT department that provided them with the information that they required. For example,

> *IT departments are always ready for assistance. (P48)*

P102 from India reported that she solved her problems by discussing with other colleagues as required.

> *We solve own problems after meetings and discussions with colleagues. (P102)*

The main providers of information for online teaching decision making and problem solving were documented as the IT Department for technical problems, and work colleagues for other information and problem solving.

P1 and P2 answered 'no' to this question but their comments showed that they did ask for help.

> *Ask for help as required. (P1, P2)*

Comments received from the participants revealed that many of the casual/sessional academics had a lack of information as finding a line of support was not easy for these educators (P32) or they had no time provided (P64).

> *No transactional time has ever been provided to sessional. It's a complete joke and sends a message that the university doesn't give a fuck about sessional. As result I resent the university. Nothing changes. They exploit casual labour and do not offer permanent part time employment; I've been here for 7-8 years and still a casual. (P64)*

In general, for educators with ongoing employment enough information was provided, but this was not provided to quarter of the online teachers.

5.3.6.8. Other cognitive ergonomic information

In answer to the exit question asking if there were any other cognitive ergonomic factors that affected their online teaching 23 participants answered 'yes'. Comments were provided from five different countries Australia (8), India (2), USA (1), Slovakia (1), Ghana (1) with ongoing (5), casual (4) and fixed term (4) employment status. The main themes were ill health effects, communication, and using technology.

P14 reported having ill health effects due to sitting too long doing online teaching work. Other ill health effects were reported by P5 and 57.

> *I get some symptoms of nausea, vertigo, and headaches from too many hours on Zoom (P5).*

> *Work-stress load sometimes. Currently with preparation for start of semester – refreshing, updating learning materials - with other administration issues. Human-technology interaction - introduction of new technology - change management and enough time to learn. (P57)*

As with P57, previous studies by Gil-Monte, (2005); Menghi, (2015) and Othman and Sivasubramaniam, (2019) concluded that, educators are at a high risk of developing anxiety, stress, and burnout due to being exposed to a various work stressor in their daily activities. The World Health Organisation defined burnout as the result of an imbalance between the demands and pressures of work, versus the knowledge and abilities of workers specially in the professional field (Vargas Rubilar & Oros, 2021).

Other problems were related to communication.

> *I think there is a huge disconnect between lecturers and students. No one seems to understand the others' perspective. Once student told me that on their Facebook page, they thought that it was as though the course was designed to deliberately make them fail. On the other hand, I've heard lecturers complain about student engagement. I don't think all lecturers understand the pressure of learning online and that students choose this mode because they do not have the flexibility to come on campus. I think that some lecturers assume that most students are young full-time students with few commitments other than a casual job. Many live students live overseas and have full-time jobs and other family commitments that affect their engagement. There is also the added stress of COVID-19 and lockdown for some. (P21)*

Lack of communication and collaboration between student and educators in online teaching were also reported by P41, P52 and P79 as cognitive ergonomic problems.

Major (2010), wrote that sometimes educators new to their field, or experienced educator changing from face-to-face teaching to online teaching, are challenged by new technology This was reflected in the comments provided by P89 and P111.

> *Main cognitive ergonomic problems are understanding new technology. Once I understand how to use the technology, I am usually alright to use it (P89).*

> *Technology is updating rapidly, sometimes it's difficult to achieve such level of skill. (P111)*

Another problem, described by P119 as a cognitive ergonomic problem was,

> *Home set up - and cost involved. (P119)*

This problem may have been because not having a good home set up for online teaching work affected the educator's ability to concentrate. Although they answered yes, P4, P59 and P120 wrote that they did not have any other cognitive ergonomic factors that affected their work.

5.3.6.9. Section Summery.

In this section the effect of cognitive ergonomic factors on the educators teaching online were evaluated. A word cloud for most common words emerged from the comments received for the questions related to Cognitive ergonomic factors was developed through NVivo. Figure 61 shows that the most common words in the word cloud were '**support,**' '**technology**' and '**time**'.

Figure 61

Word cloud for most common words for Cognitive Ergonomics factors

The participant answers received related to cognitive ergonomic factors showed that main issues the online educators experienced were understanding technology and available time for learning. Educators who had a technology background were less likely to face technology related problems.

The advantages and issues related to social ergonomic factors on online teaching work are discussed in the next section.

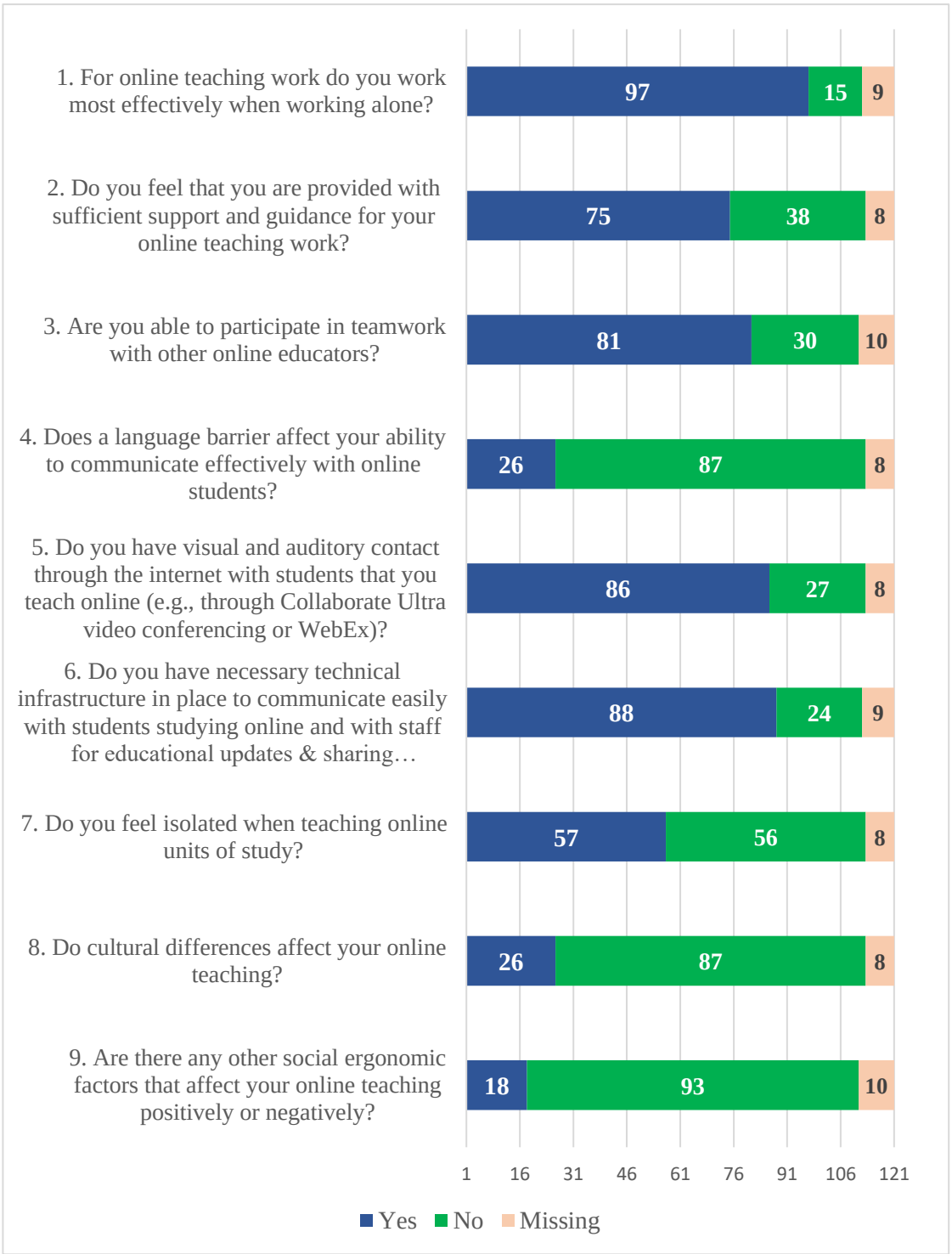
5.3.7. Social Ergonomic Factors in Online Teaching

5.3.7.1. Introduction.

Social ergonomics considers people's social needs at work as well as human potential and limitations. It includes meeting people's social needs, group work, socially caused stress e.g., bullying, hours of work, and communication. García-González et al. (2020) reported that psychosocial risk factors in online university teaching included isolation resulting from a lack of face-to-face interaction. Disappointment, distress, and alienation of educators might increase due to the difficulty of having formal and informal communication within the organisation, including reduced accessibility to organisational or peer support (García-González et al., 2020).

In the questionnaire there were 9 questions focused on social ergonomic factors. These questions had yes/no answers with the options of giving explanatory comments. Figure 62 shows the number of participants who answered yes/ no to each question and how many chose not to answer. About half of the educators who taught online reported feeling isolated when teaching online units of study, but most indicated that, for online teaching work, they worked most effectively when working alone.

Figure 62
Social ergonomic considerations



5.3.7.2. Working alone.

For the question 'For online teaching work do you work most effectively when working alone?' 97 (80.2%) respondents answered yes while 12.4% (15) participant said that they worked more effectively when working with others. Eighteen participants provided a comment to explain their yes or no answer. The comments were grouped according to their themes as described in Table 46.

Table 46
Preference for working alone for most effective output.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Prefers working alone	P10, P1, P16, P57 (Fixed term), P14, P48, P55, P105 (Ongoing), P24, P25, P32, P51, P70 (Casual)	6M. 7F	Australia 8 Lebanon 1 USA 1 India 1 Ghana 1 Slovakia 1
Do not prefers working alone	P39, P65 (Ongoing), P25, P119 (Casual), P89 (Fixed term)	2M. 3F.	Australia 4 Singapore 1

Twelve participants from 6 countries provided comments to explain their answer. P105 wrote that she had better productivity while working in a quiet environment. P10 explained why she preferred doing teaching work alone.

> *I previously co-taught an online course with another instructor, and it was a complete nightmare! (P10)*

P51 wrote a similar comment. P1, P55, P57, P70 documented that they were comfortable working alone but had good experiences when working within a team.

> *Overall, yes - but I have had positive experiences when working with colleagues to help with large student numbers to monitor chats. (P57)*

P16 said that though she prefers working alone it did slow communication with others.

> *It takes longer to communicate the message to other people. (P16)*

Some participants wrote about working alone from home.

> *Because I conduct it from home, I am able to plan by trade off my personal activities. (P14)*

P24 and P48 also conducted their online teaching work from home and wrote similar comments. The comments received from the educators who said that they did not like to work alone included that this restricted being involved in team activities, they preferred face-to-face interaction, or liked to have others around.

> *During lockdown a colleague and I collaborated in our online teaching. We had a ball and the students loved it. (P39)*

> *I prefer to team-teach when online or face-to-face. (P65)*

P119 wrote a similar comment. As a summary, explanations for preferring to work alone were that this enabled better productivity, more work time and task freedom, or they had a previous experience of working with difficult people. People who did not like working alone preferred teamwork, did not like to be alone, and had previous good experiences in working with other educators.

5.3.7.3. Support and guidance.

Participants' answers to the question 'Do you feel you are provided with sufficient support and guidance for your online teaching work?' indicated that 75 (62%) felt that they had enough support and guidance, while 31.4% (38) disagreed with this. The main comment themes are recorded in table 47.

Table 47
Sufficient guidance and support for online teaching.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Sufficient guidance and support received	P2, P48 (Ongoing), P19, P32, P117, P118, (Casual), P1, P57, P89, (Fixed term)	3M, 6F.	Australia 7 Lebanon 1 USA 1
Lack of guidance and support received	P25, P117, P120 (Casual), P102 (Fixed term)	1M, 3F.	Australia 3 India 1

Nine comments were received, and it was identified that there were a good support teams at some universities.

> *The LTS team in SoE are amazing. Seek help and they are there every time. (P117)*

Sometimes. Individuals are very helpful but finding the right individuals is difficult as even searching the university website brings up marketing not relevant information. (P32)

P19 wrote that sometimes the educators were not informed of organisational changes which might affect them.

Although the line manager resigned, and none informed us. (P19)

Four comments were received to support the answer that the educators did not receive sufficient guidance and support for online teaching. Sometimes the extent of support provided varies each year (P25), or for some there was no support, so they had to learn by themselves (P102), and support was not very easy to find specially for the new educators (P120).

Varies - last year was less well supported. (P25)

Self-learned. No guidance was provided except suggestions to use certain platforms. (P102)

About two thirds of the online educators felt supported by the systems and people in place at their university. Reasons for non-support and guidance included difficulty in identifying support, lack of essential communication, and the requirement to be self-reliant.

5.3.7.4. Teamwork.

Regarding on ability to participate in teamwork with other educators teaching online, 81 (67%) participants stated that they could work with a team and 24.80% (30) were not able to participate in teamwork. Comments were provided by some educators to explain their 'yes', 'sometimes' or 'no/not applicable' answers and main themes identified through NVivo analysis are listed in table 48.

Table 48
Ability to participate in teamwork.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Ability to participate in teamwork	P2, P48, P60, P83, (Ongoing), P25, P32, P79, P119, P121, (Casual), P76 (Fixed term)	5M, 5F.	Australia 4 India 4 Lebanon 1 USA 1
Do not participate in teamwork	P27, P39 (Ongoing), P117, P118 (Casual), P1, P31, P89 (Fixed term)	1M, 6F.	Australia 6 China 1

Two thirds of the educators were able to participate in teamwork, including ability to participate electronically (P60, P121).

> *We hold web meeting and sharing of resources. (P60)*

Or, if there was more than one tutor for any unit there were ways to work as a team.

> *If there are other tutors in your unit, you do teamwork. (P25)*

While P2 wrote that he had a limited opportunity.

> *Very limited training session at the beginning of each school year in the fall semester only.*

Seven comments were received from participants who answered no. Their explanation includes that they were not involved with teamwork teaching (P1, P89)

> *Do not have any teamwork teaching. (P89)*

P117 wrote that her casual employment did not allow time for teamwork.

> *Being employed for a couple of hrs a week and expected to read emails constantly, etc., etc., etc., is totally ridiculous. People do it because they are passionate and loyal, but it is really unfair.*

It was easier for online educators teaching large units of study that had multiple educators to participate in teamwork, but more difficult for casual or sessional staff who worked alone.

5.3.7.5. Language barriers.

The majority of participants did not think that a language barrier affected their online teaching, with 87 (71.9%) writing no and 26 **(**21.49%) writing yes. Thirteen comments to explain their yes or no answer were received.

Table 49
Language barrier affect on the ability to communicate effectively

Stressors	***Participant number + employment type***	***Gender***	***Country***
Does affect	P2, P41, P48, P105 (Ongoing), P23, P32, P115, P120 (Casual), P1 (Fixed term)	4M, 5F.	Australia 7 Lebanon 1 USA 1
Does not affect	P56 (Ongoing), P22, P25, P84 (Casual)	2M, 2F.	Australia 2 India 2

Although all the students successfully passed the standard graduate admission examinations e.g., TOEFL, GMAT, GRE, etc., some international students had language problems, which could affect insight into course content, being able to be a part of effective communication in the online discussions and affect expressing opinions or perspectives (Liu et. al., 2010). Nine comments were received to explain how language was a barrier. Language barriers arose when the educators were involved in teaching students who had English as their second language.

> *Sometimes international students require more explanation than students whose 1st language is English. (P1)*

> *Many of my students struggle with English and misinterpret information even after multiple explanations and demonstrations. (P32)*

P23 had a similar comment. P115 wrote that in online learning it's the choice of the students to actively engaged in online session, so generally the students who were struggling with the language were not actively engaging themselves thus educators were unaware of their difficulties until they submitted their assignments.

> *Hard to say - I suspect some of the students with English difficulties either drop out early on in the unit or do not engage in the online sessions, then they submit work that have clearly had difficulty with but they have never made themselves known to you before and, as a sessional tutor, I have no way of knowing at the beginning of the unit who has English language difficulties.*

Four participants explained why they were not affected by language barrier due to the availability of translating any material as necessary.

> *At worst it is all written so can be translated. (P25)*

According to P56, using preferable language while explaining the course information to specific student in need would be an option, which could be possible if the educators themselves were well conversant with that specific language.

> *I normally teach in English but switch to other languages depending upon the ease of participant. Makes it easy to put my point to the participants.*

About one fifth of the online educators experienced a language barrier when teaching students. The main reason was because the students did not have English as their first language, and because these students did not ask for help when they did not understand what was being taught.

5.3.7.6. Visual and auditory contact.

There were 86 (72%) educators who felt that they had good visual and auditory contact with students through the internet while teaching online, however 22.31% (27) did not. Comments to explain yes or no answers were grouped as per their themes in table 50.

Table 50

Audio-visual contact through the internet with students while teaching online

Stressors	***Participant number + employment type***	***Gender***	***Country***
Audio Visual Contact	P2, P42, P48, P54, P60 (Ongoing), P25 (Casual), P44, P76, P57, P89, P111(Fixed term)	6M, 5F.	Australia 4 India 3 USA 1 Croatia 1 Lebanon 2
Audio Contact only	P5, P39, P45, P55, P56, P114, P115 (Ongoing), P24, P117, P119 (Casual), P4, P16, P102 (Fixed term)	8M, 5F.	Australia 7 India 3 Slovakia 1 USA 2
Do not have visual and audio contact	P12, P30, P83 (Ongoing), P32, P51, P84, P116, P118 (Casual)	1M. 6F.	Australia 5 India 1 Taiwan 1

Eleven participants wrote that they were using technology, including Zoom, WebEx, Collaborate Ultra, video conferencing app etc., to stay audio visually connected with the students while teaching online as explained by P60.

> *My class platform allows interaction though camera, oral as well as board sharing. (P60)*

Thirteen comments were received which explained that the educators only had audio connectivity with their online students. A reason provided by one educator was:

> *The auditory contact through Collaborate and Zoom allow me to work more effectively as I have a hearing disability. (P4)*

Communication is the predominant challenge for individuals with hearing impairment either spoken or written. Communication assistive technology can be classified into three further systems as: Telecommunication (Cell phones, amplified and captioned telephones, pagers, TTY/TTDs), closed captioning, and person to person and group communication activities (Web cameras, computer assisting note taking devices, real time captioning and voice to text devices) (Hersh & Johnson, 2003). Assistive technologies help persons with special needs in several ways to function normally, recognise communication and sounds (Posse & Mann, 2005), and managing their time (Farooq & Iftikhar, 2015).

Many online teachers must deal with connectivity issues, bandwidth issues, etc. while conducting online teaching (Joshi et al., 2021). The speed of internet connection and data availability sometimes pose a barrier as using visual communication requires more data, better speed, and connectivity. With internet restrictions the students were forced to use audio only communication as commented by P16 and P24.

> *We usually have only audio contact. The students do not use cameras so that there is small internet data intake. (P16)*

> *But I generally turn off my video in case it affects the quality of the session for students on low bandwidth. (P24)*

Similarly, research by Arora and Srinivasan (2020) found that the educators teaching online had network issues.

Islam et al. (2020) and Nielsen & Sheppard (1988), found that pre-recorded video lectures have equivalent importance to that of written or face-to-face lectures. P12 chose to use pre-recorded lectures.

> *I chose pre-recorded lectures for the best illustration of course materials. (P12)*

A way of conducting online classes is by using pre-recorded video lectures, optical inspiration along with media-rich audio is a major advantage (Islam et al., 2020). Online recorded lectures have functions like 'play', 'forward', 'rewind', and 're-watch', which offers to the students the convenience of listening to lectures at their own pace.

P30, P32, P51, P116 from Australia expressed their frustration at the reluctance of participation of the students, especially those who were struggling and not turning their devices on while attending online classes. P32 explained:

> *I do but often the students who struggle are reluctant to participate and I cannot walk up and have a quiet chat with them when I have a large group online from all over the world to listen to the 45 minutes I have to talk to them. (P32)*

Currently, ZOOM application is commonly used for teleworking, distance learning, and teleconferencing worldwide. The greatest advantage of live ZOOM lectures is that they create similar atmosphere as physical face-to-face classes are organised. This application allows more interaction between the educator and the students by allowing to see eye movement, body movement, and hear voices; additionally, they can engage with educator or with other students by a chat function. Alternatively, it can be identified as multimodal; where students can visualise teachers' gestures, and teachers can see students' gestures, vice versa (Islam et al., 2020). The use of Zoom is banned at many universities worldwide due to security issues.

The major problems preventing audiovisual contact between online educators and their students were explained as having poor internet facilities and students being reluctant to turn on their devices, even when they were struggling with learning.

5.3.7.7. Technical infrastructure.

In answer to the question, 'do you have the necessary technical infrastructure in place to communicate easily with students studying online and staff for educational updates and

sharing information?' 88 (72.7%) of the study participants reported yes, and 21.4% (24) wrote 'no'. The answers to this question were significantly different for educators who taught engineering, mining, or mineral processing. The ratio of '**yes**': 'no': 'missing' answers for the participants teaching engineering, mining, and mineral subjects were **27 (73%),** 5 (13.5%) and 4 (10.8%). For teaching other subjects were **60 (71.4%),** (22.6%) and 5 (6.0%) which showed that having access to necessary technical infrastructure depends on subjects taught as more educators teaching engineering, mining and mineral subjects required having access.

Seven comments from people in 4 countries were received to explain their yes answer. P2, P24 and P89 had available email, phone, Collaborate, Blackboard (P21), Microsoft Teams (P1), Webex, laptops (P119) and Learning Management System (P56). Explanations included,

> *Email is fine. We can jump on Collaborate or Teams if need be. (P24)*

> *Learning Management System has a discussion module and a question & answer module. (P56)*

Other participants explained why they answered no. There was a lack of technological knowledge by students (P73), absence of staff support (P62), internet issues (P102, P104) and other communication problems. For example,

> *Most students lack high speed internet connection. (P102)*

> *According to P62 there was* no staff support or meetings.

Most participants had the required technical infrastructure, however, in some countries there were problems with the internet and students' knowledge of technology and at some universities there was a lack of staff support.

5.3.7.8. Feeling isolated when teaching online units of study.

The answer to the question regarding feeling isolated while teaching online received an almost equal number of 'yes' 49.56% (57) and 'no' 50.44% (56) answers. Seventeen participants provided comments explain their 'yes/no' answer. Reasons for not feeling isolated included liking to work alone (P4, P48, P64) and using different methods to interact with their students (P26, P55).

> *I prefer working alone on the whole. The work culture at the university is not at all receptive to sessional in a substantive way - only with the bullshit rhetoric. (P64)*

P111 did not feel isolated but missed face-to-face interaction.

> *But I miss face to face interaction with students.*

Feelings of isolation arose from being unable to building any kind of bond or lack of interaction with the students or just using the screen, with no student interaction, while teaching (P5, P41, P76, P84, P111 and P115).

> *I prefer to build a rapport with my students to best be able to teach them but also provide help as the program lead. This is very difficult in an online setting. (P41)*

P97 did not feel isolated when working with a good team.

> *When working in an SP with an excellent UC and team, I do not feel isolated. It is invigorating and feels like team teaching. When I am working in an SP without a strong UC or team, I often feel isolated and rely solely on my bank of knowledge and skills to ensure teaching consistency.*

P95 did feel isolated but the flexibility of online teaching compensated for the feeling of isolation. Four participants explained that they sometimes felt isolated. P51 reduced the feeling of isolation by 'sometimes sitting in on another staff members class prior to mine.'

When teaching online about half the participants felt isolated. This occurred mainly when online teaching was a solitary activity, or when there was little student interaction with the educator.

5.3.7.9. Cultural differences.

Most of the online educators 71.07% (86) reported that cultural differences did not affect their online teaching, however, 22.31% (27) participants did report that cultural factors affected their online teaching. Comments received from the participants indicated that the educators were mainly affected by language differences. Occasionally they were affected by the way culturally different people interpret information.

Barriers arising from cultural differences were misunderstanding (P2, P55), language barrier (P5, P120), difficulty faced while interacting (P41) and facing interacting problem due to not turning on visual device (P24, P116).

> *Sometimes I feel the misunderstandings (both cognitive and affective) between students and teacher is minimal in a face-to-face teaching, but an online mode can aggravate it. (P55)*

> *Language barriers are more pronounced online. Students with learning disabilities can struggle with Zoom. Lower SES students have difficulty participating for a number of reasons (no quiet place to work, or technology limitations). (P5)*

> *Without students turning on their mics and video, it is sometimes difficult to 'connect' with students. (P116)*

P65 reported being affected by cultural differences as she was working in a foreign country.

> *I work in Singapore so as I am a guest in this country I am constantly learning about the cultural context.*

Gay (2013) wrote that cultural differences between the educator and their students may provide challenges that affect the quality and efficiency of teaching and learning. However, teachers that were conversant with the cultural background and the language of the students in used their knowledge to overcome the barrier.

> *I am able to communicate in both English and the regional language. This enables me to have a wider reach among the students. (P83)*

Some positive experiences were identified resulting from cultural difference as this provided a learning opportunity. P20 and P117 wrote that they enjoyed interacting with the students from different cultures, while P4 wrote:

> *If anything, the cultural differences enhance my online teaching. (P4)*

Cultural factors were reported to both positively and negatively affect online teaching for about a fifth of the online educators.

5.3.7.10. Other social ergonomic factors.

For the question, ‘are there any other social ergonomic factors that affect your online teaching?’ most online educators 76.86% (93) answered ‘no’18 participants answered yes

with 12 of the respondents writing a comment to explain why. The main theme that emerged was lack of engagement with the students (P89, P102, P111), not being able to identify the level of understanding of the students due to no visual interaction (P57, P102, P117), lack of resources (P83, P65), students prefer face-to-face interaction (P41) and low student turn up (P61).

> *With on campus teaching, I get to know the students and their learning styles well. Online students do not always attend classes and just watch and listen to classes in their own time. I do not get to really know online students. (P89)*
>
> *Inability to view students and understand how they are absorbing the class lectures and discussions. (P102)*
>
> *Many students lack access to proper internet connectivity due to their economic backgrounds. (P83)*
>
> *Working with people in different time zones. Not getting to know students better to accommodate cultural differences. (P21)*

P14 wrote about back and waist pain which did not fall under social ergonomic factors but was due to physical ergonomic factors. The next question was a ranking question to identify the order of importance for each ergonomic factor.

5.3.7.11. Section Summary.

A word cloud for the most common words from comments received for the questions related to Social ergonomic factors was generated through NVivo. The following figure shows that the most common words used by the participants were time and contact, followed by team.

Figure 63

Word cloud for most common words for Social Ergonomics factors

The data received relating to social ergonomic factors identified that the educators were experiencing issues related to inadequate time and interaction (good and bad) with students and colleagues. For some educators it was identified that absence of visual contact with the students caused extra mental stress as they were unable to judge the level of subject understanding by the students. An advantage for students in studying online is that they can watch or listen to the class at a time that suits them, which can be at any time, and not when the class is held. Except for more than half of the online educators feeling isolated when teaching online units of study, social ergonomic factors were generally positive with good communication with colleagues and the students who did attend classes.

5.3.8. Order of importance of each ergonomic factor.

At the end of this section of the questionnaire participants were asked to rank the importance of each Ergonomic Factor for providing safe, healthy, effective online teaching with a value of 1 to be the most important and 5 to be the least important. Therefore, the factors with the lowest mean value were the most important. On a scale of 1 to 5 the value received for mean ranking ranged from 2.59 for importance of Physical Ergonomic Factors

(most important as closest value to 1) to 3.54 for Social Ergonomic Factors (least important as closest value to 5).

Table 51
Rank of each ergonomic factor.

Ranks	Mean Rank
1. Physical Ergonomic Factors (most important)	2.59
2. Cognitive Ergonomic Factors	2.90
3. Organisational Ergonomic Factors	2.97
4. Environmental Ergonomic Factors	3.03
5. Social Ergonomic Factors (least important)	3.51

From the ranking results it can be seen that online educators valued most having good physical ergonomic conditions for their work, followed by having cognitive needs met, then having organisational support, good environmental conditions and lastly having social requirements met. It was also noted that more than 80% of online educators reported working best when working alone.

Seven open ended questions were asked in the next section to obtain a more in-dept understanding of the facilitators and barriers faced by the educators while conducting their work.

5.3.9. Open Ended Questions

5.3.9.1. Engaging Factors.

The first question asked "What engages you most in teaching in an online teaching and learning environment? If none, what are the relevant ergonomic factors that might have caused this?" Total 74 participants provided comments which included 3 as 'none'. All received comments were grouped as per their theme as listed in Table 52.

Table 52

Factors helps the educators to engage while teaching online.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Interaction and engagement with students	P12, P41, P42, P54, P59, P73, P114 (Ongoing), P26, P32, P62, P64, P71, P72, P94, P97, P98, P116, P119 (Casual), P10, P16, P17, P31, P89 (Fixed term)	10M, 13F.	Australia 17 USA 2 Taiwan 1 Slovakia 2 Lebanon 1
Flexibility	P3, P50, P77(Ongoing), P21, P25, P69 (Casual), P33, P57 (Fixed term)	4M. 4F.	Australia 6 India 1 Iran 1
Course material	P45, P56, P60, P61 (Ongoing), P78, P111 (Fixed term)	4M. 2F.	Australia 2 India 4
Technical tools and online resources	P14 (Ongoing), P79, P115 (Casual), P4, P11, P8, P88 (Fixed term)	3M.4F.	Australia 1 India 3 USA 1 Ghana 1 Slovakia 1
Accessibility	P51, P121 (Casual)	2F.	Australia 2
Miscellaneous	P5, P40, P52, P53, P55, P58, P63, P65, P105 (Ongoing), P13, P19, P70, P84, P95, P99, P104, P117 (Casual), P34, P76, P100 (Fixed term)	7M. 13F.	Australia 10 India 6 Taiwan 1 USA 1 Lebanon 1 Singapore 1
Negative	P27, P39 (Ongoing), P23 (Casual), P18 (Fixed term)	1M. 3F.	Australia 2 China 1 Slovakia 1

Motivation factors for educator online teaching.

When asked what engaged them the most when teaching online 23 educators reported that it was the social ergonomic factors of working with students (P10, P16, P26, P59), communicating with students (P2, P16, P17, P31, P32, P62), student discussions (P98, P114), student feedback (P12, P54), student engagement and interaction (P72, P73, P94, P116, P119), and providing engaging student activities.

> *Interactive activities, anything that engages the students and gets them to think and respond. One-way lectures aren't great anyway and are even worse in an online setting. (P41)*

> *Interactive lessons; Movement; Organisational outlets; Cooperative learning. (P42)*

P71 enjoyed *'interaction with students and supporting them to succeed,'* while P89 was most engaged while *'asking and answering questions.'* These comments indicate that communicating with students engaged educators the most in online teaching. For the Likert scale questions related to online teaching the highest agreement score (84.3%) was for 'Some online students are good communicators, engage well with the educator and other students to promote online discussion and student subject learning.' Similarly, for this open-ended question, it was a high priority for the educators to engage with the students.

For other online educators it was the people that they worked with. For example,

> *A collaborate teaching team with positive mindsets and student focused. (P97)*
>
> *Engaged and motivated students and staff support (P64)*

Almost all educational systems emphasise engagement and interaction between the educators, students, and course contents especially for online teaching, as these are the key elements for conveying information, enhancing teaching quality, providing direction, resulting in improving learning outcomes (Kang & Im, 2013; Yoo et al., 2014) (P16, P97). Thus, having good engagement and interaction with their students in online classes was important for online instructors (Purarjomandlangrudi & Chen, 2020). Communication competence is also believed to be a person's ability to select communication performance, which is responsible for achieving desired social relationship (Purarjomandlangrudi & Chen, 2020). This communication skill is important for both educators and students. Studies shows that there are very distinct splits in the satisfaction levels for different cultural backgrounds (Purarjomandlangrudi & Chen, 2020).

Flexibility.

The second highest number of responses related to Flexibility (P3, P21, P25, P33, P50, P57, P69, P77) as there were educators who preferred working from home rather than always having to work on the university campus, and online teaching could be conducted from home. For example:

> *Working from home is great, love it! Can keep teaching for a long time now without excessive travel. Ease of use of teaching platforms like Moodle and Zoom, perfect! (P50)*

Ease of working from home! Collabs are more relaxing at times than face to face. (P25)

An advantage of being able to work from home is that this saved time (P3). In contrast to the other educators who looked at the flexibility of their own work, P57, an Australian male, looked at the students' flexibility, and was engaged by having a wider range of students in his class.

I believe face to face teaching is the preferred due to the instantaneous feedback etc. However, online teaching allows flexible learning and a wider audience across geographical boarders - and addresses time constraints for students. What engages me - ability to reach a wide range of students. It's more flexible for the students (P57).

Flexibility is a term generally associated with online education (Stone, 2019). Studies shows that online teaching and learning is more flexible. It saves time and money since it does not involve traveling (Coman et al., 2020). Thus, flexible work options provide for the human resource management strategies intended to help organisations in reducing the unfavourable effect of environmental uncertainties by accepting variation on where, when, and how job responsibilities are performed (Ganiyu, 2021; Giannikis & Mihail, 2011; Weideman & Hofmeyr, 2020).

Technical tools and online resources.

Seven of the participants wrote that the technical tools they were able to use engaged them the most in their online teaching work. For example:

Just the urge to learn new techniques of online teaching (P88).

The quality of operation of the online platform, the ability to share information from various applications. (P11)

Ease of use of online resources is one primary advantage of online teaching. (P79)

Interaction using teaching aids (P14).

When the technical tools (Collaborate, Group map etc) work, they are really effective teaching tools. Can be very stimulating for discussion and learning. (P115)

The flexibility of having meetings more frequently (as and when required) was another advantage identified by P4.

> *The use of Collaborate and Zoom which are so helpful. Also, the use of web-hybrid as opposed to web-based which allows meetings every other week or once monthly in classroom as opposed to every day/week.*

Some educators just liked using technology (P80). One of the most significant advantages of online teaching is that the educators can quickly categorise the areas for documents related to course material, assignments, class notes and other information. Creating a 'virtual notebook' that helps both educators and students to easily find course related information online (P11). The accessibility is much higher as all the information is posted on the website, which is accessible any time and from anywhere (P79). Online educators can use of threaded discussions to inspire critical thinking, especially when they include students from around the country or the world (Posey et. al., 2010).

Course materials.

For engagement some participants wrote about improving the clarity of the content (P45), adding animation or video to make student learning more interesting (P60), topic of discussion (P78), and preparing the course content for online teaching (P56, P63, P111). For example;

> *Preparation for teaching in online mode, to make the things easier for students. (P111)*

These educators looked at the course materials engaging the students.

Accessibility.

Another aspect that facilitated the online teaching work was the accessibility of asking questions, providing, or receiving feedback, looking at course work, etc., which can be done any time any day (P121).

> *Ease of access. The fact that information can be accessed 24/7. Not confined to class. (P121)*

> *Access to students in a COVID situation or over distance (P51)*

Miscellaneous.

Other areas were identified by the participants included just enjoying online teaching (P19, P76), having the flexibility to arrange guest speakers (P5), online consultation (P34),

supporting students as they learn (P52, P70, P95, P100, P105) reduced anxiety (P58), learning more (P13), variety of work (P117), and social interaction (P65). For example,

> *I like that you can get great guest speakers. Some small group activities translate well. (P5)*

> *The enthusiasm and positive nature of our students. Relaxed atmosphere, autonomy (P99).*

> *Online is fine for content delivery and can be efficient for time use. Some collaboration is also possible online. Socially, we and the students benefit from some face-to-face as it changes the dynamics of the learning and encourages communication. (P65)*

Some educators were more engaged when teaching online because they were less anxious.

> *What I enjoy about online teaching is the reduced anxiety of performing 'live' in front of a class, no commuting, being able to work from home. (P58)*

However other educators were more engaged in online teaching because the work environment was better.

> *The physical setting of the teaching environment and the accessories. The good and adequate environment for teaching with respect to adequate lighting, less noise and comfortable room temperature are the factors that drive my engagement. (P84)*

One of the educators summed up what engaged her as,

> *It is the way of the world at present. I'm enjoying expanding my skill set to work in this new world of teaching. (P104)*

Most of the participants explained why they enjoyed the experience of online teaching, and the most common answers were that they enjoyed encouraging student learning, the flexibility of being able to work from home and the teaching work.

5.3.9.2. Non-engagement

There were also some negative comments received about online teaching engagement which included the following.

> *A feeling of discomfort. (P18)*

Very little engages me (P39).

I Find it quite demotivating. I would not like to be a student of an online course. (P23)

These comments made it obvious that some educators did not like online teaching. For participants who answered no, the next question asked if there were any ergonomic factors that caused their lack of engagement. Sixteen comments were received explaining the reason for the educators of not feeling engaged. Five participants were concerned with being affected by social ergonomic factors. For example,

Social ergonomic factors as students are isolated from the presenter. (P1)

The isolation and lack of human interaction (P39).

P14, P41 and P97 wrote organisational and cognitive ergonomic factors were the reasons for not feeling engaged in online teaching platform. To create engagement the following was required.

An experienced UC, and eager Tutors. Social and organisational. (P97)

No physical or environmental ergonomic factors were included by the educators to explain why they were not engaged when teaching online.

5.3.9.3. Differences between classroom teaching and online teaching.

The next question was 'what differences have you found between traditional classroom teaching and online teaching in the areas of course materials, assessment methods, and support from co-workers, teaching satisfaction and any ergonomic factors? Seventy-six answers were received, and comments were grouped as listed in the Table 53.

Table 53
Differences between Classroom and Online Teaching.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Ergonomic factors	P3, P50, P65, P58, P61, P83, P73 (Ongoing), P51, P62, P64, P69, P72, P79, P98, P104, P115, P119 (Casual), P4, P18, P57, P76, P80, P88, (Fixed term)	7M. 16F	Australia 14 India 5 Iran 1 Slovakia 1 Singapore 1 USA 1
Teaching satisfaction	P2, P5, P27, P35, P39, P45, P52, P53, P54, P55, P59 (Ongoing), P19, P21, P23, P26, (Casual), P1, P31, P33, P34, P100, P111 (Fixed term)	11M. 10F	Australia 14 India 4 USA 2 China 1
Assessment methods	P12, P41, P60, P114 (Ongoing), P13, P72, P79, P104 (Casual), P10, P11, P17, (Fixed term)	6M. 5F.	Australia 4 India 2 Slovakia 2 Taiwan 2 USA 1
Course materials	P14, P56, (Ongoing), P32, P71, P72, P84, (Casual), P89, (Fixed term)	4M, 3F.	Australia 4 India 2 Ghana 1
Co-workers support	P42, (Ongoing), P72, P104 (Casual)	1M. 2F.	Australia 2 Lebanon 1

Ergonomic factors.

The highest number of comments received described one or more ergonomic factors that affected teaching work. Comments made by 11 participants described social ergonomic factors. For example,

> *Lack of personal interaction with students. (P69, P61, P98)*
>
> *Miss casual communications with individual students (P51).*
>
> *Isolation when teaching online. (P119)*
>
> *In online course we are not able to encounter face to face communication and class experience. (P3)*

P18 recorded that personal contact in the classroom was more effective than digital contact. Digitalisation has changed university teaching (Jena, 2015; Meyer and Barefield, 2010; Markowitz et al., 2018). Isolation from a lack of face-to-face contact or interaction was one of the psychosocial risk factors commonly reported related to online university teaching (Dolan, 2011; Fouche, 2006; Mintz-Binder & Allen, 2019; Schulte, 2015).

Some educators preferred classroom teaching because of the social interaction that this provided.

> *You can be more engaging and do group work on campus. (P62)*

> *I think, students are more engaged and responsive in offline classes as compared to the online mode (P83)*

> *Online is different to face-to-face teaching. It is harder to develop a relationship with my students. I have got a very sore neck when sitting at my computer for too long. (P10).*

As well as social ergonomic factors physical ergonomic factors were also highlighted as causing health problems.

However, P58 experienced better work-life balance and less anxiety with online teaching.

> *This has resulted in reduced anxiety and stress, better work-life balance, and better physical and mental health for me personally. (P58)*

P4 reported being happy having uninterrupted working conditions when working from home.

> *I can get so much more done working from home than in an office with constant interruptions. (P4)*

Some educators preferred working from home which could be done with online teaching, however physical and environmental ergonomic factors needed to be considered when teaching from home or university.

> *Need to ensure that workplace/home office is suitable and comfortable (72).*

> *I prefer home-based work for flexibility. My home is a more comfortable environment than the lecture room etc at uni. The room we use in building 201 is cold in winter and very hot in summer. There is no A/C! We have an old broken exhaust fan in the room. We have 40+ people in there. Its ridiculous and insulting work conditions. P64)*

P57 reported on the difference between face to face and online teaching.

> *I believe face to face teaching is the preferred due to the instantaneous feedback etc. However, online teaching allows flexible learning and a wider audience across geographical boarders - and addresses time constraints for students.*
> *Ergonomic Issues.*
> *- Sitting at a desk for prolonged periods - preparing material*

- *Workload sometimes a problem at peak times (P57).*

P57 had a physical ergonomic problem with sitting and an organisational ergonomic problem with workload. Disproportionate workload was related to the many tasks university educators were required to do beyond the scope of teaching duties, such as administrative tasks, research, or organising seminars, etc. (Kinman, 2001). García-González et al. (2020) reported that high workloads and the lack of boundaries between work at home and family spaces were other problems which affected the educators negatively. The approach of using virtual environments was normalised without prior evaluation of the vulnerability of the individuals who work online may face resulting from technological innovations, such as higher levels of stress and physical, musculoskeletal disorders, psychological disorders such as burnout, anxiety, and depression, which can lead to an increase in work absenteeism (García-González et al., 2020).

Teaching satisfaction.

Twenty-one comments were received focusing on the teaching satisfaction of the educators teaching online. According to P59 *Not as enjoyable to teach online, but far less preparation time.*

However, the main theme was lack of visual interaction which is a social ergonomic factor.

> *It is far more satisfying teaching face to face. You can read the body language. Students feel freer to ask questions. Group work is easier to organise and monitor. It allows teaching to be more intuitive and flexible. Human beings are meant to learn socially. (P39).*

> *In classroom teaching physical presence and face to face interaction make students more attentive, practical paper discussion is easy and more effective in classroom teaching, laboratory experiment cannot be conducted in online mode, overall teaching satisfaction in online mode is less than classroom teaching. (P111)*

> *There is no teaching satisfaction in online teaching. (P100)*

Teaching satisfaction was jeopardised by the lack of collaboration and interactivity (P23, P35), difficulty with engagement (P26, P33, P55), not getting to know students (P1), lazy attitudes of online students (P19, P21), difficulty of having group discussion (P5), lack of

student feedback online (P54) and lower response rate (P45). There was also a time lag problem.

> *The time lag. It may take 5 minutes to explain something f2f whereas the time lag between emails means that it could take days to solve a small issue. Listening to lecturers who think students are lazy if they ask for clarification. If students are learning online there is a tendency to second guess yourself because there is no one there to confirm if you are on the right track. (P21)*

> *I don't know if the students are engaged in the online course when I am teaching. (P27)*

> *Face to face instruction allows non-verbal communication, spontaneity, free exchange, meaningful connection as humans and more. (P2)*

In general participants considered teaching was more effective when conducted face-to-face.

Assessment methods.

Eleven comments were received from the participants focused on 'assessment methods' in online education. Preventing students from cheating was an area identified by P10.

> *One of my main concerns with teaching online is cheating. It is very difficult, if not impossible, to prevent a student from cheating if s/he wants to cheat. Ideally, my preference would be for every exam to be taken on campus at predetermined times (listed in the Schedule of Classes) so the students know when the dates/times of the exams are prior to enrolling in the class (P10).*

> *Online assessment methods can be more challenging particularly without the ability to invigilate responses. (P41)*

Similar comments to these were made by other participants. Assessments are a very important part of any course. Finding effective techniques for assessment in online learning were challenging (Liang & Creasy, 2019), as online assessment techniques require a better ongoing systematic (Robles & Braathen, 2002). Both formative (i.e., monitor the student's learning progress over the entire course duration) and summative (i.e., evaluate the knowledge and skills acquired by students at the end of the course) assessments should be in place for online learning (Tartavulea et al., 2020).

Course materials.

Seven comments received which were focused on the course material. The educators wanted to have well prepared (P14), easily accessible (P32), clear and explained in a methodical way (P71) course materials. For example,

> *Course material need to be more explanatory type in case of online teaching. Assessment methods for online teaching are more varied in terms of covering online tests, online assignments, and online interviews. (P84)*

Other participants reported on the need for more course materials when teaching online (P89), that online course materials needed to be screen friendly (P72) and that course materials were similar for online and face-to-face teaching (P56).

Support from co-workers.

Three educators wrote that they were happy with the support they receive from co-workers. P42 described the support system for both.

> *Online learning: It happens online; anytime, anyplace; flexible pace; alone. Supports an independent learning style. The primary source of information is online content. Limited interaction. Traditional learning: It happens offline; forced in a schedule and place; imposed pace; together with your colleagues learning from and with each other. The primary source of information is the teacher. Extensive interaction between teachers and colleagues (P42).*

> *I have very supportive Unit Coordinators, who respond quickly to my questions (P104).*

Support from co-workers was an enabler.

Similarities and differences.

According to P51, P97, P99, P120 and P121, online teaching is completely different from face-to-face teaching. For example,

> *Traditional classroom teaching requires a different skillset than online teaching. Consistent feedback between Tutor and students is the single most effective online teaching tool. Communication is key when teaching online. Using mixed methods for teaching is also imperative. Engaging in discourse, using a variety of engaging teaching tools or technologies, and knowledge of unit content is key. Collegial teams with a strong, supportive UC is also important. (P97)*

There are obvious differences. Not all classroom teaching is traditional these days. Students still interact with technology during class time. It's more social when face to face. Often students are younger. Online students are often working and juggling family responsibilities, they have different needs. You just need to adjust accordingly to accommodate everyone (P99).

Face-to-face teaching allows for engagement by the majority of the class. As the teacher, you ensure this occurs. The biggest issue with online teaching is connecting with students to increase engagement. However, as I am a new tutor, I would need to see how this impacts results before I label it as an issue. Potentially the students are absolutely fine with this and prefer to only ask questions when necessary (P121).

Students were not engaging in face-to-face contact and just wanted to watch recorded lectures remotely, so perfect for everyone. Many students are working too so cannot spare the time to do face to face. (P50).

Other educators (P25, P70, P77, P95) thought that there was no difference between the two educational methods.

5.3.9.4. Online teaching enablers

The next question asked 'In the online teaching environment what helps you to teach most effectively and why?' There were 68 comments received for this question. All the comments were grouped according to their theme as listed in Table 54.

Table 54
Participants Comments

Stressors	***Participant number + employment type***	***Gender***	***Country***
Engaging Students	P35, P39, P54, P73 (Ongoing), P19, P21, P25, P32, P62, P69, P70, P79, P97, P99, P117 (Casual), P89 (Fixed term)	4M, 12F.	Australia 15 India 1
Use of Technology	P2, P12, P27, P41, P55, P56, P58, P65, P60, P114 (Ongoing), P13, P115 (Casual), P4, P111 (Fixed term)	7M, 7F.	Australia 4 India 4 Taiwan 2 USA 2 China 1 Singapore 1
Resources	P3, P5, P52 (Ongoing), P51, P72, P121 (Casual), P31, P80(Fixed term)	2M, 6F.	Australia 5 India 1 Iran 1 USA 1
Ergonomic Factors	P14, P40, P45, P59, P83 (Ongoing), P84, P64, P95 (Casual), P11, P17, P33, P34, P57, P88 (Fixed term)	9M, 4F. 1 Prefer not to say	Australia 7 India 3 Ghana 1 Slovakia 2 Lebanon 1
Miscellaneous	P53, P105 (Ongoing), P71, P98, P104, P120 (Casual), P18, P76, P100 (Fixed term)	3M, 6F.	Australia 5 India 3 Slovakia 1

Engaging students.

The majority of educators believed that engaging students helped them to teach effectively. Educators and students were separated physically from one another in online education, and this absence of face-to-face interaction left some students feeling isolated, less accountable for their learning and not engaging in class which made some educators frustrated. To promote student engagement educators should create opportunities for teacher learner interaction while designing the course (Martin & Bolliger, 2018). P19 and P32 reported doing this.

> *Lots of motivational strategies for the students to try to keep them active and engaged. (P19)*

> *Regular contact and a conversational tone with students to encourage real intellectual risk taking. (P32)*

> *A quiet working environment where I can engage with my students consistently and often. I find engaging consistently and with a positive "can do" attitude is what benefits my students the most. (P97)*

Educators were required to be approachable, considerate, receptive, and ready to take the time to connect with students (Cherry & Flora, 2017) (P70, P73). P35 and 39 wrote that being able to see students online and having good interaction with them was important. Facilitating discussions, giving timely announcements, regularly communicating through email and phone calls, and providing proper feedback on assignments are the contributing factors to a supportive online environment (Frazer et. al., 2017; Metcalf & Haugen, 2018; Richardson et. al., 2016) (P54). To be able to teach effectively P25 required:

> *Knowing the unit. Have good preparation time. A good cohort who want to engage with you.*

P21 required:

> *Time and space to craft answers that support student learning.*

To teach effectively and provide student feedback it was important for the students to want to engage in their learning (P117) and for the educators to have enough time to make this possible (P54, P62, P89, P99).

Use of technology.

To engage students in critical thinking and problem-solving some educators used technology as a tool (Kurt, 2010) (P2, P13, P27, P41, P55, P56, P58, P65, P111, P114, P115). P60 liked technology because.

> *The My class platform helps me identify non-participating students. (P60)*

While P4 liked technology because,

> *Collaborate and Zoom are very helpful as I can use them to both hear better and read lips.*

Technology was used as a resource to help make online teaching effective.

Resources.

Resources were used to help the students learn effectively (P3, P5, P31, P51, P80). P5 explained:

> *Use multimodal resources as students learn in different ways. (P5)*

P121 identified that the accessibility of the resources was a major factor helping effective teaching.

> *Structure of the course. Ease of access to resources. Ability to upload video with visual instructions and the system can cope with this. Ability to use padlet to engage students (would be good if the uni provided this, I use the free one and need to delete them frequently as only allowed three for free).*

Miscellaneous.

There were 3 similar comments related to the organisational factor of saving time (P11, 34, 83). For example,

> *I value saving time the most, I'm currently able to deliver higher performances. Online work activities will save me 5-7 work trips per month. (P11)*

Also important for effective online teaching was the environmental ergonomic factors enough light (P100) and quiet (P14, P17, P45, P84). For example,

> *Peace at work, colleagues and phones do not disturb. (P17)*

Social ergonomic factors such as

> *Constant contact with my Unit Coordinator and my student group. (104)*

were important (P104, P105). Working from home (P40 P59) and the flexibility of online teaching was appreciated by P33, P57, P64, P88, P95). For example,

> *The physical strain associated with travelling for offline class is absent in online mode. That helps me conserve more energy and makes this physically less tiring for me (P83)*

As a conclusion P120 wrote:

> *I can teach good students effectively. The rest, I can't.*

Participants reported that effective teaching was influenced by the students, technology, resources available, including time, ergonomic factors, flexibility, engagement, and motivation.

5.3.9.5. Online Teaching Barriers and possible solutions.

The next question asked 'Describe any barriers you have experienced in online teaching and why these were barriers? If you did experience a barrier, how did you overcome this barrier?' Sixty-eight comments were received. Answers are categorised in Table 55.

Table 55
Barrier to effectively online teaching.

Stressors	***Participant number + employment type***	***Gender***	***Country***
Organisational Ergonomic Barrier			
Time	P3, P12, P61 (Ongoing), P97, P98 (Casual)	2M, 3F.	Australia 3 Iran 1 Taiwan 1
Subjects with laboratory classes	P21(Casual)	1F	Australia 1
Negative students' feedback/ attitude	P27(Ongoing), P19 (Casual)	2F	China 1 Iran 1
University interventions needed	P53 (Ongoing), P117 (Casual)	1M. 1F.	Australia 1 India 1
Cognitive Ergonomic Barrier			
Technology related	P64, P104, P116, (Casual), P18, P111 (Fixed term)	1M, 4F.	Australia 2 India 2 Slovakia 1

Stressors	*Participant number + employment type*	*Gender*	*Country*
Internet issues	P42, P63, P105 (Ongoing), P119 (Casual), P76, P80, P88 (Fixed term)	3M, 4F.	Australia 2 India 3 Lebanon 1
Stress	P9 (Fixed term) P51 (Casual) P14 (Ongoing)	1F.	Czech Republic 1 Ghana 1 Australia 1
Social Ergonomic Barrier			
Student interaction/ engagement	P2, P35, P52, P55, P56, P60, P65, P114 (Ongoing), P25, P32, P69, P70, P72, P79, P84, P99, P120, P121 (Casual), P1, P11, P16, P33, P101 (Fixed term)	12M, 11F.	Australia 13 India 6 Slovakia 2 Singapore 1 USA 1
Language barrier	P13, (Casual), P41 (Ongoing), P57 (Fixed term)	2M, 1F.	Australia 2 Taiwan 1
Cultural difference	P95 (Casual)	1F.	Australia 1
Isolation feeling	P17 (Fixed term)	1F.	Slovakia 1
Students not turning up	P54 (Ongoing), P89 (Fixed term)	1M, 1F.	Australia 2

Ergonomic Factors.

Social ergonomic barriers were that the online educator did not get to know students to be able to teach them effectively (P1, P16, P41, P79, P121), students did not attend classes when the educator was present (P2, P89), students did not attend classes at all (P54, P56, P70), educator unable to see students (P11, P55, P101), student language and cultural barriers (P13, P57, P95), classes are just talking to the monitor as students are not present (P17, P52) and lack of student participation in classes (P25, P32, P33, P35, P60, P65. P69, P72, P84, P114, P120). P99 explained her social ergonomic problem as:

> *Lack of real engagement by some students who just hand in assignments worth marks otherwise have minimal interactions. (P99)*

The way that P99 tried to overcome this barrier was,

> *I try different ways to get students to interact, I find shorter simpler tasks seem to engage more students.*

Not all participants found ways to overcome social ergonomic barriers, despite trying.

Cognitive ergonomic barriers were related to stress from being new to online teaching (P9, P51) and requiring more education to teach online effectively (P53, P104).

Lack of time was an organisational barrier recorded by some participants (P12, P3, P61, P98 P117). As explained by P97,

> *Limited time constraints due to time allocations not meeting actual time used (particularly in marking and moderation). (P97)*

To overcome this barrier P97 commented:

> *Relied on my knowledge and experience. Asked questions consistently to improve my knowledge. Take on aspects of the UC role in order to create a consistent teaching and learning experience for the students and my colleagues.*

P64 reported:

> *I put in way more hours than paid for to teach students online. I'm leaving tertiary work after this semester. I have had enough.*

For this educator a way to overcome this barrier was to find new employment.

Technology barriers.

Other barriers were related to technology including students not having access to enough data and university not migrating all students into the class until part way through the semester (P14), technology not working, including during class time (P18, P45, P76), no electricity (P42), internet often not working for educator and for students (P63, P83, P88, P105), very slow internet (P80), technology difficult to use for educators and students (P111, P116) and lack of technical knowledge (P64). It was reported as being difficult to overcome the problems related to technology but P119 commented:

> *Problem. Internet access can sometimes drop out in regional areas.*
>
> *Solution. I have access to multiple internet devices and can swap. This is costly for me but necessary.*

Miscellaneous.

A barrier reported by P21 was teaching practical subjects online:

> *I teach a practical subject and many of my students say that it can't be taught well online.*
>
> *Solution. Because of others' perceptions that a practical subject can't be taught online, I undertook a master's degree in my field to understand the student experience. I also took an online ACER professional development course. I think it has made me a better online teacher. NB. All of this cost, $20, 000 at my own expense, because I think online students can be short changed if they are taught*

by people who think that there is little difference between online teaching and f2f teaching. (P21)

Another barrier was students' attitudes as explained by P19:

Student attitude (I pay therefore you will pass me regardless of whether I do any work or not). It's easier for students to complain when you are not face to face - keyboard warriors! Students thinking you should be available 24/7 and in real time.

Solution: I just keep trying to be highly visible and engaging. (P19).

From the participants' comments written related to barriers it was obvious that the educators were committed to providing a high standard of online teaching. Their main barriers were related to technology, ergonomic factors, and the attitude of some students. Where possible educators worked hard to overcome these barriers.

5.3.9.6. ***Most important factors for online teaching.***

The exit question, 'List the most important factors you consider are required to enable you to teach successfully online', was an open-ended question to allow participants to describe what affected their online teaching the most. The comments were grouped according to the four main themes as listed in table 56.

Table 56
Exit Question.

Factor	***Participant number + employment type***	***Gender***	***Country***
Organisational ergonomics. University support and resources.	P14, P35, P42, P45, P52, P53, P55, P60, P61, P63, P65, P83, P89, P114, (ongoing) P4, P11, P18, P33, P57, P80, P88, P101, (fixed term) P19, P71, P72, P95, P97, P98, P99, P121, P115 (casual)	16 females. 15 males.	Australia 17 India 8 Slovakia 2 Ghana 1 Lebanon 1 Singapore 1 USA 1
Cognitive ergonomics. Education, knowledge, and engagement.	P2, P5, P12, P14, P27, P36, P41, P50, P53, P56, P60, P73, P77, P83 (ongoing) P1, P18, P31, P34, P57, P76, P89, P100, P111 (fixed term) P13, P25, P51, P79, P99, P62, P97, P120, P121 (casual)	20 females. 12 males.	Australia 15 India 10 Taiwan 2 USA 2 China 1 Ghana 1 Slovakia 1
Environmental and Physical ergonomics.	P3, P45, P60, P114 (ongoing) P84, P95, P99, (casual)	2 females 5 males.	Australia 4 India 2 Iran 1
Personal qualities.	P3 (ongoing) P21, P97, P104, P117 (casual)	4 females 1 male.	Australia 4 Iran 1

Organisational ergonomics.

According to P18, P95, P57, P98 an organisational factor that enabled educators to teach successfully online was having sufficient work time. Work flexibility was important for P95, while P52 reported the need for having:

> *Resources, technical support, peer collaboration, and not overloaded with units and students.*

Support from the university was considered important by P4, P72, P115. P 71 wrote:

> *Having security in my employment.*

As the type of support required P53, P55, P60, P63, P65, P80, P114 and P121 requested university providing online teaching resources. P97 explained that there was a need for:

> *Excellent internet connection! Learning Management System that is stable and consistent. IT support that is swift with resolutions. Access to knowledge. All policies, links, unit materials etc are accessible online, anytime.*

P4, P11, P14, P33, P42, P45, P65, P60, P65, P83, P95, P101, P114, P121 and 97 required a functioning internet for successful online teaching. P11 wrote:

> *The most important factors for me are the functioning of technology and online platforms.*

Not all participants thought that it was the university's responsibility for having a functioning internet as P88 from Indi wrote :

> *State should take the responsibility of providing the infrastructure for online teaching. All students should have access to technology irrespective of class and economic position.*

P42 from Lebanon reported that if the government provided constant electricity (sometimes there was only electricity for one hour or less a day) and a good online connection that online teaching would be more successful.

Technical support from the university was an important factor for successful online teaching for P52, P97 and P61. P19 requested:

> *An IT team that works on the weekends like we do in Open Universities Australia. (P19)*

> *Technology needs to work for both the teacher and the students. (P89)*

As well as having a functioning internet P35 requested having:

> *Reliable interactive time and attendance system.*

As a summary, successful online teaching relied on having a working internet, working technology, and university supplied resources. Educators requested security of employment, not to be overloaded with work, have enough time to do their work, and have a university system which did not allow students the flexibility to attend online classes when they wanted to, but required students to attend each class at a set time, as was required with face-to-face teaching.

Cognitive ergonomics.

To enable successful online teaching there needed to be a willingness and a zeal to learn the latest online technology and software used for online teaching (P14, P34, P51, P60, P76, P110,). P89 explained,

> *Technology needs to work for both the teacher and the students. There needs to be good communication by both the teacher and all students to and between each other. Everyone needs to be motivated to learn and achieve as students learn from their teacher and teachers learn from students.*

There was also a need for:

> *Effective training in pedagogy in general and online teaching in particular. (P31)*

An important factor was having a subject knowledge, ability to use technology, and online teaching tools (P1, P13, P18, P53, P73, P76, P77, P99, P111). Aspects of this were explained by P25, P57 and P121:

> *Know the unit and the content. Know how to present and engage in the collabs. Be organised and professional. Well prepared lecture materials and teaching aids. (P25)*

> *Passion and experience in teaching. Training - Technology - Experience with online - familiarisation of the teaching platform and technology. (P57)*

> *Ability to use a variety of technologies to engage students (upload instructional videos, use padlet a visual bulletin boards for organising and sharing content). (P121)*

The study materials were important to P36. P56 explained that for effective online teaching it was important to have:

> *Good and engaging teaching material. Participant involvement. (P56)*

> *Teach the same unit more than once. Have all units reviewed. Many people are not making resources and sharing them which means I have to do it for each new unit and then I add them to the blackboard. I don't get paid for that as I am casual. (P62)*

As explained by P62 online educators worked hard to have effective teaching materials, even when they were not paid to do this.

Emotional engagement is a cognitive ergonomic factor as engagement is controlled by the mind. Engagement was important for P2, P12, P27. Engagement was two ways; the educators needed to be engaging (P50), and so do the students, as explained by P5, P79, P83 and P120.

> *Being enthusiastic for students, bring energy and passion for the unit. (P50)*

> *We need to be able to ask the students to turn their cameras on. (P5)*

> *Most importantly the face-to-face interaction. (P79)*

> *Students being more serious and attentive in the classes. (83)*

> *If students are keen and able (bright/motivated/capable) then the teaching is a delight, and the learning is fantastic. If students are not, then they don't engage with me anyway. Sad isn't it. (P120)*

As explained by the online educators having a good knowledge of technology to be used and the subject taught was important for effective online teaching. For some educators training was required to gain this knowledge. Also important was having educators who could engage the students in learning and students who were capable of learning and motivated to learn.

Environmental and physical ergonomics.

For P3, P45, P60, P84, P95, P99 and P114 it was important to have a study space, which was quiet and had good lighting in which to be able to do the online teaching work. P99 explained,

It's important to have a comfortable and ergonomic work environment.

Personal qualities.

The final most important factors required to successfully teach online were describes as having appropriate communication skills (P3), resilience and a sense of humour (P104), and being willing to use technology (P117). Other qualities were having:

Motivated, engaged, and experienced Unit Coordinator. Committed Tutors. (P97)

Empathy and compassion, knowing that you are sometimes your students only point of contact. (P21)

5.3.9.7. Section Summary.

In this section seven open ended questions were asked to identify online teaching facilitators and barriers faced by the educators and recommendation to overcome the barriers. Having a working internet and working technology were identified as the main facilitators, and these not working were the main barriers. Educators reported struggling to finish their teaching related work within the allotted time, though most of them liked online teaching flexibility they missed physical and visual interactions with students. The next section describes the research conclusions and recommendations.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction.

The aim of this research was to identify and assess ergonomic factors that affect educators' experience with online teaching. To achieve this, a questionnaire was made and uploaded to Qualtrics and the link was emailed to the educators teaching in universities in Australia, and other countries, especially those who were involved in teaching engineering, mining, and minerals subjects. Based on the questionnaire survey and data analyses, results were derived to make the conclusions presented in the following section. In this research qualitative data analysis was used to identify online educators' opinions of how they were affected by the 5 ergonomic factors. Analytical statistics were used to identify the relationship between descriptive statistical information and ergonomic factor information.

6.2. Conclusions.

6.2.1. Ergonomic factors that facilitate the provision of online teaching for minerals and mining engineering educators.

The first research objective was to identify the ergonomic factors that were perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering. From the questionnaire results analysis, the model developed from a review of published literature was amended to include the questionnaire results. Conclusions are having sit-to-stand desks, having enough space for the resources, and having adequate storage space were identified as the best options to reduce physical discomfort thus increase effectiveness while teaching online. Matt finish worksurfaces help to reduce the glare; task lights help to provide enough light, which helps to reduce the eye discomfort and the availability of good thermal control system also helped to maintain the optimal temperature to facilitate online teaching work. Conclusions are ergonomic set up of the working area was important, but most individuals were not able to do this as all the specifications were dependant on an individual's anthropometric measurements. For online educators who do not have ergonomic knowledge, assistance from a professional would be the best choice. Because this is very expensive it should be provided by the university to enhance productivity and protect educators' health.

Having more paid hours to complete all online teaching related duties including teaching preparation, developing new or updating existing course material, providing feedback, and answering students' queries were identified as the facilitating factors by the participants. It was concluded that having allocated paid hours for training would encourage the educators to participate in training for both technology as well as policies and procedure, and gaining this knowledge will help to facilitate their effectiveness.

More interaction between students and educators was identified as facilitating the effectiveness and motivation of online teaching. It was concluded that if there were strict rules imposed by the university that the students should join for a set number of compulsory online learning hours this would assist the mining and minerals processing online educators to know the students, thus helping them to interact with them more efficiently, however this may be difficult for students who have work and other commitments during class hours. The updated model is included in Figure 64 with the new knowledge generated through this research included in red.

6.2.1.1. Revised Model

Figure 64
Ergonomic factors that facilitate online teaching.

6.2.2. Online teaching barriers.

The next research objective was to detect the ergonomic factors that were perceived by university educators to be barriers to providing online teaching. Conclusions related to this objective are displayed in Figure 65. From the questionnaire results analysis, the model of online teaching barriers developed from published literature was amended to include online education barriers identified by the research participants. Physical ergonomic factors that were a barrier to online teaching included inadequate height/design of the desk or working surface. Lack of resources storage space and inadequate width of the workstation were factors identified by the participants that were not included in the model developed from a review of published literature. Participants did not mention being affected by the size of the room they were teaching from, but they did identify the feeling of discomfort due to glare and having air quality issue due to old carpet being in the room that they worked in. Some participants reported not having any knowledge of the university policies and procedures and not being able to locate them. A majority reported problems were inadequate time allotted for teaching preparation, student communication, marking, providing students with feedback, supervising, and assisting co-workers, marking moderation work, developing new and updating existing course materials. Issues related to software was another organisational ergonomic factor that participants identified as a barrier to effective online teaching.

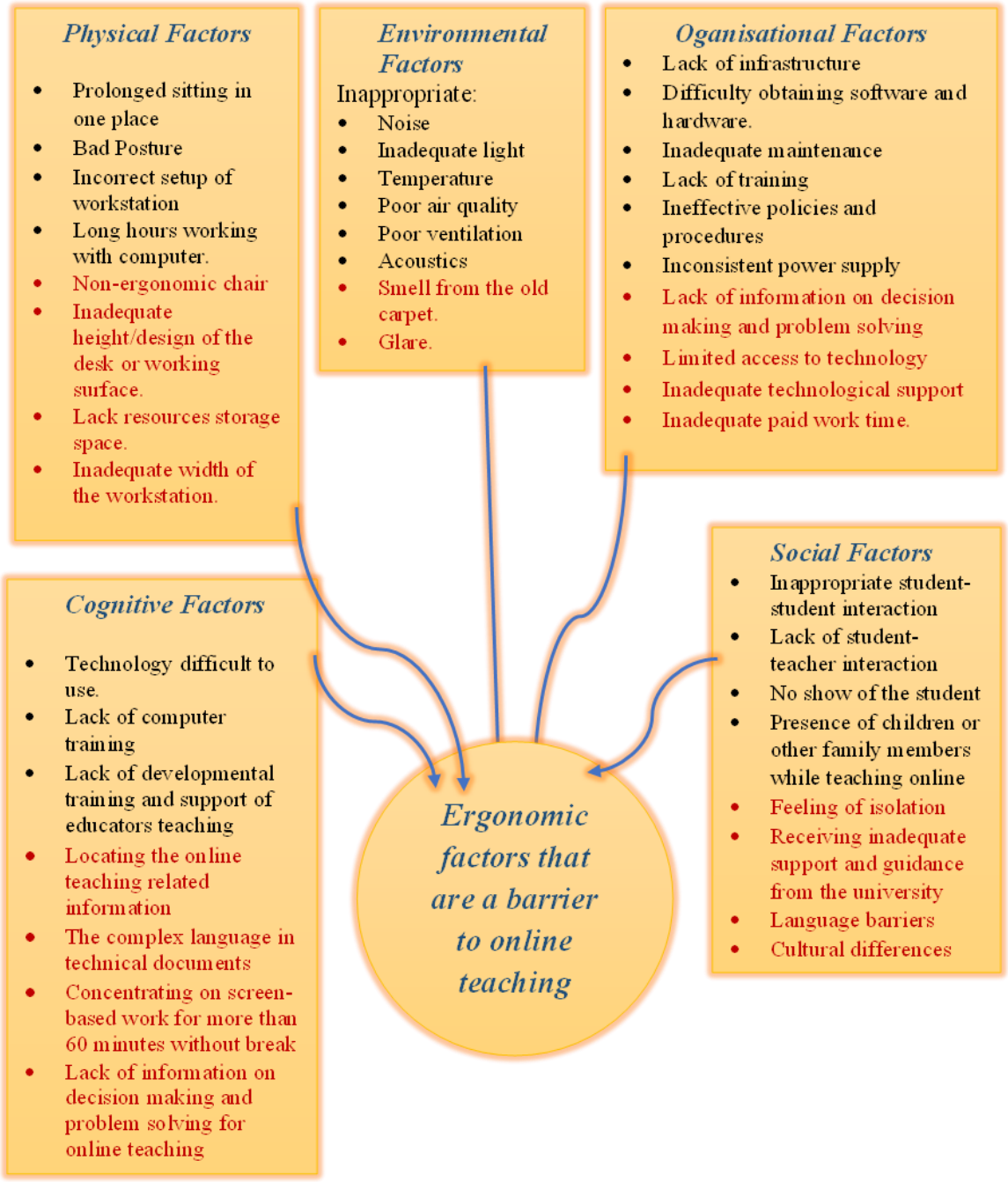
Lack of technology related training provided by the university, inadequate technological infrastructure, difficulty in locating online teaching related information and the complex language of technical documents were identified as barriers. Concentrating on screen-based work for more than 60 minutes without break, lack of information on decision making and problem solving in online teaching platform were other factors that participants reported were a barrier to their effective teaching.

Feeling of isolation, receiving inadequate support and guidance from the university, language barriers, cultural differences were the other issues related to social ergonomic factors that were identified as online teaching barriers by the participants. Bullying and playing multiple roles were not identified as problems by the participants, so those items were removed from social ergonomic factors. The updated model is included as

the following figure with the new knowledge generated through this research included in red.

6.2.2.1. Revised Model for Barriers

Figure 65
Ergonomic factors that are barriers to Online teaching



6.2.3. Differences between engineering and other academics.

Conclusions related to the third research objective, which was to identify the differences between engineering and other academics, were that the participants commented that there were different challenges faced by the educators teaching different subjects. One third of the research participants were teaching engineering. In the results of the quantitative analysis, conducted using Chi-square test between the ergonomic factors and the subjects taught (engineering vs non-Engineering), most of the factors had no significance. However, environmental ergonomic factors, such as having a lighting control device, a greater number of educators teaching engineering subjects were using this than educators teaching other subjects; fewer numbers of educators teaching engineering subjects identified that there was inadequate time for marking, providing feedback, updating existing units and for teaching preparation (Organisational ergonomic factors) than educators teaching other subjects; a greater number of educators teaching engineering subjects identified that they had audio-visual contact through the internet with students (social ergonomic factor) while teaching online than the educators teaching other subjects.

6.2.4. Ergonomic factors and online teaching work.

The last research objective was to identify the causal relationship of the five ergonomic factors towards experience in online teaching. It was concluded that a greater number of male educators confirmed that the height of their worksurface were adequate, and they were at the level of their elbow, they were able look straight at the monitor; received adequate time for marking and providing feedback than the female educators. A greater number of female educators were facing difficulties in understanding the online teaching related technology than male educators.

A greater number of educators from developed country had appropriate surface area for their workstation (physical ergonomic factor); using surface areas with matt finish (environmental ergonomic factor) and received sufficient support and guidance (social ergonomic factor) than the educators from developing country. A greater number of educators with fixed term employment were using seats with inappropriate seat surface size, workstation with inadequate height and did not have easy accessibility to resources than the educators with ongoing employment. A greater number of educators with casual employment were using fully adjustable seats, and seats with adequate

lumbar support (physical ergonomic factor), inadequate time received for marking and providing feedback, and had greater ability to communicate with their students in comparison with the educators with ongoing employment.

Conclusions were that educators with more online teaching experience had more ergonomic related issues to some physical and environmental ergonomic factors than the educators with less experience. It was concluded that the educators with more online teaching experience had more difficulty with the cognitive ergonomic factor of the understandability of related documents and that they receive less training (organisational ergonomic factor). Educators with less online teaching experience stated that they were struggling to finish all their online teaching related work within the allotted time (organisational ergonomic factor), identified lack of support and guidance (social ergonomic factor), were more affected by language barriers (social ergonomic barrier), and dealing with inadequate technical infrastructure (organisational ergonomic factor).

6.2. Research Aim Conclusions.

The aim of this research was to identify and assess ergonomic factors that affect educators' experience with online teaching. Conclusions were that there were ergonomic factors which facilitated the effectiveness of online teaching work. Participants identified that the flexibility of being able to teach from anywhere option motivated them to teach online as online educators had the option of working from home enabling them to save the travel time, cost related to travel and to work without any distraction. However, it was concluded that there were some factors identified which hindered the effectiveness of online teaching work. The main factors identified were lack of allotted time for carrying out teaching related duties, feelings of isolation due to lack of physical interaction with students and colleagues, not able to comprehend the level of understanding of each student due to lack of visual interaction, noise and other distraction due to having other people at home specially children, lack of support and guidance, experiencing physical discomfort of not having an appropriate ergonomic work station setup and having feelings of burnout, stress and anxiety due to not having appropriate technological knowledge or training.

6.3. Recommendations.

It is recommended that universities provide adequate support and guidance to improve the productivity, physical and mental health of the educators teaching online work, thus, improving the effectiveness of online teaching work. Other recommendations are listed below:

1. The educators should receive professional ergonomic help to setup their working area including those teaching online from home.
2. Cost of work-related ergonomic furniture should be reimbursement by the employer.
3. All the educators must have a designated workspace at the campus, including casual staff, if required to work from the university.
4. More training should be made available for the professional development of the educators, emphasising the use of technological tools required for content development, updating existing content and sharing contents with students.
5. Education should be provided by the university on policies and procedures, and these should be easily accessible for the educators teaching online.
6. All the time required for work related training should be paid for.
7. Increasing the allotted paid times for online teaching preparation, checking assignments, providing feedback and other online teaching work should be provided for.
8. Technology training for students should be implemented.

6.4. Summary.

The outcomes from this research included the following:

- A recommended model of online teaching work facilitating factors, with important points for each of the five ergonomic factors, was developed based on the research findings. This will help if any future situations arise, like the COVID-19 pandemic, and will also help to facilitate the work of online educators, particularly in mining the industry.
- A fact sheet, a checklist, case study and case study QA have been developed (see Appendix 14, 15, 16 &17) which has been provided to the National Tertiary Education Union and university management to use to consider work

related ergonomic factors as part of university orientation and ongoing education for the educators teaching online.

- A PowerPoint presentation for use in orientation and ongoing education, that includes case studies, has been developed for education and assessment to develop knowledge of, and assess the level educators of understanding of ergonomics, how they affect individuals and which measures can be taken to promote healthy and productive work (Appendix 18).

Research findings have been shared with minerals, mining engineering and other academics through the National Tertiary Education Union (see Appendix 20).

A virtual dissemination to share the research findings has been presented at the International Educational Conference "*A Focus on Pedagogy. Teaching, Learning & Research in the Modern Academy*" as 'An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors' presenting the results of the focus group discussion (see Appendix 12).

An article has been published in the *Taylor & Francis, "AMPS PROCEEDINGS SERIES. ISSN 2398-9467*", titled "An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors." See (Appendix 13).

An article has been published on part of the literature review section "Effect of COVID-19 Pandemic on Traditional Teaching" published in the *International Journal on Studies in Education* (see Appendix 11).

The findings of this research have been shared through a presentation by the researcher at the "*5th World Congress of Education held in Sapporo, Japan, November 2023*" with the presentation title of 'An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors for mining and other educators' See Appendix 19.

The PhD research report will be publicly available through the Curtin University library e-space and a link to this will be emailed to all research participants.

After the outbreak of COVID-19, which resulted in a compulsory shift from face-to-face teaching to emergency online teaching, there was a need to identify the ergonomic factors which facilitate, and those which hinder, the effectiveness of online teaching work and to recommend possible interventions to reduce adverse effects. This research reviewed 845 publications and identified the facilitating factors, and the factors hindering online teaching work. It has made a significant, and important contribution to the knowledge about the ergonomic factors that have effects on online teaching work. Most of the previous studies, related to online education, focused on student learning. No previous published research was found related to how all five ergonomic factors affected the work of mining and mineral engineering online educators. There were no publications found which covered the difference in effect on the work of teaching engineering subjects or non-engineering subjects online, international differences, and how educators employment status affected online teaching. The findings of this research fulfilled the gap in the knowledge of these specific areas.

This study identified the barriers which hinder the effectiveness in online teaching work and made recommendations to enable the online educators to be able to work more effectively with less ill health effects. A revised model of both facilitators and of barriers for online educators has been developed, based on the findings of this research. It was identified that support is the most important factor for online educators' work effectiveness.

Knowledge gained from this research can be used to improve the online teaching work related physical, environmental, organisational, cognitive, and social ergonomic factors for the educators teaching online, especially for minerals and mining engineering subjects, to enhance their effectiveness and health. Findings of this research can also be used by policy makers, designers, hardware, and software developers to improve the work systems and equipment to make the online teaching work safe, healthy, and more productive.

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8. APPENDIX

APPENDIX 1 LETTER OF SUPPORT FROM THE NTEU

20th May 2020.

To whom it may concern,

I write on behalf of the Curtin University Branch of the National Tertiary Education Union (NTEU) in support of the research titled 'An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.' This research will be conducted by Mitali Ghosh under the supervision of Dr Apurna Ghosh and Dr Janis Jansz. The findings of this research will be used to improve the health and safety of our members who perform online teaching in minerals, mining engineering and other subjects and has the potential to improve the effectiveness of online teaching and student learning.

Through this letter we acknowledge that the Curtin University Branch of the NTEU will facilitate this research by providing our Members, who meet the selection criteria, with information on the possibility of participating in this research as a focus group member and, using the invitation email developed by Mitali, of the opportunity to participate in the research by answering the research questionnaire and checklist.

In the long term, this research is of great interest in providing the NTEU with information to enhance our knowledge of the physical, cognitive, organisational, social, and environmental ergonomic factors that affect online teaching academics with ongoing employment, fixed term employment and those with sessional employment and ways to make their work safe and healthy. We look forward to the potential benefits that this research will bring to university educators in Australia and internationally.

Yours sincerely,

Tony Snow
NTEU Curtin Branch President

APPENDIX 2 RESEARCH EMAIL INVITATIONS

EMAIL INVITATION TO EDUCATORS TO PARTICIPATE IN THE RESEARCH FOCUS GROUP

Project Title: ***An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace***.

As no published literature has been identified related to how all 5 ergonomic factors, (physical, cognitive, organisational, social and environmental), affect university educators who provide online teaching research is planned to:

- Identify ergonomic factors that are perceived by university educators to facilitate and hinder the effective provision of fully online teaching
- Determine if there are differences in staff perception by their employment type.

This research would involve you:

1. Reading the information letter that details all relevant information and giving consent to participate in this research.
2. Taking part in a focus group discussion related to university educators' perception of how ergonomic factors effect online teaching.

You are able to withdraw from participation at any stage without any penalty or negative consequence. You will not be identified personally in this research.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au .

If you have questions or require further clarification please do not hesitate to contact me Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my principal supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel +61 8 9088 6108).

Thank you for your time.

Kind regards,

Mitali Ghosh

EMAIL INVITATION TO EDUCATORS TO PARTICIPATE IN THE PILOT STUDY

Project Title: ***An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace***.

As no published literature has been identified related to how all 5 ergonomic factors, (physical, cognitive, organisational, social and environmental), affect university educators who provide online teaching research is planned to:

- Identify ergonomic factors that are perceived by university educators to facilitate and hinder the effective provision of fully online teaching
- Determine if there are differences in staff perception by their employment type.

This research would involve you:

3. Reading the information letter that details all relevant information and giving consent to participate in this research.
4. Completing a pilot study questionnaire related to university educators' perception of how ergonomic factors effect online teaching in week one and then the same questionnaire again a week later to assist with determining the reliability of the questionnaire developed from focus group findings.

You are able to withdraw from participation at any stage without any penalty or negative consequence. You will not be identified personally in this research.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au .

If you have questions or require further clarification please do not hesitate to contact me Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my principal supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel +61 8 9088 6108).

Thank you for your time.

Kind regards,

Mitali Ghosh

EMAIL INVITATION TO EDUCATORS TO PARTICIPATE IN THE RESEARCH SURVEY

Project Title: ***An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace***.

As no published literature has been identified related to how all 5 ergonomic factors (physical, cognitive, organisational, social and environmental) affect university educators who provide online teaching we are currently undertaking research to:

- Identify ergonomic factors that are perceived by university educators to facilitate and hinder the effective provision of fully online teaching
- Determine if there are differences in staff perception by their employment type.

This research would involve you:

1. Reading the information letter that details all relevant information and giving consent to participate in this research.
2. Completing an anonymous survey that can be accessed through the web link https://curtin.au1.qualtrics.com/jfe/form/SV_6GnWa7EpafJj7n0

Should you experience difficulties or issues in accessing this survey or research material then please contact me Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my principal supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel +61 8 9088 6108).

You are able to withdraw from participation at any stage without any penalty or negative consequence. You will not be identified personally in this research.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au .

If you have questions or require further clarification please do not hesitate to contact me Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel+61 8 9088 6108) .

Thank you for your time.

Kind regards,

Mitali Ghosh

APPENDIX 3 FOCUS GROUP PARTICIPANTS' INFORMATION STATEMENT

Curtin University

PARTICIPANT INFORMATION STATEMENT FOR FOCUS GROUP PARTICIPANTS

HREC Project Number:	HRE2020-0585
Project Title:	**An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace**.
Principal Investigator:	Dr Apurna Ghosh. WA School of Mines: Minerals, Energy and Chemical Engineering.
Student researcher:	Mitali Ghosh
Version Number:	Version 1.
Version Date:	30-5-2020

What is the project about, project aim, why it is being done, research benefits and why is this research important?

I am seeking to undertake research for my Doctor of Philosophy - Mining and Metallurgical Engineering at Curtin University in regards to how ergonomic factors within your learning environment may affect you. The title of the study is: *An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.* The aim of this research is to identify how physical, social, environmental, organisational and cognitive ergonomic factors affect educators in an online teaching environment. It is anticipated that the findings of this research will generate knowledge that can be used to improve the physical, cognitive, social, organisational and environmental ergonomic factors for academic staff with different employment conditions in being able to perform more effectively in online teaching. This research provides you with an opportunity to express your opinion but there will be no direct benefit to you from participating in this research unless the university that you work at chooses to implement the findings of this research.

Who is doing the research?

This research is being conducted by Mitali Ghosh to obtain a Doctor of Philosophy at Curtin University. It is funded by the University and will be conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007). There will be no costs to you for participating in this research and you will not be paid for participating.

Why am I being asked to take part and what will I have to do? Are there any risks, side-effects, discomforts or inconveniences from being in the research project? Who will have access to my information?

You are requested to participate in this research as you have online teaching responsibilities so would be able to provide valuable information to assist to achieve the research aim.

Your participation in this research is voluntary and would comprise of approximately two (2) hours (no longer) for a focus group meeting at Curtin University. An audio-recording device will be used during the group meeting so we can concentrate on what you have to say and not distract ourselves with taking notes. After the interview/focus group we will make a full written copy of the recording. You will be asked questions about your online teaching experiences. Whilst all care will be taken to maintain privacy and confidentiality of any information shared at the focus group discussion, you should be aware that you may feel embarrassed or upset if one of the group members repeats things said in the confidential group meeting. When the focus group results are written you will not be identified personally as answers will be reported as group data or anonymous quotes. The only people who will have access to the focus group information will be the researcher, Mitali Ghosh, and her research supervisors. The research data from this study will be held on the researcher's password protected computer and in the Curtin University R Drive for seven years and then it will be destroyed. You are able to withdraw from participation at any stage without any penalty or negative consequence. There are no foreseeable risks anticipated for anyone who chooses to take part in this study. We are not able to send you any results from this research as we do not collect any personal information to be able to contact you, however a summary of the research findings will be published in the National Tertiary Education Union publication, the Advocate, once the research has been completed. You will not be identified in any results that are published or presented. It is envisaged that the data collected will also be reported in journal articles, conference proceedings, seminars and presentations to share the research results to improve the ergonomic factors for online educators', facilitate effective provision of online teaching and an educator centred healthy workplace environment.

Do I have to take part in the research project?

Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project. You do not have to give us a reason; just tell us that you want to stop. Please let us know you want to stop so we can make sure you are aware of any thing that needs to be done so you can withdraw safely. If you chose not to take part or start and then stop the study, it will not affect your relationship with the University, staff or colleagues. We will destroy any information we have collected from you.

What happens next and who can I contact about the research?

Should you be willing to participate in this research, you will need to complete a consent form. Please contact Mitali Ghosh on mitali.ghosh@student.curtin.edu.au if you would like a consent form to be sent to you to consent to take part in the research focus group. Signing the consent form is telling us that you understand what you have read and indicates that you agree to take part in the research. You will be given a copy of the information sheet and the consent form to keep.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). If you have questions or require further clarification please do not hesitate to contact me, Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel+61 8 9088 6108). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08)

9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au Thank you in anticipation of your valuable contribution.

Yours sincerely,

Mitali Ghosh.

APPENDIX 4 PILOT STUDY PARTICIPANTS INFORMATION LETTER

PARTICIPANT INFORMATION STATEMENT FOR PILOT STUDY PARTICIPANTS

HREC Project Number:	HRE2020-0585
Project Title:	An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.
Principal Investigator:	Dr. Apurna Ghosh. WA School of Mines: Minerals, Energy and Chemical Engineering.
Student researcher:	Mitali Ghosh
Version Number:	Version 1.
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This research is being conducted by Mitali Ghosh to obtain a Doctor of Philosophy - Mining and Metallurgical Engineering at Curtin University. It is funded by the University and will be conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007). There will be no costs to you for participating in this research and you will not be paid for participating.

Why am I being asked to take part and what will I have to do? Are there any risks, side-effects, discomforts or inconveniences from being in the research project? Who will have access to my information?

You are requested to participate in this research as you have online teaching responsibilities so would be able to provide valuable information to assist to achieve the research aim. Your participation in this research is voluntary and would comprise of:

1. Completing an on-line anonymous ergonomic factors questionnaire related to ergonomic factors that may affect educators who teach online. This questionnaire will take approximately 30 minutes to complete.
2. You will complete the online questionnaire through Qualtrics in one week and then again through Qualtrics in the following week to assist with determining the reliability of the questionnaire developed from focus group findings.

When the research results are written you will not be identified personally as answers will be reported as group data only. The only people who will have access to the online questionnaire will be the researcher, Mitali Ghosh, and her research supervisors. The research data from this study will be held on the researcher's password protected computer and in the Curtin University R Drive for seven years and then it will be destroyed. You are able to withdraw from participation at any stage without any penalty or negative consequence. There are no foreseeable risks anticipated for anyone who chooses to take part in this study. We are not able to send you any results from this research as we do not collect any personal information to be able to contact you, however a summary of the research findings will be published in the National Tertiary Education Union publication, the Advocate, once the research has been completed. You will not be identified in any results that are published or presented. It is envisaged that the data collected will also be reported in journal articles, conference proceedings, seminars and presentations to share the research results to improve the ergonomic factors for online educators', facilitate effective provision of online teaching and an educator centred healthy workplace environment.

Do I have to take part in the research project?

Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project. You do not have to give us a reason; just tell us that you want to stop. Please let us know you want to stop so we can make sure you are aware of any thing that needs to be done so you can withdraw safely. If you chose not to take part or start and then stop the study, it will not affect your relationship with the University, staff or colleagues. We will destroy any information we have collected from you.

What happens next and who can I contact about the research?

Should you be willing to participate in this research, you will need to complete a consent form. Please contact Mitali Ghosh on mitali.ghosh@student.curtin.edu.au if you would like a consent form to be sent to you to consent to take part in the research pilot study. Signing the consent form is telling us that you understand what you have read and indicates that you agree to take part in this pilot study. You will be given a copy of the information sheet and the consent form to keep.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). If you have questions or require further clarification please do not hesitate to contact me, Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel+61 8 9088 6108). Should you wish to discuss the study with someone not directly involved, in

particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au Thank you in anticipation of your valuable contribution.

Yours sincerely,

Mitali Ghosh.

APPENDIX 5 RESEARCH SURVEY PARTICIPANTS INFORMATION LETTER

Curtin University

PARTICIPANT INFORMATION STATEMENT FOR RESEARCH SURVEY PARTICIPANTS

HREC Project Number:	HRE2020-0585
Project Title:	An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.
Principal Investigator:	Dr Apurna Ghosh. WA School of Mines: Minerals, Energy and Chemical Engineering.
Student researcher:	Mitali Ghosh
Version Number:	Version 1.
Version Date:	30-5-2020

What is the project about, project aim, why it is being done, research benefits and why is this research important?

I am seeking to undertake research for my Doctor of Philosophy - Mining and Metallurgical Engineering at Curtin University in regards to how ergonomic factors within your learning environment may affect you. The title of the study is: *An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.* The aim of this research is to identify how physical, social, environmental, organisational and cognitive ergonomic factors affect educators in an online teaching environment. It is anticipated that the findings of this research will generate knowledge that can be used to improve the physical, cognitive, social, organisational and environmental ergonomic factors for academic staff with different employment conditions in being able to perform more effectively in online teaching. This research provides you with an opportunity to express your opinion but there will be no direct benefit to you from participating in this research unless the university that you work at chooses to implement the findings of this research.

Who is doing the research?

This research is being conducted by Mitali Ghosh to obtain a Doctor of Philosophy - Mining and Metallurgical Engineering at Curtin University. It is funded by the University and will be conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007). There will be no costs to you for participating in this research and you will not be paid for participating.

Why am I being asked to take part and what will I have to do? Are there any risks, side-effects, discomforts or inconveniences from being in the research project? Who will have access to my information?

You are requested to participate in this research as you have online teaching responsibilities so would be able to provide valuable information to assist to achieve the research aim. Your participation in this research is voluntary and would comprise of responding to an anonymous, online questionnaire on ergonomic factors that may affect educators who teach online. The online questionnaire will take approximately 30 minutes to complete. The information collected in this research will be non-identifiable (anonymous). This means that we do not collect individual names and all information collected is anonymous. No one, not even the researcher, will be able to identify your information. The only people who will have access to the online questionnaire will be the researcher, Mitali Ghosh, and her research supervisors. The research data from this study will be held on the researcher's password protected computer and in the Curtin University R Drive for seven years and then it will be destroyed. There are no foreseeable risks anticipated for anyone who chooses to take part in this study. We are not able to send you any results from this research as we do not collect any personal information to be able to contact you, however a summary of the research findings will be published in the National Tertiary Education Union publication, the Advocate, once the research has been completed. You will not be identified in any results that are published or presented. It is envisaged that the data collected will also be reported in journal articles, conference proceedings, seminars and presentations to share the research results to improve the ergonomic factors for online educators', facilitate effective provision of online teaching and an educator centred healthy workplace environment.

Do I have to take part in the research project?

Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project up to the point of submission of the online questionnaire as all submitted responses will be anonymous. We will be unable to destroy your information because it has been collected in an anonymous way

What happens next and who can I contact about the research?

If you choose to participate in this research at the start of the questionnaire, available via the link provided, there is a checkbox to indicate you have understood the information provided here in the information sheet and consent to answering the questionnaire. Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). If you have questions or require further clarification please do not hesitate to contact me, Mitali Ghosh at mitali.ghosh@student.curtin.edu.au or my supervisor Dr Apurna Ghosh at Apurna.Ghosh@curtin.edu.au (Tel+61 8 9088 6108). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au Thank you in anticipation of your valuable contribution.

Yours sincerely,

Mitali Ghosh.

APPENDIX 6 CONSENT FORM

Curtin University

CONSENT FORM

HREC Project Number:	HRE2020-0585
Project Title:	An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.
Principal Investigator:	Dr. Apurna Ghosh. WA School of Mines: Minerals, Energy and Chemical Engineering.
Student researcher:	Mitali Ghosh
Version Number:	Version 1.
Version Date:	30-5-2020

- I have read, [*or had read to me in my first language]*, the information statement version 1 listed above and I understand its contents.
- I believe I understand the purpose, extent and possible risks of my involvement in this project.
- I voluntarily consent to take part in this research project.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007) – updated March 2014.
- I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	

Declaration by researcher: I have supplied an Information Letter and Consent Form to the participant who has signed above, and believe that they understand the purpose, extent and possible risks of their involvement in this project.

Researcher Name	
Researcher Signature	
Date	

APPENDIX 7 FOCUS GROUP QUESTIONS

Questions for On-line Educators

Introductory positioning statement: The online learning platform is an important educational method that is used at Universities in Australia. To improve online teaching and learning experiences and effectiveness, cognitive, physical, organisational, environmental and social ergonomic factors that impact your online teaching are being explored. The aim of this focus group is to identify the impact that ergonomic factors have on educators who teach at least one unit of study fully online in tertiary education.

Follow up exploratory questions.

1. Please share with the group your employment position, type of employment, number and type of units of study that you teach online.
2. Why did you choose to teach online? (Salaz, Johnston, & Pickles, 2018)
3. What engages you most in teaching in an online teaching and learning environment? If none, what are the relevant ergonomic factors that might have caused this? (Martina, et al., 2019; Jansz et al., 2018; Bailey& Karen, 2009)
4. Do you come across any problems with teaching mining and metallurgy in an online environment? If yes what are these problems and which ergonomic factors are they related to? (Rasheed, Kamsin, & Abdullah, 2019)
5. Do you find that available software and technologies influences your online teaching practice, assessment development, student engagement or anything else? If so what are the advantages and disadvantages that you have found with technology and software in online teaching? (Johannesen, Erstad, & Habib, 2012)
6. Is there enough information/support provided before, during and after adoption of new technology used in online teaching? (Scherera, Siddiq, & Tondeur, 2019 ; Aldunate, & Nussbaum, 2013)
7. How does the requirement for technology use knowledge effect your online teaching? (Hutchison, 2019)
8. What are your experiences in teaching online students from different backgrounds and needs? (Kormos, & Nijakowska, 2017)

9. Physical ergonomic factors are related to human anatomical and anthropometric measurements. Examples include having a comfortable chair, enough room to do your teaching work, a desk and a computer to use that is at an appropriate height. Are there any physical ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why. (Jansz et.al. 2018)
10. Environmental ergonomic factors are related to your teaching environment. Examples are the noise, lighting, workplace temperature and ventilation in your teaching environment. Are there any environmental ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why (Jansz et.al. 2018).
11. Organizational ergonomic factors are those that are controlled by the University. Examples are allotted time for updating the materials, marking the assignments and providing feedback using Blackboard. Are there any organizational ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why (Jansz et.al. 2018).
12. Cognitive ergonomic factors are related to how you think and process information. Examples are if you know and understand all university policies and procedures, Blackboard, Turnitin, and online educational tools. Are there any cognitive ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why (Jansz et.al. 2018).
13. Social ergonomic factors are related to your interaction with other people. Example are the opportunities for collaborating with students and co-workers in your online teaching and all communication. Are there any social ergonomic factors that affect your online teaching? If so is the effect good or bad? Explain why (Jansz et.al. 2018).
14. Are you involved in supervision of online research students? If so please describe any ergonomic factors that affect your online teaching of research students (Yang, et.al. 2018).
15. What differences have you found between traditional class room teaching and online teaching in the areas of course materials, assessment methods, and support from co-workers, and any ergonomic factors? (Bezuidenhout, 2015; Boelens, Wever,& Voet, 2017)
16. In the online teaching environment what helps you to teach most effectively and why? (Bailey, & Karen, 2009)

17. Describe any barriers you have experienced in online teaching and why these were barriers. If you did experience a barrier how did you overcome this barrier? (Kearns,2016; Ferreira, Conceicao, & Saldiva, 1997; Panigrahi, Srivastava, & Sharma, 2018)
18. What are the most important factors you would recommend are required to enable you to teach successfully in the online teaching and learning environment?

    Exit question.
19. Is there anything else that you would like to tell about your online teaching experiences?

APPENDIX 8 QUALTRICS QUESTIONNAIRE

Project Title: *An Evaluation of Perceptions of Influencing Ergonomic Factors for Academics with Online Tertiary Teaching to Mining and Other Populace.*

Project Title: An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors

I am seeking to undertake research for my Doctor of Philosophy at Curtin University in regard to how ergonomic factors within your learning environment may affect you. The title of the study is: An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors. The aim of this research is to identify how physical, social, environmental, organisational and cognitive ergonomic factors affect educators in an online teaching environment. It is anticipated that the findings of this research will generate knowledge that can be used to improve the physical, cognitive, social, organisational and environmental ergonomic factors for academic staff with different employment conditions in being able to perform more effectively in online teaching. This research provides you with an opportunity to express your opinion but there will be no direct benefit to you from participating in this research unless the university that you work at chooses to implement the findings of this research.

This research is being conducted by Mitali Ghosh to obtain a Doctor of Philosophy at Curtin University. It is funded by the University and will be conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007). There will be no costs to you for participating in this research and you will not be paid for participating.

You are requested to participate in this research as you have online teaching responsibilities so would be able to provide valuable information to assist to achieve the research aim. Your participation in this research is voluntary and would comprise of completing an on-line anonymous ergonomic factors questionnaire related to ergonomic factors that may affect educators who teach online. This questionnaire will take approximately 20 minutes to complete.

The information collected in this research will be non-identifiable (anonymous). This means that we do not collect individual names and all information collected is anonymous. No one, not even the researcher, will be able to identify your information. The only people who will have access to the online questionnaire will be the researcher, Mitali Ghosh, and her research supervisors. The research data from this study will be held on the researcher's password protected computer and in the Curtin University R Drive for seven years and then it will be destroyed. There are no foreseeable risks anticipated for anyone who chooses to take part in this study.

We are not able to send you any results from this research as we do not collect any personal information to be able to contact you, however a summary of the research findings will be published in the National Tertiary Education Union publication, the Advocate, once the research has been completed. You will not be identified in any results that are published or presented. It is envisaged that the data collected will also be reported in journal articles, conference proceedings, seminars and presentations to share the research results to improve the ergonomic factors for online educators', facilitate effective provision of online teaching and an educator centred healthy workplace environment.

Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project up to the point of submission of the online questionnaire as all submitted responses will be anonymous. We will be unable to destroy your information because it has been collected in an anonymous way.

If you choose to participate in this research at the start of the questionnaire, available via the link provided, there is a checkbox to indicate you have understood the information provided here in the information sheet and consent to answering the questionnaire.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0585). If you have questions or require further clarification please do not hesitate to contact me, Mitali Ghosh at Mitali.ghosh@postgrad.curtin.edu.au , or my research supervisor Dr. Apurna Ghosh at Apurna.ghosh@curtin.edu.au or my co-supervisor Dr. Janis Jansz at j.jansz@curtin.edu.au (phone: 9266 3006). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email at hrec@curtin.edu.au Thank you in anticipation of your valuable contribution.

ELECTRONIC CONSENT.

Clicking on agree indicates that you have read the above information and voluntarily agree to answer the questionnaire.

- ○ Agree
- ○ Disagree

My gender is:

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

My present age is:

- ○ Less than 25 years
- ○ 26-35 years
- ○ 36-45 years
- ○ 46– 55 years
- ○ 56 – 65 years
- ○ Over 65 years

Please write the country you live.

Please write the State or Territory you work in.

My employment position is:

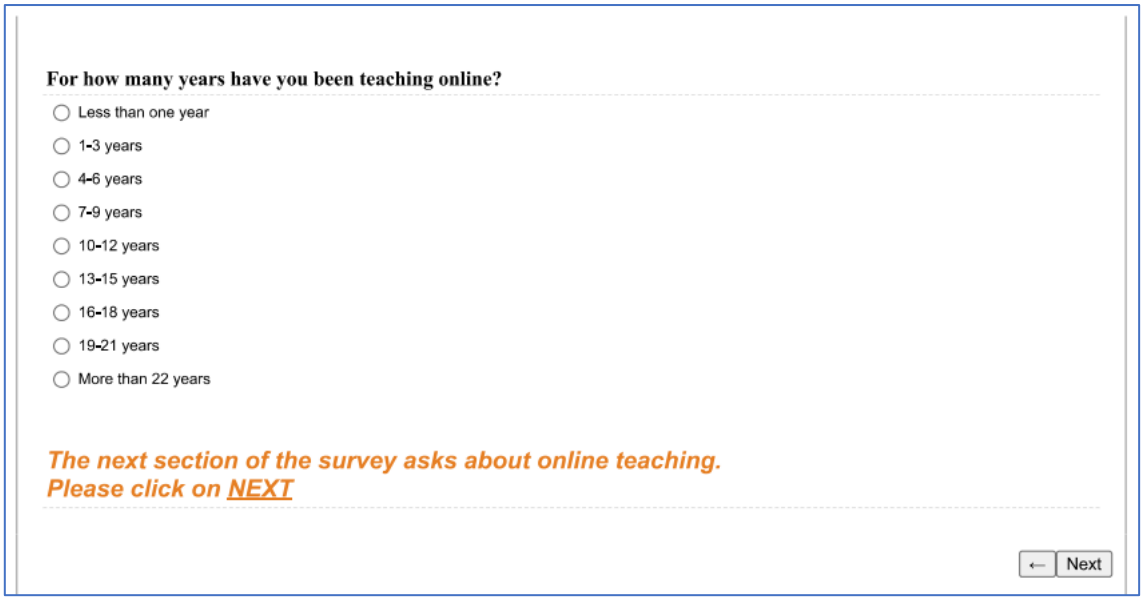
- ○ Teaching focused
- ○ Teaching and Research
- ○ Research focused

My university employment is:

- ○ Fixed term
- ○ Casual
- ○ Ongoing

For how many years have you been teaching at a university?

- ○ Less than one year
- ○ 1-3 years
- ○ 4-6 years
- ○ 7-9 years
- ○ 10-12 years
- ○ 13 -15 years
- ○ 16-18 years
- ○ 19-21 years
- ○ More than 22 years


For how many years have you been teaching online?
Less than one year
1-3 years
4-6 years
7-9 years
10-12 years
13-15 years
16-18 years
19-21 years
More than 22 years
The next section of the survey asks about online teaching.
Please click on NEXT
← Next

Do you teach an engineering unit of study online?

- ○ Yes
- ○ No

Do you teach minerals or mining engineering?

- ○ Yes
- ○ No

Is any of your teaching online?

- ○ Yes
- ○ No

For all online taught subjects do you mostly conduct online teaching from

- ○ University office
- ○ University classroom
- ○ Outside of the University (e.g. Home)

Do you think effectiveness of online teaching depends on the subject you teach online?

- ○ Yes
- ○ No

Please explain

Please write the name of each unit of study that you teach online.

Has the COVID 19 pandemic affected your method of teaching (online or on campus)?

- ○ Yes
- ○ No

Please provide comment

Did you need to provide any extra online teaching support to students during the COVID-19 pandemic?

- ○ Yes
- ○ No

Please provide comment

Did having to conduct online teaching during the pandemic cause you to be depressed, anxious or stressed?

- ○ Yes
- ○ No

Please provide comment

← Next

Please scored all of the following statements using a 5 point Likert scale with (1) strongly agree, (2) agree, (3) neither agree or disagree, (4) disagree, (5) strongly disagree or (N/A) not applicable. Please select the response that best describes your level of agreement to each statement.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
I prefer teaching online due to its flexibility	○	○	○	○	○	◉
I did not choose to teach online	○	◉	○	○	○	○
Online teaching and learning are integrated into the university's educational structure	○	○	○	○	○	○
I find the online teaching environment allows me to pace my teaching to reduce work stress.	○	○	○	○	○	○
I can avoid/minimise travel time	○	○	○	○	○	○
Able to use a variety of strategies to assess a student	○	○	○	○	○	○
It is easy to share ideas with other teachers in the online setting.	○	○	○	○	○	○
I can balance work and personal commitments while teaching online	○	○	○	○	○	○
I have no problems with online teaching	○	○	○	○	○	○
Encounter unstable internet access during class time	○	○	○	○	○	○
The technology involved in online teaching can be confusing	○	○	○	○	○	○
Online teaching takes more time than classroom teaching	○	○	○	○	○	○
It is hard to motivate and engage students in an online teaching platform	○	○	○	○	○	○
The absence of face to face interaction with students is a disadvantage	○	○	○	○	○	○
The temperature in my workplace is sometimes too hot or too cold when I am doing online teaching work	○	○	○	○	○	○
The Blackboard (online) system enhances my sense of isolation from students	○	○	○	○	○	○
Some students do not have adequate technological skills as are required for studying online	○	○	○	○	○	○
My workstation furniture is uncomfortable to use for online teaching	○	○	○	○	○	○
There is often too much noise in my workplace for me to concentrate	○	○	○	○	○	○
At times there is inadequate ventilation in my work environment	○	○	○	○	○	○
The allocated work time is not adequate to develop a new online course or unit of study	○	○	○	○	○	○
There is inadequate technical support for online teaching	○	○	○	○	○	○
Online teaching technologies are not very user friendly which makes teaching online difficult	○	○	○	○	○	○
I look for new technology to enable online teaching innovations	○	○	○	○	○	○

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
Sometimes it is very challenging to cope with the constant change/upgrading of the software	○	○	○	○	○	○
It is very stressful when there is a computer software failure during class	○	○	○	○	○	○
The software and technologies available assist me with online teaching and student engagement	○	○	○	○	○	○
Teaching online enables me to use innovative student learning assessment practices	○	○	○	○	○	○
The university offers software education before adoption of each new online software	○	○	○	○	○	○
There is inadequate time and support to learn about new technologies available for online teaching	○	○	○	○	○	○
Prerequisite technical skills are not clearly identified before beginning online teaching	○	○	○	○	○	○
There is little or no opportunity to observe other educators using technology for online teaching prior to committing to teach online.	○	○	○	○	○	○
Support is provided by the university during and after the adoption of new technology for online teaching.	○	○	○	○	○	○
There is not enough training and assistance available for the teachers who are in the transition from classroom (face-to-face) teaching to online only teaching.	○	○	○	○	○	○
An active peer-mentoring program for online university teaching and for using online technology is available.	○	○	○	○	○	○
I felt challenged when required to learn how to use new online software and this made my online teaching less effective	○	○	○	○	○	○
I have adequate computer skills to successfully manage online teaching	○	○	○	○	○	○
The technologies involved in online teaching can sometimes be confusing, so I do not use unfamiliar technology when teaching online	○	○	○	○	○	○
Online teaching methods need to be adapted to meet the needs of culturally and intellectually diverse student groups	○	○	○	○	○	○
Online teachers have the responsibility to be aware of their students' online skills; for example, mature aged students who are new to studying online at a university	○	○	○	○	○	○
As online students become more culturally diverse, the teacher's job becomes increasingly challenging and time consuming	○	○	○	○	○	○
Some online students are good communicators, engage well with the educator and other students to promote online discussion and student subject learning	○	○	○	○	○	○
Language barriers can affect my ability to interact with students who do not have English as their first language	○	○	○	○	○	○

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
Some online students require a lot of explanation to understand simple concepts and I am not provided with enough work time to be able to teach at this level	○	○	○	○	○	○
When dealing with students I sometimes misinterpret different communication styles as behavior problems	○	○	○	○	○	○
I find it challenging when university students, enrolled to study online, do not have the technology to use for online learning.	○	○	○	○	○	○
I teach students in countries where there are technology restrictions that make online teaching difficult.	○	○	○	○	○	○
I have enough work time allocated by the university to supervise research students who are off campus and studying online	○	○	○	○	○	○
There is not always adequate resources available for me when supervising research students who are off campus and studying online	○	○	○	○	○	○
Miscommunication is more likely to occur when supervising research students who are off campus and studying online than when supervising research students studying on campus.	○	○	○	○	○	○

Are you involved in supervision of online research students?

○ Yes

○ No

Previous Next

I have enough work time allocated by the university to supervise research students who are off campus and studying online

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
I have enough work time allocated by the university to supervise research students who are off campus and studying online	○	○	○	○	○	○
There is not always adequate resources available for me when supervising research students who are off campus and studying online	○	○	○	○	○	○
Miscommunication is more likely to occur when supervising research students who are off campus and studying online than when supervising research students studying on campus	○	○	○	○	○	○

Previous Next

PHYSICAL ERGONOMICS (Human anatomy fit related to physical activity)

Is the seat that you sit on for online teaching of a comfortable height and has back support? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
Are the seat height, slope and back adjustable?	○	○	
Is the seat surface of an appropriate size?	○	○	
Does the seat back provide mid lumbar support (lower back region)?	○	○	
Is the seat front well rounded and not placing excess pressure on the underside of the legs?	○	○	

Is your workstation desk an appropriate height and width to use for online teaching work? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
Is the working surface at the level of elbow?	○	○	
Does the desk width allows easy access of teaching equipment like notes, books, etc.?	○	○	
Is there enough height clearance and room for knees?	○	○	
Is the width of the work surface appropriate, such that all required task accessories can be	○	○	

	Answer	Please provide comment
	Yes No	Comment
located within comfortable reach and viewing distance?		
Is the area under the desk large enough to accommodate your legs and any accessories, such as a footrest?	○ ○	
Do you have and use a sit stand desk.	○ ○	

Do you have adequate workspace and storage for your online teaching work? Please consider the followings:

	Answer	Please provide comment
	Yes No	Comment
Is there enough room for easy access to your study resources?	○ ○	
Do you have adequate storage for your online teaching resources?	○ ○	

Is your computer screen height and angle of the screen adequate for online teaching work? Please consider the following:

	Answer	Please provide comment
	Yes No	Comment
Consider if you are you able to look straight ahead at the monitor without bending or twisting your neck or trunk?	○ ○	

Is your computer (or other electronic device) keyboard and mouse comfortable to use for online teaching work? Consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
Can you operate your keyboard and mouse whilst keeping your elbows next to your body.	○	○	
Are you able to keep your fingers, wrist and forearm in a relaxed posture while typing?	○	○	
Does your hand and fingers fit comfortably over the mouse and its controls?	○	○	

What physical ergonomic factors help to make your online teaching work comfortable?

Are there any physical ergonomic factors that can be improved to make your online teaching work more comfortable?

○ Yes

○ No

Please provide comment if there are any other physical ergonomic factors that affect your online teaching work.

Previous Next

ENVIRONMENTAL ERGONOMICS (Fitting the work environmental factors to your needs)

Is the lighting in your workplace satisfactory? Please consider the followings:

	Answer		Click to write Column 2
	Yes	No	Answer 1
Is there enough natural light or artificial light for your online teaching work?	○	○	
Is a lighting control device available?	○	○	

Do you experience glare on the screen when working online? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
Is the monitor screen placed such that light from windows and overhead lighting do not cause glare?	○	○	
If not, are glare screens or other glare reducing methods used?	○	○	
Are movable task or desk lights available?	○	○	
Do work surfaces have a matte finish to reduce light reflection?	○	○	

Do you work in a shared office? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
If you work in a shared space state how many people the office is shared with and how this affects your teaching work positively or negatively.	○	○	

Does the noise level in your workplace distract? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Answer 1
Is noise from traffic, music, people etc., distracting you when teaching, or preparing online teaching work?	○	○	

Is the room temperature comfortable? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
Is the room sometimes too hot?	○	○	
Is the room sometimes too cold?	○	○	

What ventilation type is in use e.g. natural (e.g. window / high window) or mechanical (e.g. air conditioner).

Is the ventilation (air circulation) comfortable? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Answer 1
Is air circulation sufficient?	○	○	
Is air quality satisfactory?	○	○	
Is the air too dry or too humid?	○	○	

Are there any other environmental ergonomic factors that you would consider affect your online teaching work? Please provide a comment if there are any other environmental factors that affect your online teaching work

Previous Next

ORGANISATIONAL ERGONOMICS (University organisation factors)

Does the organisation have clear policies and procedures for you to follow? Please provide comment

- ○ yes
- ○ No

Please provide comment

Are you provided with enough time to do all of your online teaching, communication and related student assessment work? Please consider the followings:

	Answer		Provide comment
	Yes	No	Comment
Consider time spent teaching online	○	○	
Student communication, e.g. through Emails, telephone calls or discussion board	○	○	
Marking student work and providing adequate feedback	○	○	
Supervising and assisting co-workers with online teaching and marking work.	○	○	
Marking moderation work.	○	○	

Are you provided with enough time to research information, develop and update your online study materials? Please consider the followings:

	Answer		Provide comment
	Yes	No	Comment
Consider developing a new online unit of study.	○	○	
Teaching preparation time.	○	○	

	Answer		Provide comment
	Yes	No	Comment
Updating an online unit of study.	○	○	

Do you experience any technical issues with the online teaching platform (for example, Blackboard)?

- ○ Yes
- ○ No

Please provide comment

Are you provided with adequate resources, including software, for online teaching?

- ○ Yes
- ○ No

Please provide comment

Are there any other organisational factors that affect your online teaching work?

- ○ Yes
- ○ No

Please provide comment if there are any other organisational factors that affect your online teaching work.

Previous Next

COGNITIVE ERGONOMICS (How people think & process information)

Are you provided with education on using relevant policies and procedures?

- ○ Yes
- ○ No

Please provide comment

Are work related documents that affect online teaching easy to understand? Please consider the followings:

	Answer		Please provide comment
	Yes	No	Comment
For example, is simple language used or is complex technical language used without enough explanation?	○	○	

Are you provided with adequate education on existing and on new technology available for use for online teaching?

- ○ Yes
- ○ No

Please provide comment

Is the information provided on the online learning platform easy to locate and use?

- ○ Yes
- ○ No

Please provide comment

Do you understand how to use all of the technology required for online teaching?

- ◯ Yes
- ◯ No

Please provide comment

Are you expected to concentrate on screen based work for more than 60 minutes without a break?

- ◯ Yes
- ◯ No

Please provide comment

Are you provided with enough information to make decisions and solve problems that occur as part of you online teaching work

- ◯ Yes
- ◯ No

Please provide comment

Are there any other cognitive ergonomic factors that affect your online teaching work?

- ◯ Yes
- ◯ No

Please provide comment

Please provide comment about any other cognitive ergonomic factors that affect your online teaching work

Previous Next

SOCIAL ERGONOMICS (Interaction with people)

For online teaching work do you work most effectively when working alone?

- ○ Yes
- ○ No

Please provide comment

Do you feel that you are provided with sufficient support and guidance for your online teaching work?

- ○ Yes
- ○ No

Please provide comment

Are you able to participate in teamwork with other online educators?

- ○ Yes
- ○ No

Please provide comment

Does a language barrier affect your ability to communicate effectively with online students?

- ○ Yes
- ○ No

Please provide comment

Do you have visual and auditory contact through the internet with students that you teach online [for example, through Collaborate Ultra video conferencing or WebEx]?

- ○ Yes
- ○ No

Please provide comment

Do you have the necessary technical infrastructure in place to communicate easily with students studying online and with staff for educational updates & sharing information?

- ○ Yes
- ○ No

Please provide comment

Do you feel isolated when teaching online units of study?

- ○ Yes
- ○ No

Please provide comment

Do cultural differences affect your online teaching?

- ○ Yes
- ○ No

Please provide comment

Are there any other social ergonomic factors that affect your online teaching positively or negatively?

- ○ Yes
- ○ No

Please provide comment if there are any other social ergonomic factors that affect your online teaching.

Rank the importance of each Ergonomic Factor with 1 the most important and 5 the least important for providing safe, healthy, effective online teaching.

	1	2	3	4	5
Physical	○	○	○	○	○
Environmental	○	○	○	○	○
Organisational	○	○	○	○	○
Cognitive	○	○	○	○	○
Social	○	○	○	○	○

Previous Next

Please list answers to the following questions in the comment box under each question

What engages you most in teaching in an online teaching and learning environment?

If none, what are the relevant ergonomic factors that might have caused this?

What differences have you found between traditional classroom teaching and online teaching in the areas of course materials, assessment methods, and support from co-workers, teaching satisfaction and any ergonomic factors?

In the online teaching environment what helps you to teach most effectively and why?

Describe any barriers you have experienced in online teaching and why these were barriers.

If you did experience a barrier how did you overcome this barrier?

Thank you for taking the time to complete the survey!

Previous Submit

List the most important factors you consider are required to enable you to teach successfully online.

Previous Next

APPENDIX 9 APPROVAL FOR CURTIN UNIVERSITY STAFF TO BE RESEARCH PARTICIPANTS.

From: Julie-Ann Pegden <J.Pegden@curtin.edu.au>
Sent: Tuesday, 9 June 2020 8:57 AM
To: Mitali Ghosh <mitali.ghosh@postgrad.curtin.edu.au>
Subject: 190806 Req No 2019_131 An Evaluation of University Educators Perception of How Ergonomic Factors Affect Online Teaching. (Mitali Ghosh)

Dear Mitali

Thank you for notifying us of your intention to use approximately 120 Curtin staff for research purposes.

Based on the information provided, please consider this email to be approval for your project (you do not require anything else from us).

Approval is subject to meeting the Disability Access and Inclusion Plan (DAIP) Requirement as detailed here: http://planning.curtin.edu.au/mir/surveyapprovals.cfm#what.

Please note:

- When completing the survey approvals form you were asked for up to 5 key words to describe your research. These key words (along with your contact details and project summary) will appear in our register of approved activity which will be uploaded to our website at the end of every month. You may wish to view this register to see what other researchers are doing and/or find opportunities for collaboration https://planning.curtin.edu.au/mir/surveyapprovals.cfm Please contact us if you do not wish for your project details to appear in this register.

- Ethics approval: If you can **please provide us with your ethics approval number** (if applicable) once this is available so that we can update our register, this would be appreciated.

- Promotions to Staff**:** We note that you have indicated **Email** as a proposed recruitment method. Please note that emails en-masse to staff are generally discouraged/not permitted by the Internal Communications team. They can provide you with advice, tools and information to effectively deliver communications to staff via channels such as Curtin Weekly and the Staff Portal. For more information please visit https://brand.curtin.edu.au/requests/internal-communications/ or contact internalcommunications@curtin.edu.au.

- Curtin Survey Approvals process approves research activities, samples, and research timing as specified in the application. Survey Approvals does not guarantee researchers the access to any information (e.g., lists of contact details of participants etc.) that will facilitate stated research activities. Whether requested information is allowed access should be liaised with the data owner, and it is eventually up to the data owner's discretion and consideration of relevant rules of the university and work areas. The Office of Strategy and Planning does not have authority in issuing access to any information or data that is beyond its work scope.

Best wishes with your study.

Kind regards

Julie-Ann

Julie-Ann Pegden
Evaluation Analyst/Coordinator | Office of Strategy and Planning
Curtin University
Tel | +61 8 9266 1317
Email | J.Pegden@curtin.edu.au
Web | www.evaluate.curtin.edu.au/

APPENDIX 10 ETHICS APPROVAL

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

08-Oct-2020

Name: Apurna Ghosh
Department/School: WASM: Minerals, Energy and Chemical Engineering (WASM-MECE)
Email: Apurna.Ghosh@curtin.edu.au

Dear Apurna Ghosh

RE: Ethics Office approval
Approval number: HRE2020-0585

Thank you for submitting your application to the Human Research Ethics Office for the project **An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors**.

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007).*

Approval is granted for a period of one year from **08-Oct-2020** to **07-Oct-2021**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Ghosh, Mitali	Student
Ghosh, Apurna	CI
Jansz, Janis	Co-Inv

Approved documents:

Document

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)

4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

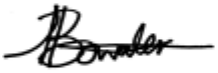
Special Conditions of Approval

It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

This letter constitutes low risk/negligible risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

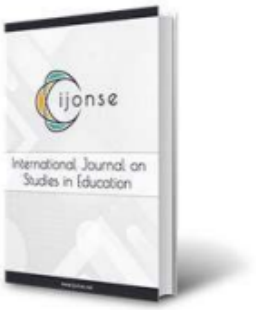
Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely



Amy Bowater
Ethics, Team Lead

APPENDIX 11 PUBLISHED ARTICLE



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Effect of COVID-19 Pandemic on Traditional Teaching

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Effect of COVID-19 Pandemic on Traditional Teaching

Mitali Ghosh, Janis Jansz, Apurna Ghosh

Article Info

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Received:
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Keywords

Traditional teaching.
Online education
COVID-19 pandemic.

Abstract

COVID 19 made a great impact on education system especially on the university education system globally. The purpose of this systematic review of published literature was to trace the history of university teaching and examine the effects of the COVID 19 pandemic on traditional teaching. Systematic review started with 720 articles and ended with the inclusion of 136 articles based on bibliometric search process. Important understandings generated are that educational methods are constantly evolving as what the ruling society values changes and when new technologies that can be used for teaching are invented. Conclusions were that this deadly pandemic overturned the traditional offline teaching and learning process and facilitated the introduction of emergency online educational platforms to be used for university teaching and student learning.

Introduction

Education began with parents teaching their children how to survive. As more knowledge became available, as well as being a parental responsibility, education became a community and then a society activity. Socrates (469–399 BC) is one of history's earliest educators whose teachings are known today. He was born in Athens of a stonemason, but grew to become one of the most influential educators of his time. Socrates believed that education helps to mould an individual by providing the knowledge to understand and determine the pathway to achieve goals and destiny. Today's education assists with indoctrinating social responsibilities, developing communication skills, critical thinking and scientific understandings. Learning is the key principal of education that is a progression of obtaining knowledge or expertise through study, involvement, or being taught. Education connects an individual to nature and to the society where the person lives, creates and acts (Radha et al., 2020). The purpose of this systematic review of published literature was to identify how tertiary education has changed from ancient times, using Indian education as an example, to the use of the internet in the times of a global COVID-19 (Corona Virus Disease of 2019) pandemic. Disasters like fire, war, earthquake, flood or pandemic can interrupt teaching and learning for weeks to months, sometimes even longer (Dohaney et al., 2020). Resilience to any kind of disruption can also be identified as institutional (Bates, 2013), instructional, and/or academic continuity (Houston, 2016; SchWeber, 2013). Academic continuity can be defined as the competency of institutions and academics to be able to continue their educational delivery system while undergoing a disruptive incident. In Australia the first COVID-19 cases were reported in end of January 2020 (World Health Organisation [WHO], 2020). Cases were related to people travelling for tourism, work or study.

Most of the universities first adopted a wait and watch approach (Truu, 2020). Social distancing and months-long quarantine forced the academics working in higher education to transition themselves to fully operational online tutors. Due to this pandemic revolutions in academia and higher education, which would have typically taken several years due to the numerous administrative regulations, were introduced promptly within days. This is a clear example of the Schumpeterian 'creative destruction' in making that will forever change the status quo in academia and higher education (Schumpeter, 1942; Strielkowski, 2020, p. 5). Academics became responsible for upskill their digital proficiencies, developing new study materials to changeover from traditional face-to-face and blended programs to a distant and/or online education delivery mode (Pather et al., 2020).

Due to the COVID-19 pandemic crisis online teaching and learning became a compulsory component of educational institutions including schools, colleges, tertiary educational institutions and universities globally. The outbreak of this deadly virus forced shut down of educational institutes globally to control the spread of the virus. This situation forced the teaching professionals to come up with an alternative method of teaching during the lockdown period thus the traditional teaching changed to web-based teaching and learning where the teaching academics and students connected virtually (Bakker & Wagner, 2020). The Covid-19 pandemic caused traditional classes to 'move online' in an essential high-priority manner (World Health Organization, n.d.), which resulted extra stresses and workloads for university academics who were already struggling in order to balance teaching, research and administrative responsibilities, as well as having work-life balance (Houston et al., 2006; Houlden & Veletsianos, 2020). Educators from all backgrounds and age group were required to develop and implement their scheduled classes from home, while all the practical and technical hurdles had to be overcome without the required technical support from the institution (Hodges et al., 2020). Not all university educators had the pedagogical content knowledge (PCK) required for online teaching (Angeli & Valanides, 2005; Kali et al., 2011; Ching et al., 2018; Shulman, 1987) which included the knowledge of the technical and administrative features of online teaching such as establishing workflows, using particular technical platform and tool etc. Ocak, (2011) and Ching et al., (2018) wrote that the complex nature of the instructional situation and inadequacies in planning and organization are some of the main difficulties described by university teachers with respect to transforming their teaching to web-based courses The COVID-19 crisis has contributed to a profusion of advice to assist teachers (Bates, 2020) with the majority focused on the tools and materials which a teacher can use while replacing their face-to-face classes with online classes (Rapanta et al., 2020).

Literature Review Methodology

To identify the transformation of teaching methods a systematic review of published literature was conducted. The steps suggested by Creswell and Creswell (2017) were incorporated to identify and review the research topic. The methodological procedure contained the following steps:

1. Identify studies and key words; search databases and websites using these keywords
2. Select a minimum of 50 research studies; prioritise them; validate the abstracts, contents and conclusions
3. Plan and design a literature map to visually represent the groupings
4. Review and consolidate the literature into themes and concepts to identify opportunities

Literature Identification

The literature review was initially instigated by evaluating seven articles related to ancient education systems, shifting from traditional education systems to online education systems and how COVID-19 pandemic effected academic systems by promoting physical distancing to help minimise the virus spread (Mefodeva et al., 2017; Harasim, 2000; Radha et al., 2020; Bakker & Wagner, 2020; Strielkowski, 2020; Griffin, 2020; Hodges et al., 2020). While looking for more information about ancient education systems and transition to online education systems the keywords used were 'Ancient Educational System', 'Ancient Education in India', 'Traditional Teaching' 'Online learning', 'Online teaching', 'digital education', 'online higher education', 'online educator', 'instructional design', 'remote teaching', 'work practices of online educators', 'Shift from traditional education system to online', 'Digitalisation', 'COVID-19', 'Pandemic', 'Social distancing'.

Selection and Validation

The selection process was completed using the following selection and validation steps (see Figure 1):

- Step 1, the abstracts of the research papers and introductions were evaluated based on their concept, e.g. if the literature was not designed to explore the traditional education system or not related to online teaching and learning or not relevant to the pandemic, then it was excluded.
- Step 2, the content of the literature was evaluated for significance to the research topic, excluding those that were not valid.
- Step 3, literature centred on gradual change of traditional education systems through to online education was included, while the literature focused on online students or school level education was excluded.

When selecting the published literature, the focus was to explore the history of traditional teaching in an ancient education system with gradual shifting towards online teaching and learning and how COVID-19 pandemic effected traditional education. The article selection process used a bibliometric search which included:

(i) Time perspective: The articles chosen for this review process were published between the years 1940 to 2020.

(ii) Assortment of database: In this study of published literature, papers were obtained from Science Direct, Web of Science, Google Scholar, and for contemporary COVID 19 information newspaper articles and published university communications.

(iii) Range of journal: Journals chosen focused on relevant areas, including Traditional education, tradition teaching methods, history of online education, online teaching, effect of COVID-19 pandemic on educational institutes, emergency remote teaching and learning. At the end of this process a total of 256 peer-reviewed journal papers were selected for further analysis.

(iv) Selection of articles: The following title and keyword search functions were used. "Traditional teaching vs online teaching" OR "Transformation of learning" OR "Impact of COVID-19 pandemic on education" OR Keywords "e-learning" AND "history of education" OR "COVID-19 impact". Initially, a total of 615 articles were found while searching by title. The following flow chart shows the method of published literature selection, quality assessment, data extraction and analysis for this review.

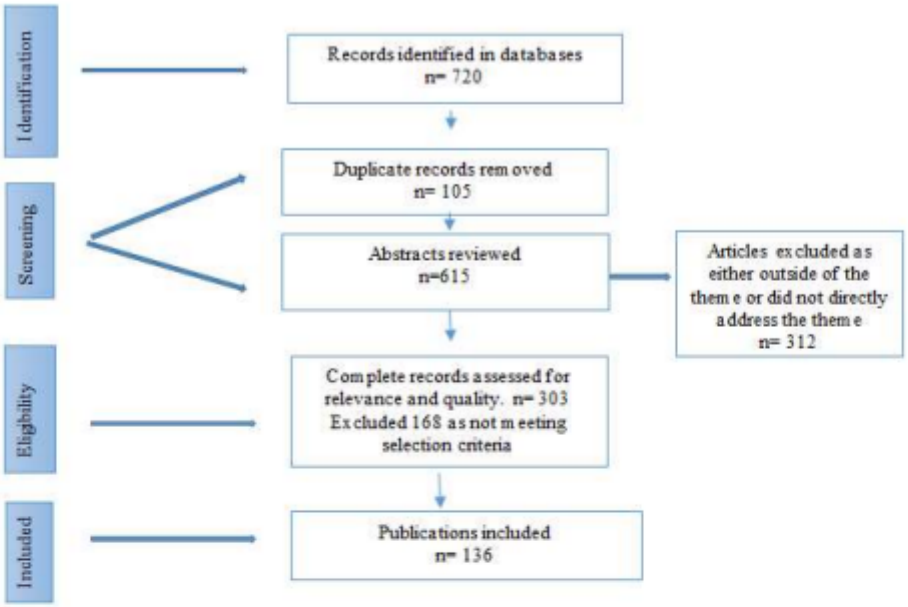

Figure 1. Flow Chart Depicting the Article Search and Selection Procedure

The first section of the review describes the history and gradual transformation of education using the country of India as an example for past educational practices.

Results and Discussion

Method of Education and Role of Educators in Ancient Times in India

Developing the students to be useful and spiritual member of the society was the main aim of ancient Indian education (Rangachar, 1964). Teaching them about the community and societal responsibilities was also a part of the ancient Indian education system. Students were constantly reminded that they are an integral part of the society thus they have some duties towards the society and they should not live a self-centred life (Mookerjee, 1989). The main aim of the ancient India's education system (Taittiriya Upanishad) was to help developing the mind and soul of individuals as well as human values such as faith, admiration, trustworthiness, self-respect, and politeness which were a very important part of their free and advanced society (Markandan, 2001). The convocation address mentioned in Taittiriya Upanishad provides an idea on the specific qualities needed for students to graduate. It is significantly similar to the requirements of modern educational systems (Markandan, 2001).

The Indian history of education can be distinguished with seven time periods as follows:

i) 2000 – 1400 BC – The Vedic education system (Chand, 2000; Sharma & Sharma, 1996). In this era the main belief of education was to develop learners' ethical, intellectual and physical abilities in such a way

that they can be an essential part of the community. In ancient epics such as "Bhagavata - Purana", "Mahabharata," "Bhagavad - Gita", comprehensive characteristic of Vedic education can be found.

ii) 1400 – 600 BC - Post-Vedic system of education (Chand, 2000; Sharma & Sharma, 1996). The main objective of post-Vedic education system was to transfer skills and knowledge to new generations through rituals, which included studying sacred materials such as the Brahmanas and the Upanishads (Sharma & Sharma, 1996; Singh, 2008), also maintaining a strict lifestyle. The main role of education was to provide for the mental, spiritual, moral and physical development of the learners. The streams of the educational program were divided on the basis of the caste of the students. Brahmans were authorized to receive intense academic and spiritual knowledge and their starting age was to be 8 years. Kchatriyas and Vaishyas started their educational journey by 11 and 12 years of age accordingly. Their educational program was less intense and professional oriented. Military discipline education was for the Kchatriyas, whereas agriculture, trade and commerce education was for Vaishys (Dzhurinsky, 1998). The students studied in teachers' residence which were generally built in an order to make the students feel at home and part of the family. This way teachers could able to help in all round developments including good habits, feeling of sacrifice, social service and develop skills that would be useful in life. Students were responsible for helping with the household chores of their teacher, which was described as the internship part of their study. This internship structure was constructed to provide maximum spiritual closeness of a teacher and a student (Albedil, 2003). The educational syllabus was predominantly religious in nature, but it also had subjects like astronomy, geometry, philosophy, mathematics, etc.

iii) From approximately 600-500 (200) BC – was the Brahmanic system of education (Chand, 2000; Sharma & Sharma, 1996). It was an advanced form of Vedic education. Subjects like Sanskrit, Arithmetic, Geometry, Astrology, Economics, History, Politics, Agriculture, Military science and Philosophy were instigated, on top of the 'Vedas' education system. Sanskrit language was taught as the main language of communication and at that time scientists wrote many sacred literatures (Chandra & Sharma, 2006; Singh, 2008).

iv) 500 (200) BC -1200 A.D. – The Buddhist system of education prevaled (Chand, 2000; Sharma & Sharma, 1996) and a new era started in the Indian history. A significant change was noticed in spiritual and economic life of the population due to emergence of this new religion which was against the inflexible caste system and supported equal birth rights of all individuals born in India (Antonov, 1973). New educational institutes were introduced for higher education like modern universities where students at the age of 16 could enrol, irrespective of any caste. Buddhist monks provided the education. Though the Brahmanic and Buddhist systems were different the Buddhist education system did not overpower the Brahmanic system; rather they admired each other and established an integrated system.

v) 1200 - 1700 A.D. – was the time of the Muslim system of education (Chand, 2000; Sharma & Sharma, 1996). A new era emerged with the Muslim/Mughal rule in India, and the Brahmanic and Buddhist systems of education were phased out. The Muslim and Mughal rulers introduced maktabs, madarsas and libraries. The Mughal emperor Akbar was considered to be the most important personality in terms of development of literature, culture and civilization. He put education at the forefront irrespective of religion. The main purposes of education during this period were to help the rulers to strengthen their position in the social and political circles (Chandra & Sharma, 2006). Generally, schools and madrasas

were the places for education. Students were provided with primary education along with the study of religion, reading, writing, arithmetic, Arabic and Persian languages. Schools were only for boys but in royal and wealthy families the boys, as well as girls, received education at home from a home tutor (Fakhrutdinova & Kondrateva, 2016). The extended syllabus included Grammar, Logic, Philosophy, Literature, Medicine, Astronomy, Greek, Agriculture, etc. Information was communicated verbally (Singh, 2008).

vi) 1700 – 1947 A.D. – was the period of British colonialism (Chand, 2000; Sharma & Sharma, 1996). This period was considered as the British invasion period. Students continued getting traditional education as well as being prepared to be able to work for the British government (Chaube, 2005). Indian nationalism started in the period of 1901-1920. The situation of India then tensed until independence in 1947, so there was very little improvement in education. With independence India inherited the British education system, which had a lack of philosophy and mechanism so reorganizing the educational system became the main focus of the Indian Government (Subramanian, 2001).

vii) In 1948 when India achieved independence the modern Indian education system started (Chand, 2000; Sharma & Sharma, 1996). Committees on education and training for primary, secondary, high school and universities were formed by the Indian government which established curriculums for the restructuring of education, allocating education into five-year periods.

Table 1 describes the basic differences between ancient education system and modern education system.

Table 1. Difference between Ancient and Modern Education System in India

	Ancient Education System	Modern Education System
i)	Bachelor students (Brahmachari) used to learn under the observation of Guru while residing in Gurukul	In modern days the majority of students travel approximately 25 to 50 km or more daily to attend school or university
ii)	All the education was taught orally and transmitted from one generation to next generation.	From early childhood students need to carry heavy bags filled with learning materials
iii)	There was no compulsory regular fee structure to attend gurukul but after finishing their education students used to offer Gurudakhina as per their affordability to show their respect.	A fee is compulsory for private education. Students must pay a small amounts to public educational organisations, which is not always affordable for everyone.
iv)	The educational system required an open environmental set up. The environment was not competitive, so students were not bothered. They received educational knowledge, social skills as well as job skills while attending Gurukul.	There is competition with each other which affects the students as well as their parents. In educational institutes developing job skills are not always part of mandatory education.

Note: Adopted from "Education System in Ancient India", by Dr. J. C. Tamboli, 2015, *Thematics Publications Pvt. Ltd.*, Copyright©Vishwbharati Research Centre.

Worldwide educationists are struggling to find solution of a central and comprehensive question which is 'what kind of education is needed for what kind of society of tomorrow?' (Bhatta, 2009, p 2). Due to global economic, environmental, and social accelerating change and tension, there are constant changes in educational systems. Some principles which are common and universal for everyone such as the educators, citizens and policymakers include the United Nations values of constitutional rights, acceptance, understanding, equality, accountability, universality, cultural integrity, the search for harmony, conservation of the surroundings and sharing of knowledge (Bhatta, 2009; Kapur, 2007; Mukhopadhyay, 2008; Pankajam, 2001). The Swiss humanitarian Johann Pestalozzi, the transcendentalists of America, Upanishadic philosophers of India and many advocates of the 'progressive' education movement have made it clear that education should be treated as the art of nurturing the ethical, emotional, physical, psychological, artistic, and spiritual—above all intellectual—scopes in the process of developing a young human being (Scott and Martin, 2004). The teacher in holistic education systems is often treated as a friend and mentor rather than a person of authority who has all the controls (Bhatta, 2009).

History and Gradual Transformation of Education to Modern Day Online Education

Traditionally, higher education institutes were developed to educate learners for lives of public service, provide advance knowledge through research, and to cultivate leaders for various extents of the public service (American Council on Education, 1949). Modern day universities, however, are mainly focused on preparing graduates with the knowledge/information, skills, and ethical accountability to fulfil the future workforce requirements to their society and to contribute fully to the global economy (Spellings Commission, 2006). The rise of new privatization, commercialization and corporatization of education are the result of the twofold role which has changed the higher education's traditional duty and has amplified the mission diversity in the process of preparing all graduates for independent contribution, dynamic social responsibilities and personal development (Kezar, 2004; Lambert, 2014). Tertiary education institutions and universities are under constant pressure to endorse the access and affordability to university/other tertiary institution education as well as to improve individuals' basic aptitudes and personalities (i.e., "noneconomic" benefits), which can be described as: the capability to think rationally, the ability to experiment the eminence quo and the aspiration to develop cultured values to enable the student to enter into the extremely competitive employment market (Brennan et al., 2013; Selingo, 2016; Tilak, 2008; Washburn, 2005). To deal with rapid change in environments of industrialization, today's workforce requires skilful employees at all levels (Ramley, 2014b). To achieve present requirements higher education institutions are re-examining and regenerating their programs of study, pedagogy and assessment policies to ensure that all students get their preferred aspects and proficiencies to contribute to the global economy and participate efficiently in social equality (Fein, 2014; Kirst & Stevens, 2015; Roksa & Arum, 2015).

Today university educators are expected to have competency-oriented skills and ability to empower the students to actively participate in learning process (Santos et al., 2019). The teaching methods are created by conception and strategy (Prosser & Trigwell, 2000). From a knowledge transmission standpoint, teaching normally has a content approach, where students are observed as passive receivers of knowledge (Santos et al., 2019). Universities have evolved in four generations to reach their present state. As stated by Wissema (2009), the

evolution of universities can be described as commencing as medieval type and progressing to research universities (Humboldt-type universities) and then to the high-tech, science and technology driven entrepreneurial teaching and research universities. The latest new stage of the evolution in academia and higher education is online and digital educational universities (Wissema, 2009; Strielkowski, 2020) as shown in Figure 2.

Figure 2. Stages of Evolution

Note: Adapted from "COVID-19 pandemic and the digital revolution in academia and higher education," by W. Strielkowski, 2020, *Preprints*, (doi:10.20944/preprints202004. 0290.v1), © 2020 by the author(s). Distributed under a Creative Commons CC BY license.

The internet plays a very important role in availability of the resources for research and learning for both educators and learners to be able to share and gain information (Richard and Haya, 2009). Technology-based e-learning incorporates learning by using the internet, intranet and other technologies to prepare study materials for learning, teach the learners and to standardize courses in an organization (Fry, 2001). The long history of gradual development of online learning is shown in Table. 2.

Table 2. Computer Networks and Online Education: History and Overview

Year	Commencement
1861	Telegraph is invented
1969	Advanced Research Projects Agency Network (ARPANET) begins. This was the technical foundation for the Internet.
1971	Email is invented
1972	Computer conferencing is invented
Mid-1970s	University courses are supplemented by e-mail and computer conferencing
1981	First totally online course (Adult education) called The Source.
1982	First online program (Executive education). Titled Western Behavioural Sciences Institute [WBSI] Executive Education (IEIS)
1983 -1989	Networked classroom model emerges (Primary and secondary education) 1983 InterCultural Learning Network [ICLN]: Research Project in 4 countries 1983 ReÂseau d'Ateliers PeÂdagogique Pilote [RAPPI]: Canada-X-Cultural Project in 5 countries 1985: National Geographic Society Kids Network 1987: American Telephone & Telegraph Company [AT&T] Learning Network 1988: Writers in Electronic Residence (WIER) 1989: NUC in British Columbia, Canada

Year	Commencement
1984	First online undergraduate courses. Called Virtual Classroom (NJIT)
1985	First online graduate courses. Nova South Eastern University Connect-Ed (New School of Social Research) OISE (University of Toronto)
1985	First labour education network. Titled Solinet and was for Canadian Union of Public Employees
1986	First knowledge building network and was called CSILE (OISE)
1986 - 1992	Online professional development communities emerge 1986 OISE Ontario Educators Online Course 1990 Global Lab, Lab Net And Star Schools, Technical Education Resource Center [TERC] 1992 Educators Network of Ontario
1986 -1989	First online degree program 1986 Connect-Ed (New School of Social Research). 1989 University of Phoenix Online
1989	Internet in launched.
1989	First large scale online course. Open University (UK)
1992	World Wide Web is invented. Conseil Européen pour la Recherche Nucléaire [CERN (Switzerland)]
1993 - 1998	First national educational networks. 1993 SchoolNet (Canada). 1995 Tele-Learning Network of Centres of Excellence [TLNCE (Canada)]. 1998 CL-Net (Europe)
1996	Virtual-U Research Project .
2000	COVID 19 pandemic with physical distancing requirements.

Note: Adapted from 'Shift happens Online education as a new paradigm in learning,' by L. Harsasim, 2000, *Internet and Higher Education*, © 2001 Elsevier Science Inc. All rights reserved

The telegraphy 150 years ago and now computer communication were revolutionary changes. E-mail and online learning platform discussion boards are the main individual communication networking application used in the field of online education while computer conferencing is used for group communication in online education for a collaborative learning environment. Computer conferencing was designed by Murray Turoff to be a ``collective intelligence'' system to be able to structure group communication for problem solving as well as for exchanging information within the group (Hiltz & Turoff, 1978).

In mid-1970s the adoption of computer networking for educational purposes began, after the invention of packet-switched networks in 1969 (Harasim, 2000). Scientific researchers, the majority of whom were from academics' backgrounds, were involved in experimenting with ARPANET, introduced e-mail and computer conferencing in their courses and by involving their students with the larger information community extended the opportunities for the student communication, interface and for teamwork (Harasim, 2000). K-12 schools started adopting network communication in the early 1980s and initiated an exclusively new methodology in online education where teachers and learners jointly launched writing and research projects (Harasim, 2000). The first fully online courses commenced in 1981 with non-credit ``mini-courses'' and executive training

programs (Harasim, 2000*)*. The Online Executive Education program was one of the first online program launched in 1982 by the Western Behavioural Sciences Institute (WBSI) (Feenberg, 1993). The first WBSI-associated faculty experienced many difficulties while trying to master the online environment as no one had tried to teach fully online courses before, nor had anyone studied in an online environment (Feenberg, 1993). Educators were proceeding blindly without having any background, base of knowledge or guidance (Feenberg, 1993). Relevant important matters surfaced from the failures such as long word-based ``lectures" are not suitable for online studies, also questions and answers do not appear on their own resulting long virtual silence due to non-participation of the students (Feenberg, 1993). Finally the group learning activities, such as discussions were introduced by the faculty and this proved to be an effective way to promote online learning (Harasim, 2000).

Canadian ReÅseau d'Ateliers PeÅdagogique Pilote (RAPPI) network (1985 ±1987) was one of the earliest examples of a network which connected the teachers and students of around 70 secondary schools in Canada, England and Italy (Harasim, 2000). With continuous growth in accessibility to computers, educators acknowledged that a wide range of activity can be performed by moulding the cyberspace according to the need (Harasim, 2000). It had also been realized that online education was a distinct field and educators started exploring how it could empower students to socialize in this new domain (Harasim, 2000). From the early 1980s, a powerful new mode of learning: online collaborative learning was developed as a result of creative applications of computer conferencing in university courses (Bradsher, 1996; Feenberg, 1993; Harasim et al., 1995; Hiltz, 1994; Hiltz & Wellman, 1997; Khan, 1997; Mason & Kaye, 1989). In 1989, the first application of computer conferencing was launched by the Open University in a large-scale distance education course which allowed access to 1,500 students with their tutors and supported peer discussions online. By mid-1980s many other experimental online applications surfaced with Solinet as one of the first wide-scale online labour education programs (Harasim, 2000). A variety of professional development networks were launched, which acted as a base for online learning environments (Camarinha-Matos *&* Afsarmanesh, 2005*)*. In the 1990s other significant firsts in online educational activities surfaced. For example, Canada's SchoolNet, (a national educational networking programs) which was a first step in networking all schools, museums, libraries, and aboriginal communities in the country (Harasim, 2000). In 1995 major online research programs, such as the Tele Learning Network of Centres of Excellence (TLNCE) were launched (Harasim, 2000). In 1996, field testing, such as Virtual-U field trials were introduced (Weiss, et al., 2007). Distance education was introduced around two centuries ago and within this period of time it had changed significantly in how learning occurs and information is communicated (Spector et al., 2008).

Transition from Face-to-face Traditional Education towards Online Education

Distance learning started as basic correspondence course through postal service, which then started using a wide variety of tools to improve (Moore, et al. 2010). Distance learning generally describes providing access to education to people who are geographically or physically distant (Moore, et al. 2010). The development of the World Wide Web in 1992 made online education increasingly accessible and permitted new pedagogical models to emerge (Harasim, 2000). An enormous expansion as well as innovations in distance education were seen to

emerge in the years between 1980 and 1990 in online education and networking fields (Harasim, 2000). Due to increasing accessibility of new technologies the term 'distant learning' then evolved to define other forms of learning, such as, e-Learning, online learning, mediated learning, learning through technology, online collaborative learning, virtual learning, web-based learning, etc. (Conrad, 2006). The cohesions found within all the definitions is that they are a form of instruction which occurs between two parties (a learner and an instructor) and are held at different times and/or places, and use different forms of instructional materials (Moore, et al. 2010). In the 21st century, there has been a paradigm shift in attitudes towards having an online education system so online learning is no longer peripheral or auxiliary but a vital part of today's conventional education system (Al-Samarraie et al., 2017).

The origin of the online education system was believed to have commenced in the late 1960s to 1971 with the development of network communication, invention of e-mail, packet-switched networks and these technological inventions open up a unique opportunity to be able to communicate and cooperate with peoples in different places and different time zones (Harasim, 2000). The 1980s and 1990s symbolized as an era of powerful improvement and growth in online education system and networking within schools and tertiary educational institutions, professional fields, workplaces and mature educational facilities (Harasim, 2000). Electronically supported learning (e-learning) provides a learner-oriented teaching/learning processes which is an internet-based education method that was first introduced in 1999 in a computer based training program seminar and was made popular as an educational tool in the 1970s by the Open University in Britain (Ong et al., 2004). E-learning teaching and learning systems can be used anywhere and anytime, with the use of the internet and allows diverse and geographically dispersed students to be provided with education in a cost-efficient manner (Ong et al., 2004). The changing mindsets towards online education and affordability of it helped in developing new pedagogical models in early 21st century (Harasim,2000). A vital transformation in learning environment emerged, and this change became global as educators and learners worldwide accepted and helped implementing e-learning through networking (Harasim, 2000).

The term online learning surfaced in the beginning of 1980, however there is no clear disclosure of the origin of the term E-learning (Harasim, 2000). Due to the continuous evaluation of learning technology and the fields associated with it, the researchers are still struggling to settle on a common definitions and terminologies (Lowenthal & Wilson, 2010; Volery & Lord, 2000). As a result, the terms are often interchanged between distance learning, E-Learning and online learning (Moore, et al., 2010). According to Dublin (2003) the existing definitions were inclined to acknowledging the specialization and interest of the researchers. A range of applications, learning methods and processes are described as an E-learning concept (Rossi, 2009). Therefore, it is not easy to locate a mutually accepted definition for the term E-learning, as stated by Oblinger and Oblinger (2005) and Dublin (2003), as cited by (Arkorful and Abaidoo, 2015, p 1). Majority of the authors describes online learning as access to learning experiences through the use of some technology (Benson, et al. 2002; Carliner, 2004; Conrad, 2002). Benson, et al. (2002) and Conrad (2002) both recognize online learning as a more recent version of distance learning with an improved access to educational opportunities for learners identified as both non-traditional and marginalized. Whereas other authors argue that it is not only the accessibility of online learning but also its connectivity, flexibility and ability to encourage diverse

communications (Ally, 2004; Hiltz & Turoff, 2005; Oblinger & Oblinger, 2005). Most of the authors believe that a relationship between distance education and online learning exists but seem unsure in their own descriptive descriptions (Moore et al., 2010).

Online education was one of the first users of the e-mail invention and the development of email is entangled with the history of computer networking. Network communication was the result of the research performed to form wide-ranging opportunities for 'meetings in mind', participatory government and interrelated social and cognitive communities (Hafner & Lyon, 1996). Online education has been criticized with tough questions during its 25-year history and this led to innovate numerous models of online education to develop new approaches for teaching and to make learning more effective (Harasim, 2000). From 1980 to 1990 the educational field experienced revolutionary changes that caused the media and some faculty members who felt that less well-trained staff were appointed to replace them, to raise questions about the quality and the value of online education (Harasim, 2000).

According to Bonk and his colleagues (1998, 2000), online teachers and mentors provide cognitive support to students by providing educational courses which includes acknowledgement, interrogating, providing direct instruction, use of different illustrations, acclaim, restructuring assignment, seeking explanation, investigation and instigating conversation. Teachers also help to build up the social presence and teaching presence in online teaching environment (Dunlap and Lowenthal. n.d.). Generally verbal and nonverbal teaching behaviours are referred as the physical and psychological (e.g., compliment, using humorous comments, sustaining physical immediacy, making eye contact etc.) link between teacher and students in face-to-face teaching platform (Christophel, 1990; Weiner and Mehrabian, 1968). However, as identified by LaRose and Whitten (2000), online teachers use different types of media settings such as text-based, audio and video to improve their immediacy due to the absence of physical proximity. In the text-based platform the instructors use examples with personal experience and ask questions, etc., whereas in video they use movements, smiles and have a comfortable attitude. Originally social presence theory (Rice, 1992; Short et al., 1976) defines 'how students could connect socially and emotionally with their instructors and peers in an electronically mediated course despite physical distance' (Whipp & Lorentz, 2009, p 4).

Differences between Emergency Online Education as a Response to Pandemic and Typical Online Education

During March 2020 almost all countries globally replaced traditional face to face education delivery system with online distance education delivery mode as an infection control measure against the spread of the COVID-19 virus which is mainly spread by respiratory droplets breathed out by the infected person (CSIRO, 2020). At 20^{D}C COVID-19 survives for more than 28 days on nonporous surfaces such as stainless steel, glass, vinyl, paper, polymer banknotes and survives for even longer at colder temperatures (CSIRO, 2020). Though many countries have been encountered a number of natural and man-made disaster prior to this pandemic, online distanced learning was not implemented as a solution for that particular crisis. Crisis distance education (CDE) is exceptional by both in its philosophies as well as in its procedure. The main differences can be described as

i) The unexpectedness of shifting traditional education mode to online distance education mode. Crisis distance education has been introduced in schools and other institutions without any previous regulations or procedures. It has been 'pushed' into the society without providing necessary skills and knowledge (Rangiwai, 2020).
ii) Internationalisation was another difference where crisis distance education was imposed globally as a non-pharmaceutical intervention. It was an international concern rather than institutional concern (Bates, 2020).
iii) Online learning became popular as a noncontact way of continuing education (Dohaney, et al., 2020).
iv) Expansion of online distance education was huge as it reached out to all schools and other educational institutions beyond its normal zone. Online education was common in the higher education field, but it was new for other school levels of education, especially for the primary schools. In the COVID-19 pandemic online distance education became mandatory for students of all age group, from kindergarten to doctoral level in many countries (Adedoyin & Soykan, 2020).
v) Fifth difference is imposition. Crisis distance education was enforced in many countries as a national, top-down 'draconian measure' (Taylor et al., 2020, p.1). Distance education became 'mission-critical' by shifting from its original state as being 'good-to-have' to 'mission-critical' (Cornock, 2020). Distance learning was enforced as a primary means to complete individuals' educational needs.
vi) The medical emergencies were the sixth difference. Generally, the main reasons for distance education depend on geographical isolation, flexibility, disability etc. but during the global COVID-19 pandemic it was used as a tool to deal with medical emergencies and tragedy (Al Lily et al. 2020).

Online TEACHING during COVID-19 Pandemic

The announcement on 30th January 2020, from World Health Organisation (WHO) of COVID-19 as a pandemic (Sohrabi et al., 2020), affected many global sectors and global systems which included, but was not restricted to, healthcare systems (Holshue et al., 2020; Peng, et al., 2020), agricultural sectors (Bhosale, 2020), manufacturing (Knieps, 2020), energy (Mohamed, 2020), socio-economic systems (Buck et al., 2020; Nicola et al., 2020) and the global education systems from pre-school to the university level followed by cancellation or postponement of various academic conferences world-wide (Impey, 2020; Panesar et al., 2020). Social distancing measures were introduced to minimise the spread of the virus which resulted complete closure of schools and other academic institutions (Alsafi et al., 2020; Harvard University, 2020; Pather et al., 2020), which affected approximately 900 million students world-wide (UNESCO, 2020). In order to cope with the situation all educational institutions, from pre-school to university switched their instructional platform to a remote learning/online platform so that students could study from their home while maintaining the social distancing and avoid the spread of COVID-19 (Ribeiro, 2020). Switching from traditional face to face instructions to online or remote delivery was not easy, a number of challenges had to overcome. The first one was the logistical challenges while another major issue was the essential amendment in the outlooks of education administrators, educators and students required for implementing compulsory amendments for the switch (Ribeiro, 2020). Transforming traditional teaching to online teaching at the time of a sudden interruption like the COVID-19 pandemic involved imaginative and flexible thinking from the educators on how to support students in attaining the learning objectives so most of the educators worked hard to respond creatively in order to teach

their students in the same manners and standards as before, though they themselves faced disruption in their lives (Cohn & Seltzer, 2020). The process of transformation was efficient for some institutions, while some had to respond with crisis-response migration process due to the pandemic (Hodges et al., 2020; Manfuso, 2020).

Covid-19 pandemic made people realise that education system is vulnerable to external dangers (Bozkurt & Sharma, 2020). The challenges limited to emergency digital transformation of instructional operations during the period of Covid-19 pandemic included the following.

Technology. The reliance on technological equipment and the requirement of the proper equipment of online learning was a big challenge for institutions, faculties and students (Adedoyin, and Soykan, 2020).

Socio-economic factor. The inequality of socio-economic status within students were a big challenge as some students depended on school or university computers and free internet (Demirbilek, 2014) which they were unable to access that due to their school closure.

Human and pets intrusions. Family members, friends or pets caused unexpected interruption or diversions for both the students as well as the educators while working in online classes from their home environment (Adedoyin & Soykan, 2020).

Digital competence Digital competence can be refer as a set of skills, knowledge and attitudes required for using Information Communication Technology (ICT) and digital devices to complete responsibilities, including problem solving, information management, teamwork with respect to effectiveness, proficiency and ethics (Ferrari, 2012). Everyone was not digitally competent not only in academic field but also in other spheres of life which make digital transformation of traditional education system difficult for some people (Bennett et al., 2008).

Assessment and supervision. In the online education platform assessments are conducted online. Proctor tools are used to supervise students completing online assessments. These tools monitor the students lap top computers, or electronic device that the student completes their assessment on. Proctor tools record students' screens, key strokes, eye movements, home environment, physical behaviour and more, during the exam or other assessment and allow the assessor to watch this (Amigud, et al., 2017).

Heavy workload. The emergency digital transformation process includes building e-platforms, cohesive existing peripheral applications into their system resulted heavy workload for ICT units of the institutions as well as for the educators. This heavy workload ended up causing unanticipated financial and time cost (Akkoyunlu & Soylu, 2006).

Compatibility The compatibility of online learning with all subjects like social science, humanities, as well as the subjects needs hands-on practical experiences e.g. sports sciences, engineering and medical sciences are required as part of instructional activities (Leszczyński et al., 2018). Remote laboratories are used as alternative laboratories in online education settings and virtual laboratories are used by online education platform to be able to fill the theory-to-practice hole (Iqbal et al., 2015).

Opportunities. There are many advantages associated with online education platform, such as flexibility (Smedley, 2010), interactivity (Leszczyński et al., 2018; Wagner et al., 2008), self-pacing (Amer, 2007) and opportunities.

Cybersecurity The computers and other portable technological devices are used daily as online educational tools which exposes the devices to various viruses and potential hacking and other cybersecurity threats (Nam, 2019).

Conclusions

The concept evaluated has been how, and why, education methods have changed from early times to the time of the COVID-19 pandemic. The important understandings generated through this review of published literature are that educational methods are constantly evolving as what the ruling society values changes and when new technologies that can be used for teaching are invented. The sudden outbreak of COVID-19 pandemic in 2020 forced the education sector to shift to fully online delivery as limited social contact was implemented to stop spreading this deadly virus. The educational institutions had to implement sudden emergency online course delivery. Published literature has identified that the majority of the students from developed and rich countries were satisfied with real-time online classes, whereas the students from developing and poorer countries suffered, mainly due to lack of computer literacy of students and educators, poor digital infrastructure, cost of internet and the digital devices required in order to continue online classes (Aristovnik, et al. 2020).

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APPENDIX 12 AMPS CONFERENCE PRESENTATION

AN EVALUATION OF TERTIARY EDUCATORS' PERCEPTIONS OF ONLINE TEACHING RELATED ERGONOMIC FACTORS

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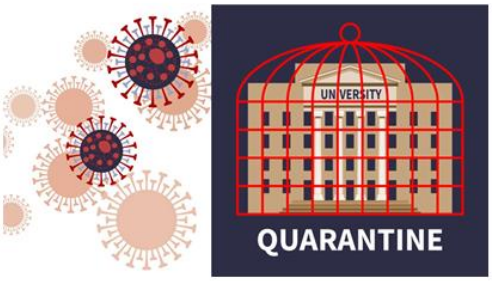
CURTIN UNIVERSITY, Western Australia

1

Contents

- Background
- Aim
- Methodology
- Findings
- Conclusions



2

Background

- Social distancing implemented to stop spreading of COVID-19 Pandemic
- This forced the tertiary institutes shift the traditional face-to-face teaching to online teaching
- Working from home affected the online educators ergonomically

3

Research Aim

To identify and evaluate ergonomic factors that impact educators' experience of online teaching.

4

What is Focus Group and why it is important

5

Methodology

- *Preparing Focus Group Questionnaire*
- *Recruiting Focus Group Participants*
- *Conducting Focus Group Discussion*
- *Focus Groups Data Analysis through Histogram, Cross Tabulation and Thematic Analysis*

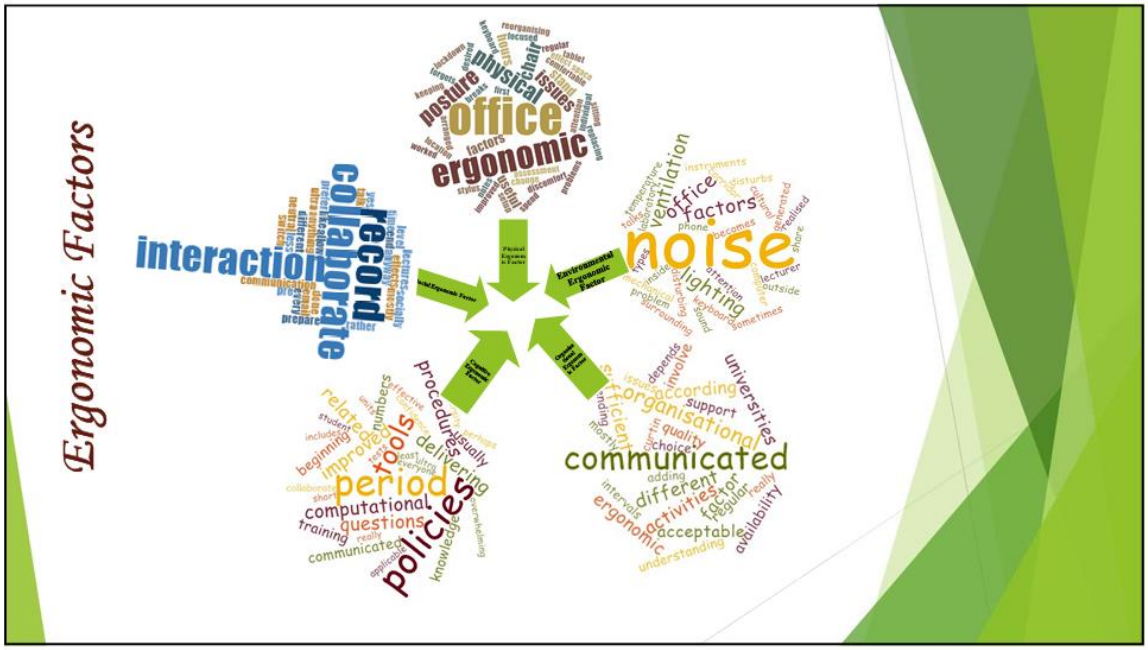
6

Findings

Demographic Details of participants

Gender	More than 3 years	Less than 3 years
Female	3	0
Male	3	6
Total	6	6

7



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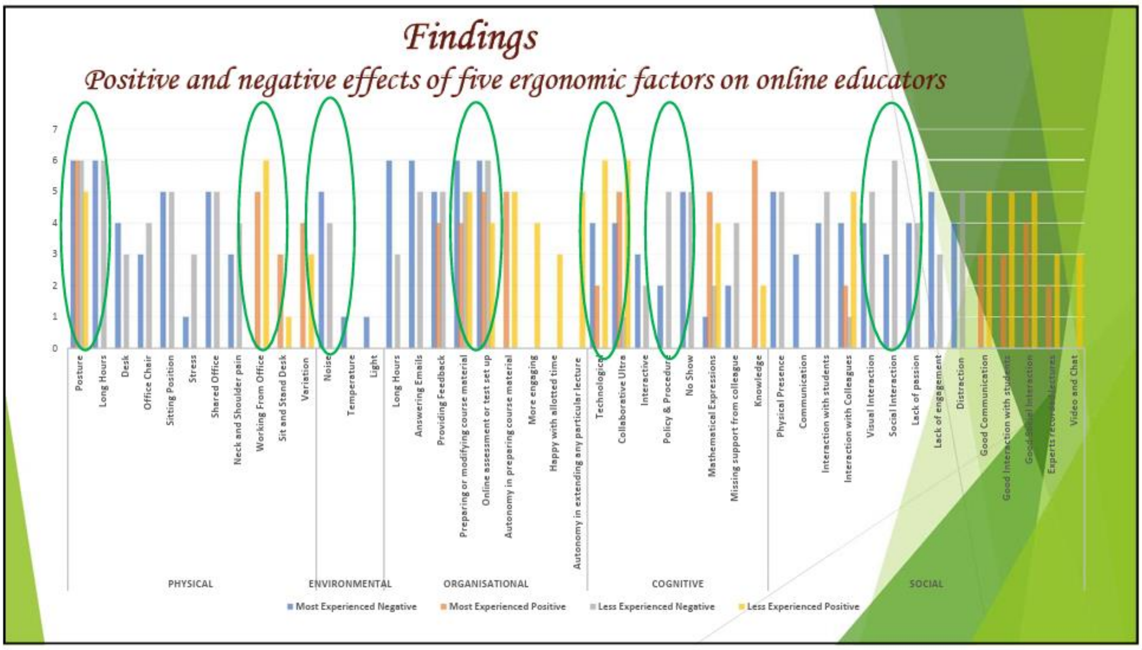
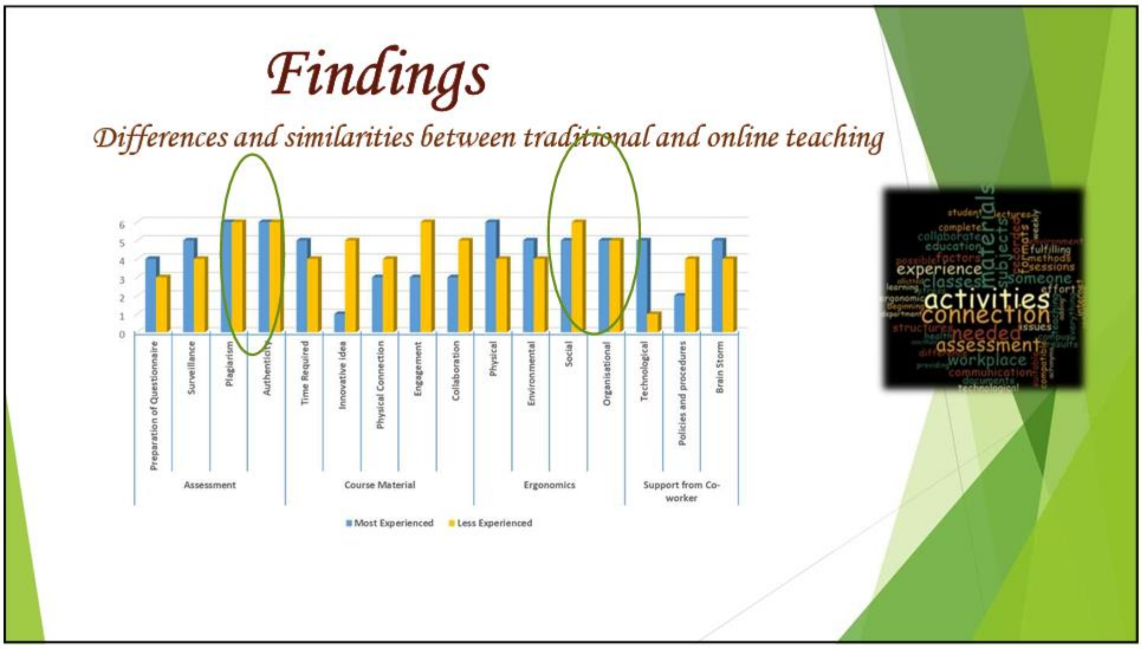
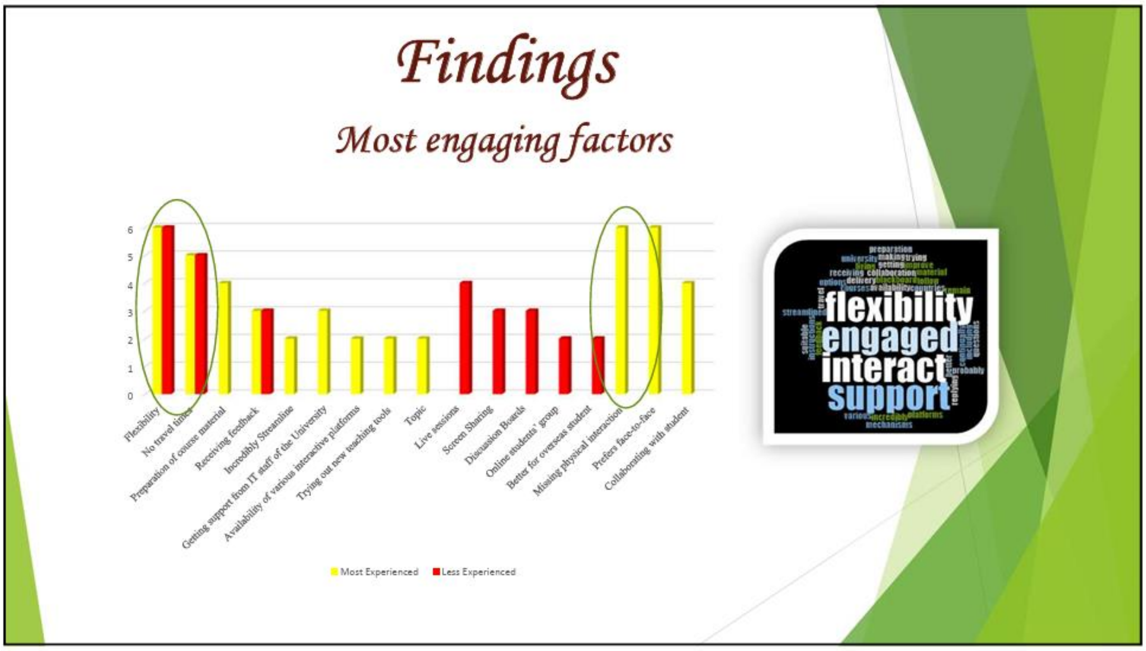

Findings
Positive and negative effects of five ergonomic factors on online educators
Posture
Long Hours
Desk
Office Chair
Sitting Position
Stress
Shared Office
Neck and Shoulder pain
Working From Office
Sit and Stand Desk
Variation
Noise
Temperature
Light
Long Hours
Answering Emails
Providing Feedback
Preparing or modifying course material
Online assessment or test set up
Autonomy in preparing course material
More engaging
Happy with allotted time
Autonomy in extending any particular lecture
Technological
Collaborative Ultra
Interactive
Policy & Procedure
No Show
Mathematical Expressions
Missing support from colleague
Knowledge
Physical Presence
Communication
Interaction with students
Interaction with Colleagues
Visual Interaction
Social Interaction
Lack of passion
Lack of engagement
Distraction
Good Communication
Good Interaction with students
Good Social Interaction
Experts recorded lectures
Video and Chat
PHYSICAL
ENVIRONMENTAL
ORGANISATIONAL
COGNITIVE
SOCIAL
Most Experienced Negative
Most Experienced Positive
Less Experienced Negative
Less Experienced Positive

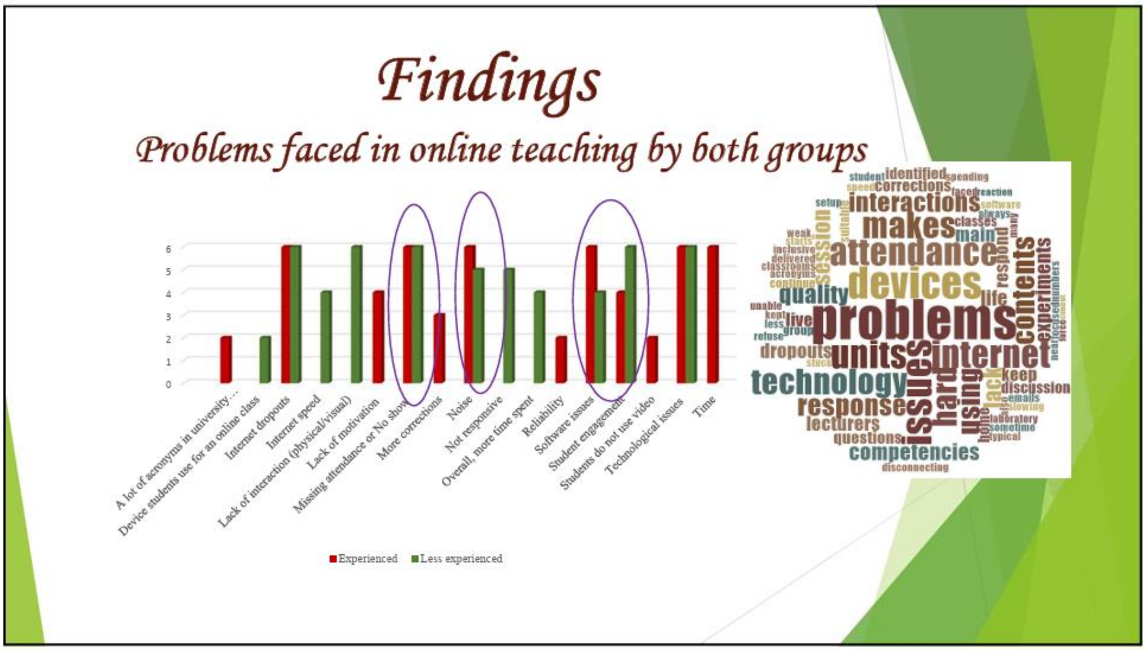
9


Findings
Differences and similarities between traditional and online teaching
Preparation of Questionnaire
Surveillance
Plagiarism
Authenticity
Time Required
Innovative idea
Physical Connection
Engagement
Collaboration
Physical
Environmental
Social
Organisational
Technological
Policies and procedures
Brain Storm
Assessment
Course Material
Ergonomics
Support from Co-worker
Most Experienced
Less Experienced
activities
connection
assessment
experience
materials
subjects
needed
workplace
classes
someone
education
collaborate
complete
communication

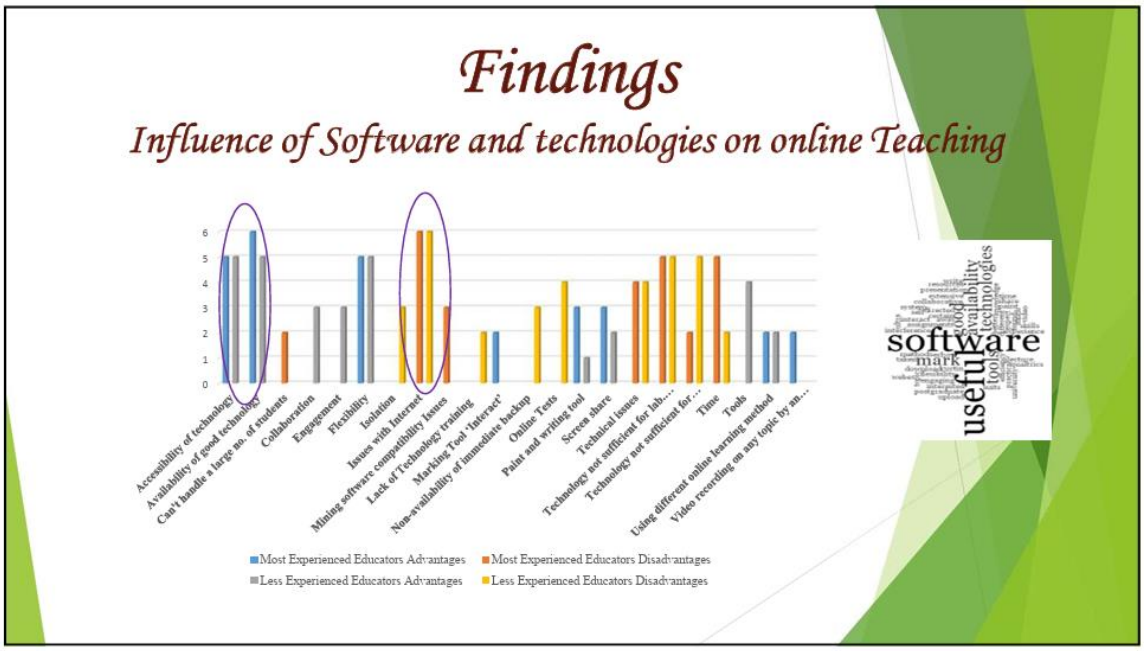
10


Findings
Most engaging factors
Flexibility
No travel times
Preparation of course material
Receiving feedback
Incredibly Streamline
Getting support from IT staff of the University
Availability of various interactive platforms
Trying out new teaching tools
Topic
Live sessions
Screen Sharing
Discussion Boards
Online students' group
Better for overseas student
Missing physical interaction
Prefers face-to-face
Collaborating with student
Most Experienced
Less Experienced
flexibility
engaged
interact
support

11


Findings
Problems faced in online teaching by both groups
A lot of acronyms in university…
Device students use for an online class
Internet dropouts
Internet speed
Lack of interaction (physical/visual)
Lack of motivation
Missing attendance or No show
More corrections
Noise
Not responsive
Overall, more time spent
Reliability
Software issues
Student engagement
Students do not use video
Technological issues
Time
Experienced
Less experienced
problems
devices
attendance
makes
interactions
units
internet
technology
issues
hard
response
lecturers
competencies
quality
dropouts

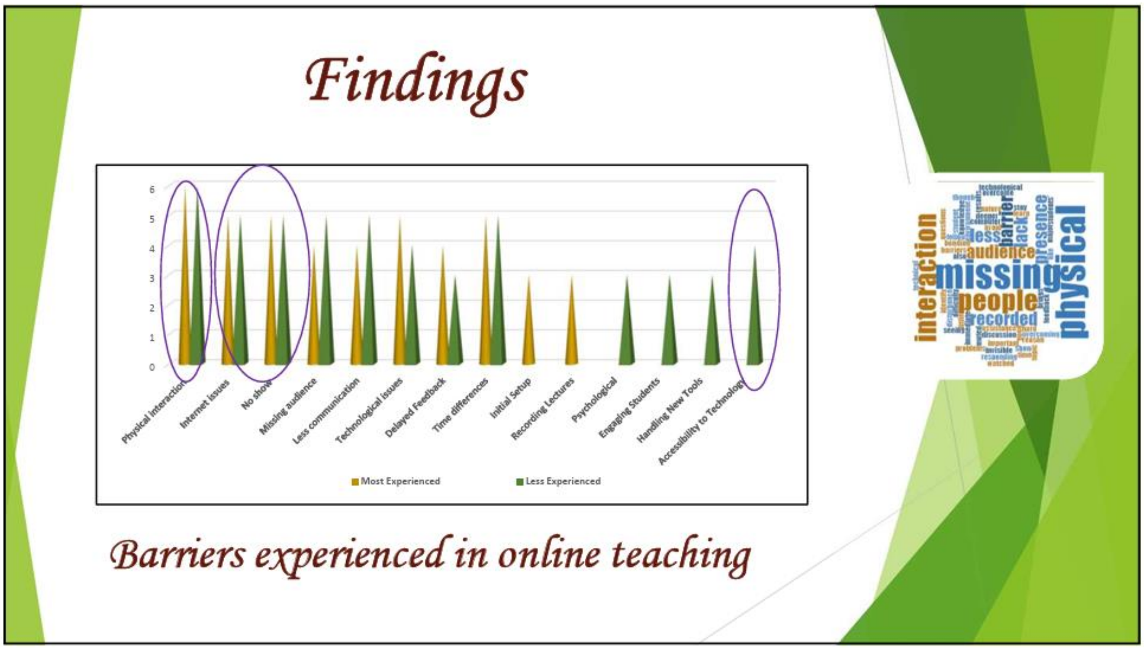
12


Findings
Influence of Software and technologies on online Teaching
Accessibility of technology
Availability of good technology
Can't handle a large no. of students
Collaboration
Engagement
Flexibility
Isolation
Issues with Internet
Mixing software compatibility issues
Lack of Technology training
Marking Tool 'Interact'
Non-availability of immediate backup
Online Tests
Paint and writing tool
Screen share
Technical issues
Technology not sufficient for lab....
Technology not sufficient for...
Time
Tools
Using different online learning method
Video recording on any topic by an...
Most Experienced Educators Advantages
Most Experienced Educators Disadvantages
Less Experienced Educators Advantages
Less Experienced Educators Disadvantages
software
useful
mark
tools
availability
technologies

13

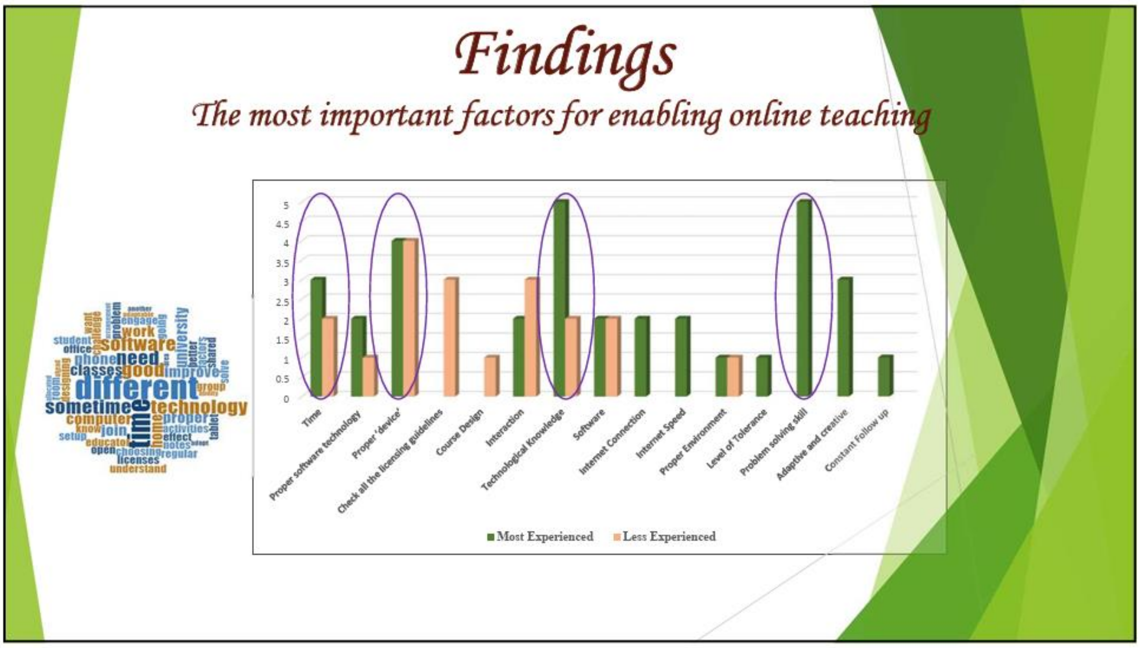

Findings
Factors affecting online teaching
Interaction
Support
Time
Classroom
Computational
Flexibility
Software
Most Experienced
Less Experienced
university
environment
technology
require
improve
flexibility
computer
understand
problems
student
software

14



Findings
Physical Interaction
Internet Issues
No show
Missing audience
Less communication
Technological issues
Delayed Feedback
Time differences
Initial Setup
Recording Lectures
Psychological
Engaging Students
Handling New Tools
Accessibility to Technology
Most Experienced
Less Experienced
interaction
missing
people
physical
presence
audience
recorded
barrier
less
lack
Barriers experienced in online teaching

15



Findings
The most important factors for enabling online teaching
Time
Proper software technology
Proper 'device'
Check all the licensing guidelines
Course Design
Interaction
Technological Knowledge
Software
Internet Connection
Internet Speed
Proper Environment
Level of Tolerance
Problem solving skill
Adaptive and creative
Constant Follow up
Most Experienced
Less Experienced
different
time
technology
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sometime
need
good
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improve
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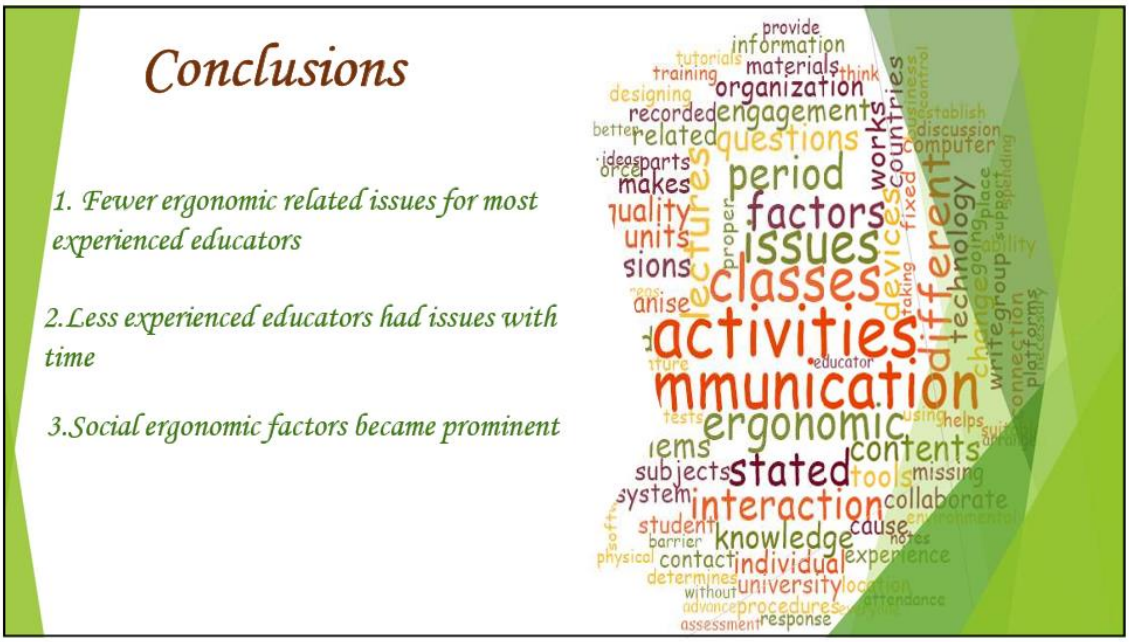

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This conference recording also available in YouTube through the following link Pedagogy: M. Ghosh (youtube.com)

APPENDIX 13 CONFERENCE ARTICLE

AN EVALUATION OF TERTIARY EDUCATORS' PERCEPTIONS OF ONLINE TEACHING RELATED ERGONOMIC FACTORS

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INTRODUCTION

In the 21st century, there has been a paradigm shift in attitudes towards having an online education system, and online learning is no longer peripheral or auxiliary, but a vital part of today's conventional tertiary education system.[1] At the end of 2019, the outbreak of the COVID-19 pandemic caused traditional classes to 'move online' in an essential high-priority manner, which resulted in extra stresses and workloads to the university teaching staff who were already struggling to balance teaching, research, and administrative responsibilities, as well as with the work-life balance.[2] Educators from all backgrounds and age groups were required to develop and implement their scheduled classes from home, while all the practical and technical hurdles had to be overcome. Some university educators do not have the proper pedagogical content knowledge(PCK),[3] required for online teaching,[4] including technical and administrative features of online teaching such as, establishing workflows, using particular technical platforms and tools, etc. Recent studies revealed that,[5] the complex nature of the instructional situation and inadequacies in planning and organization are some of the main difficulties described by university teachers with respect to changing to developing web-based courses. The educators became responsible for dynamically repurposing and redistributing resources, upskilling their digital proficiencies, and developing new materials to change over from traditional face-to-face and blended programs to a distance learning and/or online education delivery mode.[6] Some educators had been teaching online for many years, while other tertiary educators were new to online teaching.

There are benefits and barriers to online teaching. The benefits have been described as educator and student satisfaction. Cost-effective. Flexible convenient teaching. Easy to update. Provides diversity. Timesaving. Communication method. The most tolerant teaching environment. Multisensory. Develops problem-solving, soft skills, and computer/technology literacy skills. It forms a favourable environment for learning, develops student participation and improves accessibility of education.[7] Barriers to Online Teaching are acceptance; problems with the interface, interaction, and usability. There is the initial setup and ongoing cost; technology misuse; difficulties with the interaction between peers and teachers; unavoidable interruptions; minimal participation in class by students; interacting limits; changing of roles; distraction and inconvenience.[8]

As the role of online educators is different from traditional classroom educators, this potentially affects the educators ergonomically. Ergonomics (or human factors) is the scientific discipline

concerned with the understanding of interactions among humans and other elements of a system. It involves fitting the task to the person and the product to the user. Ergonomics is a universal, human-centered approach to work systems design considering physical, cognitive, social, organizational and environmental factors.[9]

PHYSICAL ERGONOMIC FACTORS

Physical ergonomics is concerned with the online educator's human anatomical and anthropometric measurements that would influence desk design, seating, computer height, and other equipment and space used. Online teaching can involve continuous hours of sitting on a chair without changing posture. Not having an ergonomically designed workplace and equipment may lead to certain musculoskeletal disorders such as back pain.[10]

ENVIRONMENTAL ERGONOMIC FACTORS

The lighting, ventilation, temperature, and noise of the room where the online educators spend most of their time are examples of environmental ergonomic factors.[11] There were some ill health effects related to online teaching reported in the qualitative study conducted by Jansz et al. (2016),[12] as one of the online educators reported that spending a large amount of time working at a computer screen in a poorly lit room caused headaches. This educator needed to purchase stronger reading glasses to continue doing online teaching.

SOCIAL ERGONOMIC FACTORS

Social ergonomics refers to the communication and interaction between students, educators, and relationships with co-workers. Time spent in online teaching includes a combination of communication through email, telephone conversations, discussion groups, chatroom questions and answers through blackboard, and for some students giving time for face-to-face conversation via the internet.[13] Students' e-mails to be answered can be sent at any time leaving less time for other activities including the educator's personal life. Studies have suggested that the online educator devotes substantial time providing technical support to the students.[14]

ORGANISATIONAL ERGONOMIC FACTORS

An organizational ergonomic factor that impacted online teaching most was the educator not having enough time to do all of the updates that they would like to make for their teaching materials, to be able to complete all work, including marking student assignments and to complete all university required paperwork within their workload allocation time.[15] Van de Vord and Pogue (p. 141),[16] stated that providing student assessment feedback is much more time-consuming for online instructors. Sessional staff who were employed to mark student assignments reported that they had to work unpaid overtime to be able to do this work and that the time allowed did not include time for giving students adequate feedback on the marked work. It was also stated that there was no time allocation provided for downloading assignments, checking them through Turnitin, uploading assignments, and doing marking moderation.[17] Gous & Roberts (p.268),[18] reported: "academic staff work long hours, even weekends."

COGNITIVE ERGONOMIC FACTORS

Cognitive ergonomics is the way that people think and process information.[19] Cognitive ergonomics involves identifying, interpreting, and processing information by an individual.[20] It includes perception, learning ability, memorizing power, problem-solving, and motivation. Cognitive ergonomic factors that were reported as impacting educators' teaching online included having

insufficient knowledge of the university policies, procedures, the usage of modern technologies, and online educational tools.[21] This research was conducted to identify how these five ergonomic factors affect, both positively and negatively, educators who teach online.

METHODOLOGY

This research began with the development of the focus group questions from an analysis of the published literature reviewed related to online teaching and the COVID-19 pandemic. It included recruiting the focus group participants, conducting the focus group interviews, and analysing the focus group responses using NVivo to identify common themes. Focus group discussions are commonly used to obtain an in-depth understanding of the issues. A focus group can be defined as a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research.[22]

Altogether 12 participants were recruited from a University as Focus group participants. All of the participants selected were academics with online teaching experience. The focus group discussion was scheduled during a busy time of the year, so the discussion was conducted through 4 mini focus groups with 3 participants in each group. Two groups were academics with more than 3 years of online teaching experience and the other 2 groups consisted of academics with less than 3 years of online teaching experience at university level. The 'mini focus group' method was used for the online focus group discussions. The participants were asked open-ended questions by the researcher as open-ended questions inspire participants to provide more detailed conversation, allowing the participants' additional areas and chances to explain and justify their answers if required. They also permit the researcher to ask any follow-up questions wherever necessary to investigate the topic in more depth.

The qualitative data analysis was performed by data coding, dividing all raw data into groups containing phrases, sentences, and/or paragraphs, assigning a code to each group, and finally grouping all the codes into themes. After being checked by participants to ensure accuracy all the interviews were transcribed in the online database NVivo for analysis.

RESULTS AND DISCUSSION

For tertiary education educators with more than 3 years of online teaching experience demographically, there was an equal distribution of gender. For educators with less than 3 years of online teaching experience, all participants were male and had begun online teaching when the COVID 19 lockdown restrictions commenced in March 2020. All of the educators with less than 3 years of online teaching experience and half of the educators with more than 3 years of online teaching experience were teaching engineering subjects. An experienced online teaching participant described how she felt when changing from face-to-face teaching-to-teaching online and said,

"I started teaching online approximately 20 years ago. At first, did not like the concept of online teaching very much, preferred face-to-face traditional teaching as in online teaching physical interaction was missing and I felt it was important. Then for about 5 years, there used to be two versions of all the classes, i.e., one was traditional face-to-face and the other was online. Same course materials and assessments were used for both versions, but the pedagogy was entirely different. Gradually online courses got more acceptance and the platforms and support improved dramatically. At first for online courses all the printed course materials used to be sent to the students, there was no visual contact opportunity available. Over the last 10 years, the online education platform has improved dramatically with the availability of various interactive platforms including Blackboard and the Internet. The online education platform has become incredibly streamlined. We started getting lots of support from the IT staff of the university. Support mechanisms got better with the availability of more collaboration options. Still personally prefers traditional face-to-face classes instead of online

versions though accept the inevitable and like to be able to do all my teaching from home with no travel."

Comparison for most engaging factors

After carefully analyzing the answers of educators with more and with less than 3 years of online teaching experience, results showed that the participants of both groups felt positive about the overall flexibility and having less or no travel time requirement when teaching online. The more experienced online educators engaged themselves in preparing course material using new pedagogy, learning and using new technologies, receiving queries and providing feedback, etc., while the less experienced educators engaged more in live sessions, using shared screens while solving the mathematical problem from scratch and informing online student groups.

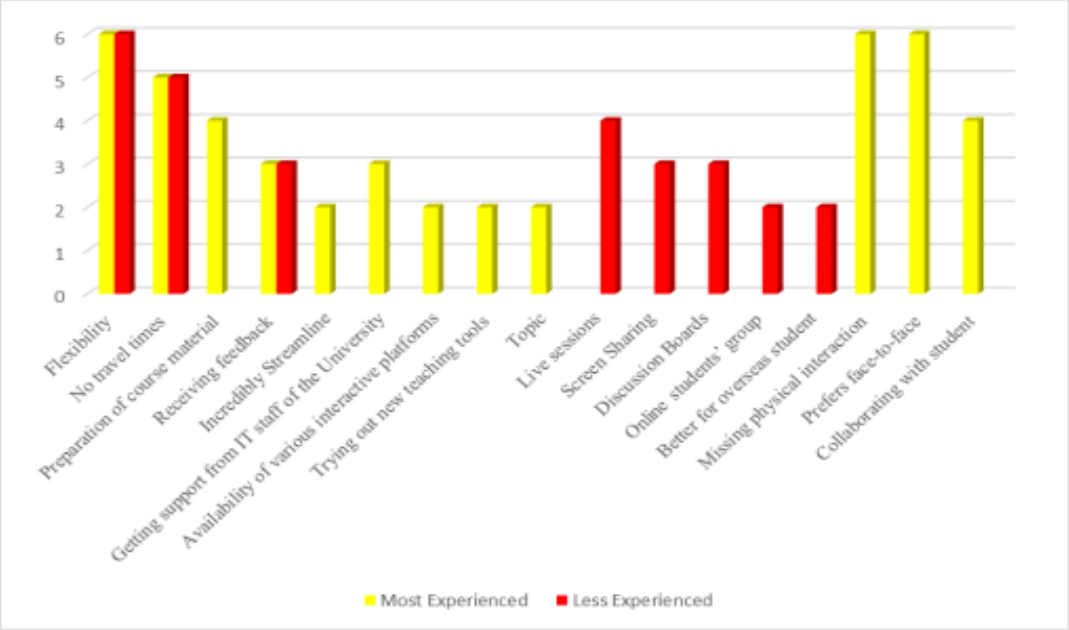

Figure 1. Engagement factors for online teaching

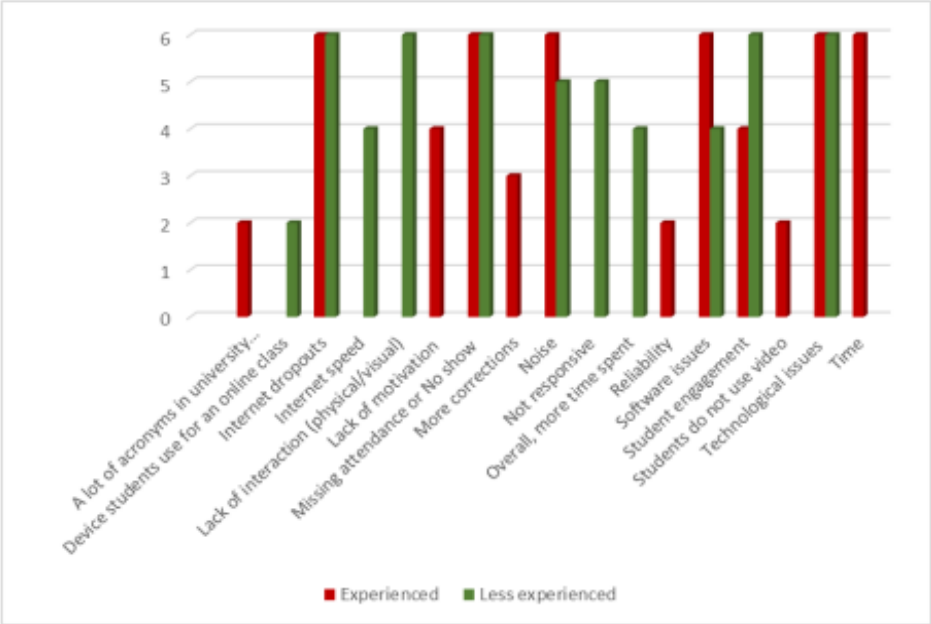

Figure 2. Problems faced in online teaching by both groups

The main problems described by both groups were lack of interaction (physical/visual), missing attendance or no show, technological issues, internet issues/dropout, etc. For example, a participant reported:

"Usually, the main problems faced are encountering problems with technology, internet dropouts or slowing down, hard to identify who is attending class as most of the time students do not use video. Unlike face-to-face teaching in an online environment, teachers are unable to see the students' reactions such as whether the student looks puzzled or needs help, etc. Hard to identify who is attending class. Hard to identify what the students are taking in as they usually turn off the audio /video function".

The experienced educators encountered problems with surrounding noise from working in a shared office, corridor noise as people passed their office, or neighborhood noise while working from home. There were more corrections of students' work required in comparison to traditional teaching. Educators did not feel connected to students and were less motivated because they were not able to see the students' facial expressions or body language to assess the students' level of understanding of the topic. Students did not use the video function, because students did not like being seen online. Less experienced educators were more concerned with the non-responsiveness of the students while attending the online class. Educators also faced difficulties due to the devices used by the students as some of the software only worked with some computers.

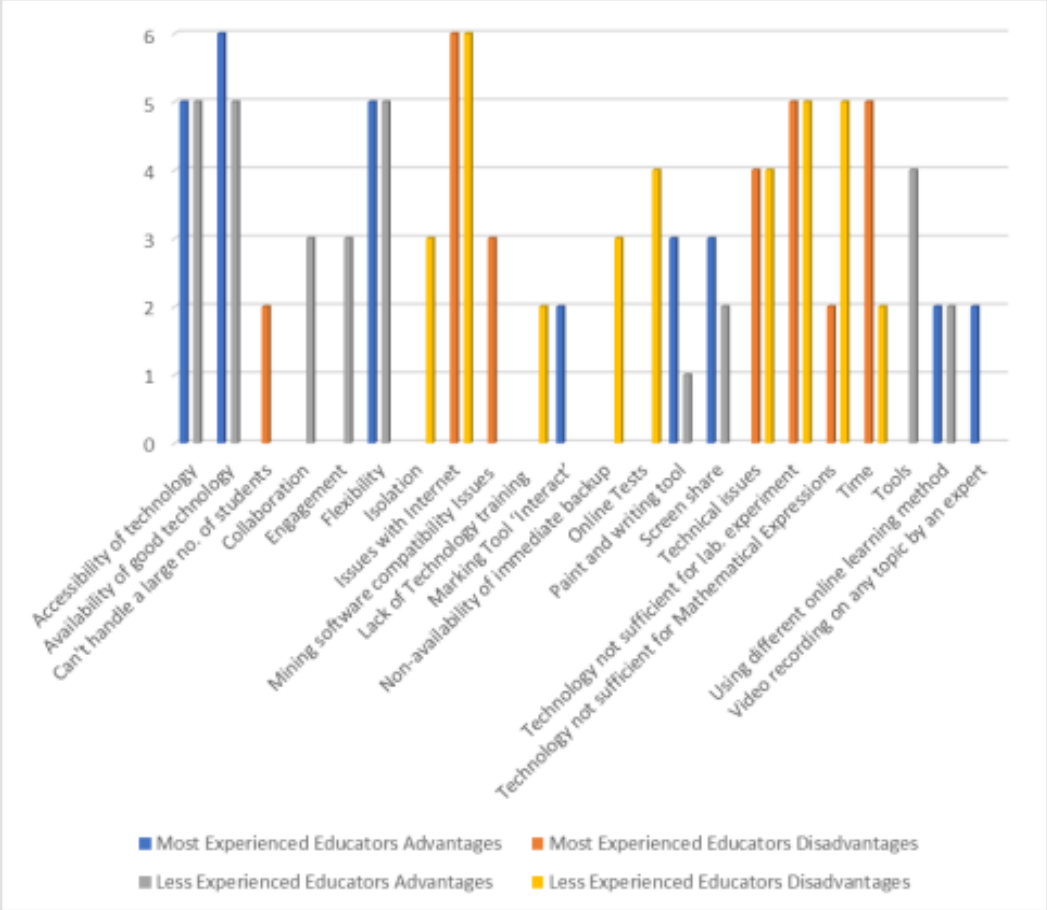

Figure 3. Software and technologies influence your online Teaching

The participants of both groups acknowledged that the software and technology helped to increase general flexibility, there were good software packages and technological tools available. They had concerns about internet issues, technical issues, and competency of software use while teaching mathematical expressions, engineering rotation, laboratory work, etc. The less experienced educators felt that the collaboration and engagement with students in the online educational platform were good and that students learning to use the software tools in their online classes added extra value in their future practical life. These educators were very conversant with technology and other mobile devices. This may have been a reason for them to feel more engaged and collaborative when teaching online. When conducting online teaching less experienced educators felt more isolated than experienced educators did.

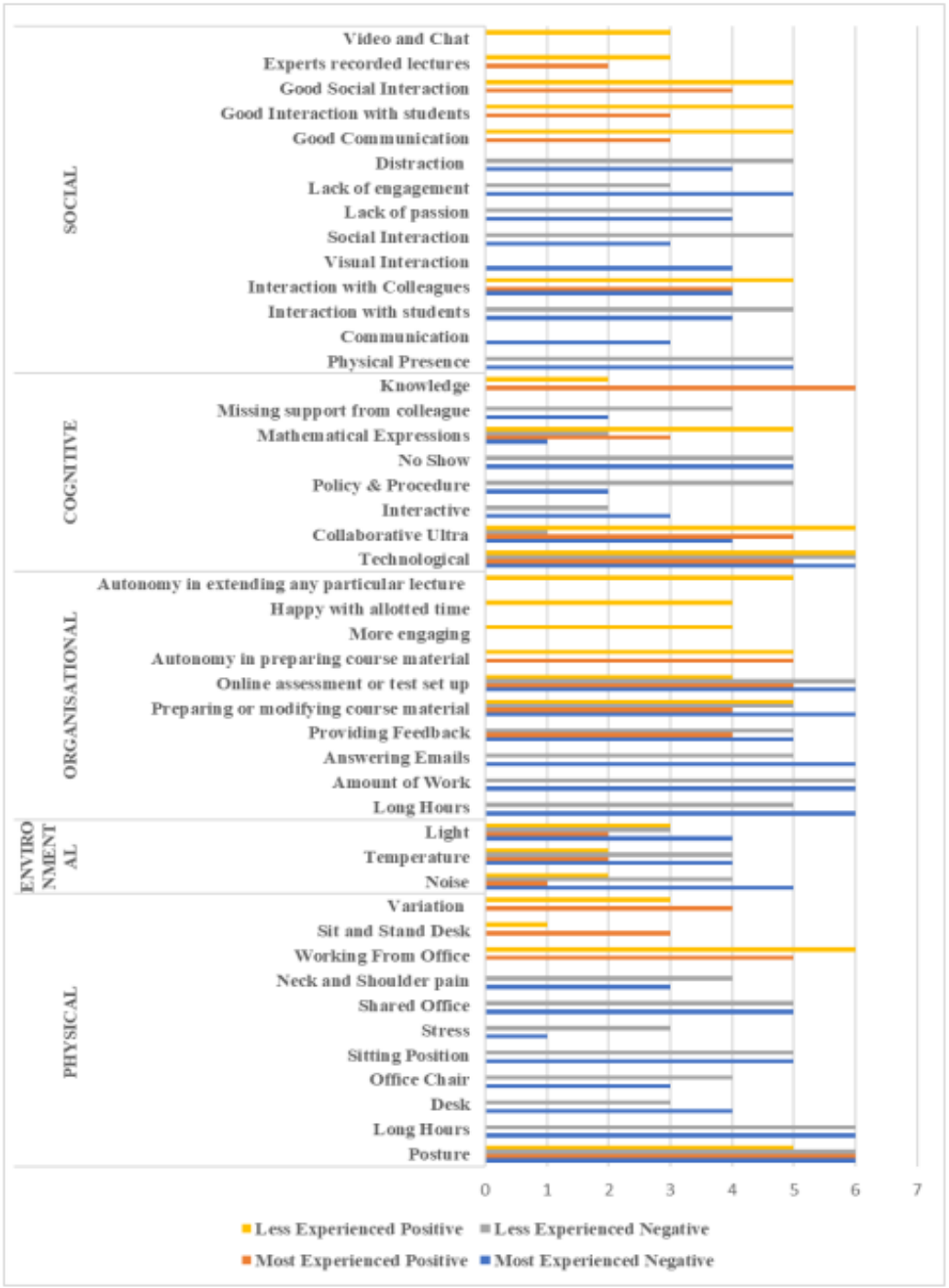

Figure 4. Comparison of positive and negative effects of five ergonomic factors for online educators

Online teaching and physical ergonomic factors

Eighty-three percent of educators with more than 3 years of online teaching experience and 100% of those with less than 3 years of online teaching experience did their online teaching in their university office. All participants from both groups said that they worked long hours. Half of the more experienced educators and 17% of the less experienced educators varied their work posture by using sit-stand desks to allow for changes in working posture when doing written work and when doing online teaching.

Environmental ergonomic factors

All the participants reported having to deal with background noises. The noise came from being located in a shared office, having corridor noise, laboratory noise from the next to the room, etc. For example, a participant said that:

"Noise can be a problem. I work in an office with 6 people. Our desks are next to each other with no barriers between them. When there are online classes, being held if a phone rings and the person answers the phone call, if a student comes in to talk to their lecturer and talks to them, or if anyone types on their computer keyboard, the noise disturbs the online lecture. Because of the closeness of the desks, these noises can also disturb the other people in the room and make it difficult to concentrate on work, particularly when people talk together for a period of time of more than 5 minutes."

One experienced educator worked from home and her home office had no environmental ergonomic issues.

Organisational ergonomic factors

The majority of experienced educators and 50% of inexperienced educators stated that generally extra time was required for efficiently completing all the demands of online teaching, such as preparation of course material depending on the subject matter, providing feedback, answering emails or messages, etc. For example, a participant stated:

"I would like to have enough time to try out new and different creative or innovative features of the software to modify the course material to be more engaging and interesting to the students. Always too busy to do this. Teaching online requires spending long hours before a computer which results in headaches and neck pain."

Also preparing online test material and conducting the test online was reported as being challenging and stressful. Suggestions were made to introduce some kind of training or university workshops to develop and check that all online prospective students have pre-requisite knowledge for learning online.

Cognitive ergonomic factors

The participants of both groups were concerned with the authenticity of the availability of technology for online assessment, detecting plagiarism, etc. The experienced educators were very conversant with the university's policies and procedures towards online teaching-related matters whereas the less experienced educators struggled with knowing the university policies and procedures.

Social ergonomic factors

Participants of both groups missed physical/visual interaction with students. One experienced educator said that "While discussing conceptual things it's easier to do this face to face than online and it is less productive collaborating with research students online."

However, another participant thought that the online teaching platform provided better visual interaction through video, chat, etc.

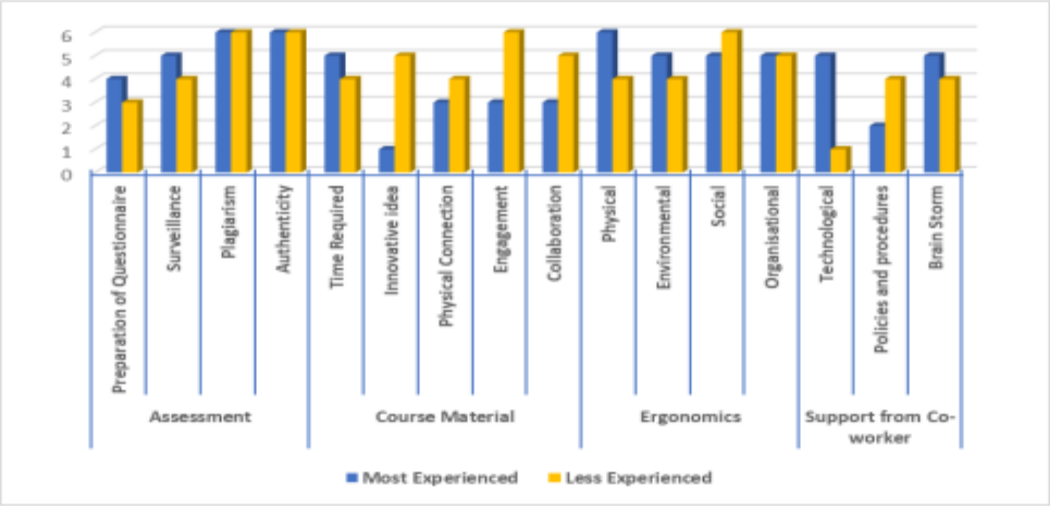

Figure 5. Differences and similarities between traditional vs online teaching

All educators said that the hardest part of online teaching was developing questions especially for science subjects, the authenticity of the assessment, and reducing plagiarism in an open book examination scenario. Preparing course material was also challenging, as they needed to develop it in such a way that it would engage the students in online classes.

Effective online teaching

Both groups agreed that better technology, the internet, and device such as smartphones, tablets, etc. were required for effective online teaching. More experienced educators revealed that spending extra time makes their online teaching more effective. Support from the technical team of the university also helped them teach effectively. Less experienced educators reported that flexibility was the main factor required for them to teach effectively.

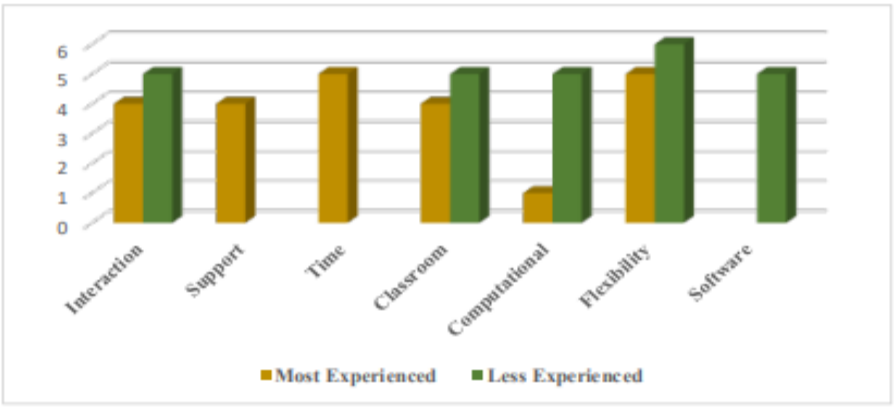

Figure 6. Comparison of factors affecting online teaching

Barriers experienced in online teaching

Participants of both groups thought physical interaction, internet issues, no show or missing audience, less communication between students and educators as students are reluctant to switch on their camera, were the main barriers. Three educators with less experienced in online teaching said that the initial setup for online teaching, getting a quiet place for recording, setting up new online classrooms, and availability for recording online classes were the main barriers. Other barriers were lack of technology knowledge, not knowing the best way to utilize software, and issues related to being able to use some software outside the university campus were the main barriers.

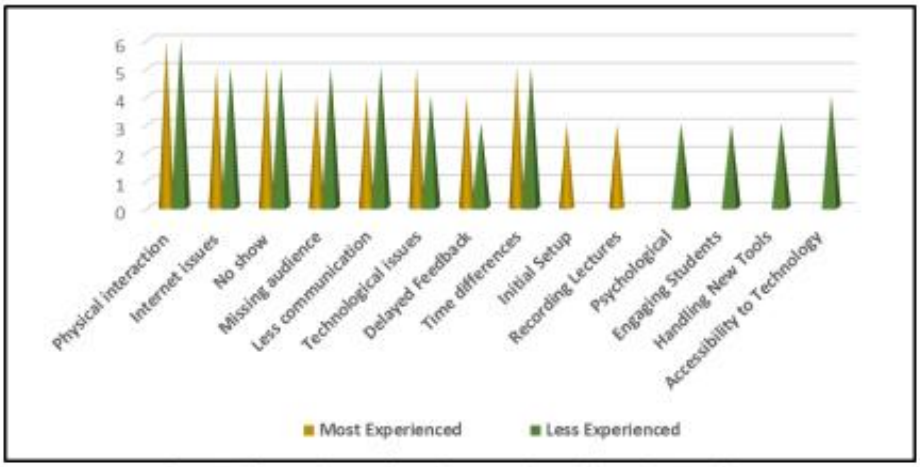

Figure 7. Comparison of barriers experienced in online teaching

The most important factors for enabling teaching successfully online

Participants of all groups reported that spending more time was required, as different subjects required a different way to design and teach the course material. To successfully teach online it was required that there was availability, and usage of the proper devices so that all the technology was compatible with the university technology used. Less experienced online educators said that students struggled with the licensing criteria for software as some software only worked within the university campus.

Figure 8. important factors for enabling online teaching

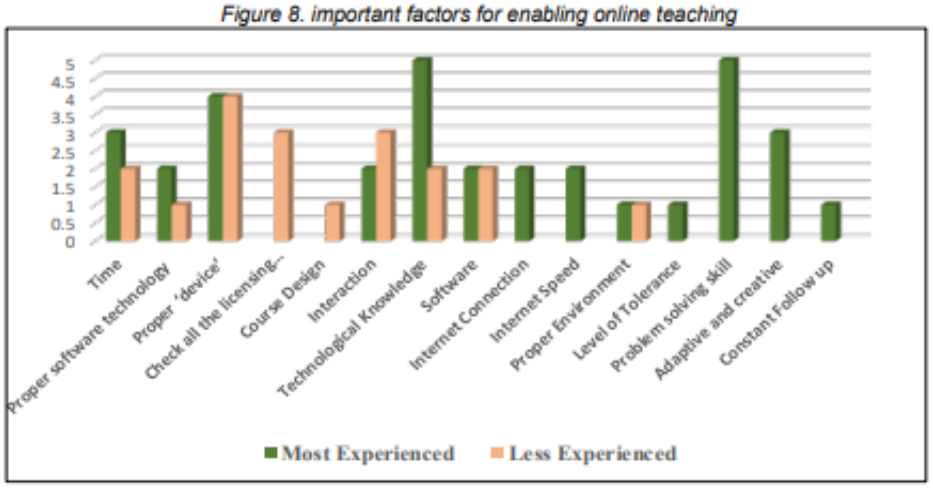

Figure 8. important factors for enabling online teaching

Online teaching is now a common form of education and, as reported by a focus group participant: 'The flexibility of availability of the online courses for the students living in other countries, level of engagement, topic, receiving feedback from students, replying to the questions of the students makes me feel more engaged.'

CONCLUSIONS

The focus group results provided 5 main ergonomic themes; organisational, cognitive, social, environmental, and physical. Participants reported having good physical ergonomic conditions in their office at work but required some improvements in their chairs and work desk when first working from home. The main organisational ergonomic concern was requiring more time to develop and conduct online teaching and provide student feedback. The noise was the main environmental problem. Cognitive ergonomic problems were identified as needing to learn new technologies which sometimes did not work well. Educators were affected by social ergonomic factors that included less personal interaction with students. Educators with more than 3 years of online teaching experience generally had fewer ergonomic-related issues than those who were new to online teaching.

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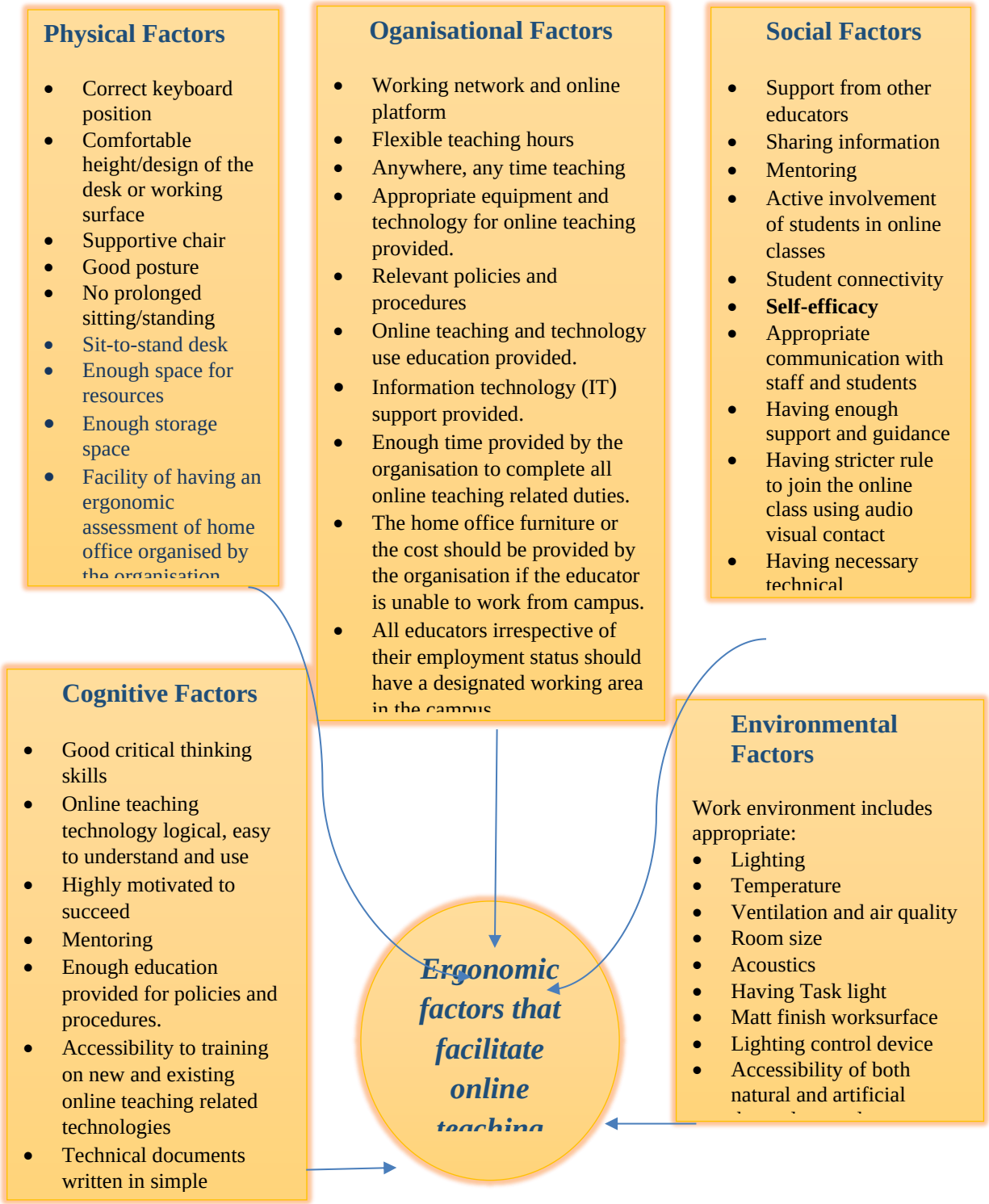
APPENDIX 14 FACT SHEET

RISK MANAGEMENT FOR EDUCATORS THAT TEACH ONLINE

(DOI: https://doi.org/10.5281/zenodo.10056559 **)**

This Fact Sheet has been developed to assist educators who teach online to consider the ergonomic factors that can affect their health and work and is based on the research findings of Mitali Ghosh.
The information below shows the ergonomic factors that facilitate online teaching work.



Ergonomics is fitting the task to the person and the product to the user. Five ergonomic factors are considered. They are Physical (human anatomy fit related to physical activities conducted), Environmental (fitting the work environment to human needs), Organisational (factors controlled by the university, or other organisation employed at), Cognitive (how people think and process information) and Social ergonomic factors (interaction with people).

Below are possible health effects that can result if ergonomic factors are not considered.

	Possible health effects				
Identify	**Physical Ergonomic Factors**	**Environmental Ergonomic Factors**	**Organisational Ergonomic Factors**	**Cognitive Ergonomic Factors**	**Social Ergonomic Factors**
	▪ Neck Shoulder, wrist and back discomfort ▪ Computer vision syndrome	▪ Distraction, fatigue, increased blood pressure and sleep disruption.	▪ Psychosocial discomfort ▪ Stress ▪ Anxiety ▪ Burnout		

If you identify any of the above health effects, or if you feel that there is a need to improve the ergonomic factors that affect your work, below are some suggested risk control measures.

	Physical Ergonomic Factors	**Environmental Ergonomic Factors**	**Organisational Ergonomic Factors**	**Cognitive Ergonomic Factors**	**Social Ergonomic Factors**
Control	• Have a Sit-to-stand desk to enable posture variation. • Workstation with enough width and height adjustable if the workstation is not at the correct height. • Fully adjustable chair	▪ Rooms with good acoustic and noise cancellation facility ▪ Provision of having a separate quite place for online teaching. ▪ Good temperature control system ▪ Proper IAQ	▪ More paid work time ▪ Home office setup or cost must be reimbursed by the university. ▪ Have proper organisational policies and procedures in place	▪ Adequate training on technology ▪ More education on policies and procedures ▪ Having provision for a break in every hour.	▪ Provide support and guidance ▪ Mentoring ▪ Have the necessary technical infrastructure with easy accessibility ▪ Promote active involvement of students in classes ▪ Promote student connectivity ▪ Self-efficacy

Please contact your workplace Health, Safety and Environment person if you identify any ergonomic related hazards that you require organisational support to implement risk control measures for.

APPENDIX 15 ONLINE TEACHING ERGONOMIC CHECKLIST

(DOI: https://doi.org/10.5281/zenodo.10056572)

When you are conducting online teaching, or teaching preparation, or marking students' work all the answers in this checklist should be 'yes'. Any negative (NO) answer indicates that a change should be made. Please choose 'Y/N'.

PHYSICAL ERGONOMIC FACTORS		**Y**	**N**
1.	**Head And Neck**		
a.	Is your head straight and balanced over your spine while looking at the computer monitor?	☐	☐
b.	Can you see your work without tilting your head down?	☐	☐
c.	If you use glasses do you use bifocals or trifocals without tipping your head back to focus?	☐	☐
2.	**Shoulders**		
a.	Are your shoulders relaxed?	☐	☐
b.	Are your upper arms close to your body?	☐	☐
c.	Are your work materials within reach and to the front of you?	☐	☐
d.	Can you operate equipment without having to reach or extend your arms?	☐	☐
e.	Is the work surface the correct height? Forearms parallel to the floor with no pressure?	☐	☐
3.	**Back**		
a.	Does your chair provide good support to your lower back (lumbar spine)?	☐	☐
b.	Is your chair adjustable? Can you adjust?	☐	☐
c.	Is it adjusted to the correct height for you with no pressure on the underside of your thighs?	☐	☐
4.	**Arms and Wrists**		
a.	Are your elbows at right angles when you type?	☐	☐
b.	Are your forearms and wrists in a neutral (straight) position?	☐	☐
c.	Is the mouse close to the keyboard and at the same height?	☐	☐

d.	Is your arm supported when using a mouse?	☐	☐
5.	**Legs and Feet**		
a.	Are your feet on the floor or on a stable footrest?	☐	☐
b.	Is there enough clearance under the workspace for your legs and knees?	☐	☐
c.	Is your chair adjusted to avoid pressure in the back of your lower legs?	☐	☐
6.	**Eyes**		
a.	Is the monitor at a comfortable viewing distance of 18-30 inches?	☐	☐
b.	Are the brightness and contrast controls set for comfortable viewing	☐	☐
c.	If you wear glasses is your eyeglass prescription up to date?	☐	☐
d.	Is your workstation positioned to avoid direct or reflected glare from windows or bright lights?	☐	☐
e.	When using 2 screens equally, is the split between the screens directly in front of you?	☐	☐
7.	**Work Methods**		
a.	Do you vary tasks during the day, so you are not in the same position(posture) for a long time?	☐	☐
b.	Do you take opportunities to rotate tasks and work different muscle groups?	☐	☐
c.	Do you take breaks throughout the day to stretch?	☐	☐
d.	Do you know how to adjust the workstation to fit your body type?	☐	☐
e.	Is your workstation properly adjusted?	☐	☐
f.	Is there ergonomic equipment available to modify your workstation?	☐	☐

ENVIRONMENTAL		Y	N
1.	**Noise**		
a.	Is the noise level in your workplace low enough not to be distracting?	☐	☐
b.	Room acoustics are suitable for teaching work.	☐	☐
2.	**Light**	☐	☐
a.	Is there enough natural light or artificial light for your online teaching work?	☐	☐
b.	Is a lighting control device available?	☐	☐
c.	Is the monitor screen placed in such a way that light from windows and overhead lighting does not cause glare?	☐	☐
d.	Are movable task or desk lights available?	☐	☐
e.	Do work surfaces have a matte finish to reduce light reflection?	☐	☐
f.	Do you have enough storage space for teaching resources?	☐	☐
g.	The room size is suitable and adequate for teaching work.	☐	☐
3.	**Indoor Air Quality**	☐	☐
a.	The room temperature is comfortable, not too hot, or too cold.	☐	☐
b.	The room ventilation (air circulation) is comfortable.	☒	☐

ORGANISATIONAL		**Y**	**N**
1.	**Time**		
a.	Enough paid time provided to complete all online teaching related work.	☐	☐
b.	Enough paid time provided to complete all student communication related work like answering emails and providing feedback for student assessments.	☐	☐
c.	Enough paid time provided to complete all supervision and to provide assistance to co-workers with online teaching and marking work if required.	☐	☐
d.	Enough paid time provided to research teaching subject information, develop, and update online study materials.	☐	☐
2.	**Technology**		
a.	Information technology (IT) support provided.	☐	☐
b.	Access to highspeed internet.	☐	☐
c.	No technical issues experienced with the online teaching platform (for example, Blackboard).	☐	☐
d.	Having stable internet access during class time	☐	☐
e.	A designated working area at the campus.	☐	☐
f.	Good reliable internet access.	☐	☐
3.	**Other**		
a.	Adequate resources, including software, for online teaching provided.	☐	☐
b.	Flexible work hours and teaching workplaces.	☐	☐

COGNITIVE		**Y**	**N**
1.	**Education**		
a.	Are you provided with education on using relevant policies and procedures?	☐	☐
b.	Is online teaching and technology use education provided?	☐	☐
c.	Are online teaching related documents easy to understand?	☐	☐
d.	Are you provided with adequate education on existing and on new technology available for use for online teaching?	☐	☐
e.	The information provided on the online teaching platform is easy to locate and use.	☐	☐
f.	Do you understand how to use all of the technology required for online teaching?	☐	☐
g.	Mentoring is provided for online teaching work if required.	☐	☐
2.	**Other**		
a.	You are not expected to concentrate on screen-based work for more than 60 minutes without a break.	☐	☐
b.	Enough information is provided on how to make decisions and solve problems that occur as part of online teaching work.	☐	☐
c.	Able to avoid/minimise travel time		

SOCIAL		**Y**	**N**
a.	Sufficient support and guidance are provided for online teaching work.	☐	☐
b.	There is social interaction between you and other staff members.	☐	☐
c.	Language barrier does not affect your ability to communicate effectively with online students.	☐	☐
e.	Do you have visual and auditory contact through the internet with students while teaching online [for example, through Collaborate Ultra video conferencing, Blackboard, or WebEx]?	☐	☐
f.	There is active involvement of students in online classes.	☐	☐
g.	There is appropriate communication between staff and students.	☐	☐
h.	You do not feel isolated when teaching online units of study.	☐	☐
i.	Allowances are made for cultural differences when teaching online.	☐	☐

APPENDIX 16 CASE STUDY 1 & 2

(DOI: https://doi.org/10.5281/zenodo.10056595)

John has been conducting online teaching at the university for five years. He has ongoing employment.

Organisational ergonomic problem.

When he first commenced online teaching, John was allowed three hours per student for marking three pieces of assessment for each student and allowed one hour per student for teaching communication work. John teaches four online units of study each semester as well as conducting research work that he has a funded research grant for. He was also allocated 10 hours per semester per unit of study for marking moderation work and for updating study materials. To save money the university has now cut the amount of time allowed per student from 4 hours to one hour and provides no time for marking moderation work and updating units of study, even though this work still needs to be completed each semester.

How might this affect John's health and quality of work?

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Recommended actions to be taken for risk control.

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Physical ergonomic problem.

John teaches 4 units of engineering study a semester for which he uses three monitors and spends prolonged hours in one position. To complete all his work on time John spends many hours marking student assignments without taking a break and has developed pain in his right hand. wrist and forearm which is becoming worse over time.

How might this John's health and quality of work be affected by these physical ergonomic factors?

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Recommended actions to be taken for risk control.

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Environmental ergonomic problem

John's workstation is in a shared office with eight other educators. He gets disturbed and distracted by the noise generated from colleagues talking on their phone or with students as well as noise coming from the corridor. The room temperature is controlled centrally so it cannot be adjusted and is sometimes too hot or too cold. The windows cannot be opened by staff to allow outdoor air to circulate. There is an unpleasant odour coming from the carpet.

How might these environmental ergonomic problems affect John's health and quality of work?

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Recommended actions to be taken for risk control.

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Cognitive ergonomic problem.

The university has just been provided with some new technology for online teaching. There is information regarding this new technology uploaded to university intranet, but John prefers hands on training to get better understandability as he does not understand the complex technological language used for explaining the new technology. The organisational policies and procedures are available on the university internet site, but John has not read them.

How might these cognitive ergonomic problems affect John's health and quality of work?

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Recommended actions to be taken for risk control.

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Social ergonomic problems.

Though John likes the flexibility of online teaching, he misses the physical and visual interactions with students. With face-to-face teaching John was better able to see the students' level of understanding on the topic from their body language and his interaction with students, but in online he cannot do this as the students do not turn on their camera, rarely speak, and often do not turn up to class as they can watch the recorded online lecture at any time that is suitable for them.

How might this affect John's health and quality of work?

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Recommended actions to be taken for risk control.

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Case study 2

Mary has sessional employment as a subject expert with practical experience, to teach one unit of study for one semester at a university. Her online teaching class time is from 4pm to 7pm on Wednesday evenings. Mary may, or may not, have work the following semester as her current contract is for the fixed term of one semester. Mary is conducting her online teaching from her home. Mary also has 32 hours a week employment in the field of work related to the subject that she teaches at another organisation and has this employer's permission to do the online teaching for the university. Mary has 2 teenage children at home to care for.

Organisational ergonomic problem.

Mary has 60 students in her online class. She is allocated an hour per student per semester to mark each student's assignments. The students generally email queries in addition to the specific allotted slots provided to them for questions, answering these emails takes lot of unpaid times. Mary lives in outskirts of city area and the internet connection is not very good in that area. Mary has been experiencing sudden dropouts while taking online classes which disturbs her and her students. Due to a slow speed, it takes a longer time to upload the teaching related documents, to download assignments for marking, and to upload them when marked which results in Mary spending extra unpaid hours doing this work. The university Information Technology Department does not work in weekends or late night, so if she experiences problems with her internet Mary is unable to get technological support if she needs this during her class or on the weekend when she does her marking or preparing materials for her class. The uncertainty of renewal of the contract makes her anxious.

How might this affect Mary's health and quality of work?

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Recommended actions to be taken for risk control.

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Physical ergonomic problems.

Mary teaches online from home and does not have a designated work area at the university campus. Mary has one 3 hours class a week and teaches using a laptop computer on her kitchen bench and sits on a chair from the dining table. She also does her teaching preparation and marking work at the kitchen bench as she has nowhere else at home to use. The bench is too high, so Mary has to raise her arms and shoulders to do this work. When Mary works for extended periods of time her arms and shoulders become sore and she starts to feel exhausted.

How might this Mary's health and quality of work be affected by these physical ergonomic factors?

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Recommended actions to be taken for risk control.

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Environmental ergonomic problem

Mary has her classes in the afternoon and her kitchen is facing west so she gets bright afternoon sunlight as well as glare from the reflection as the kitchen benchtop is made up with glossy material. The overhead light is also not appropriate for computer work, and she does not have task light. As she has teenage daughters and they come back from school around that time so they sometimes come to kitchen for nibbles or might put something in oven. She cannot use the exhaust fan as this is very noisy.

How might these environmental ergonomic problems affect Mary's health and quality of work?

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Recommended actions to be taken for risk control.

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Cognitive ergonomic problem.

Mary has just started teaching online this semester. Mary knows her teaching subject matter well but has not been provided with any online teaching training, does not know how to locate the online teaching related information, and has a lack of information on decision making, and problem solving for online teaching.

How might these cognitive ergonomic problems affect Mary's health and quality of work?

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Recommended actions to be taken for risk control.

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Social ergonomic problems.

Mary misses the support she would get from her colleagues if she was teaching on campus. Many of the students in Mary's class are international students and come from many different countries with different time zones. Sometimes Mary feels that there is a disconnection with these students as they rarely participate verbally in online classes when she asks for participation. Most of the students do not turn on their mike or video during class and sometimes have poor internet connectivity. Many of the students seem to struggle with English and misinterpret information even after multiple explanations and online demonstrations. Mary spends a lot of time trying to help these students through email communication after classes.

How might this affect Mary's health and quality of work?

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Recommended actions to be taken for risk control.

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APPENDIX 17 CASE STUDY QA 1 & 2

(DOI: https://doi.org/10.5281/zenodo.10056604)

Some possible answers:

Organisational Ergonomics

John's health effect.

- Stress
- Mental health problems.
- More prone to injuries.

Effect on John's quality of work. Working long hours and late at night to complete all his online teaching work can mean that John does not concentrate well and can make mistakes in teaching preparation or marking work.

Risk control suggestions.

John's actions

- John needs to let his line manager know that the time provided for his online teaching work is insufficient. If no action is taken by his line manager or the university management staff, then John should inform his Union Representative of the inadequate time provided for online teaching work.
- John needs to ask his line manager for additional help with marking student assignments to be provided if he is struggling to mark the student assignments and to also conduct other online teaching work within the allocated time.
- If John still has insufficient time next semester, then he would need to change at least 2 of the assessments in each unit of study to assignments that can be marked through an automated process.

University actions

- There should have been University management consultation with staff `before reducing the number of paid hours to complete online teaching, marking and other work, and if a reduction in hours was required there should have been at least a semester's notice so that the educators could plan for how they would achieve their work in this time. There needs to be better change management.
- The university needs to consult with staff, reassess its workload model, and provide a more reasonable amount of time for online teaching related work.
- If the university has financial constraints that prevent it from allowing staff adequate work time, then the number of pieces of assessment that students have marked by their educator for each unit of study should be changed from 3 to 2 assessments per student.

Physical ergonomics.

John's health effect.

- Using more than one monitor requires continuous neck rotation and this may cause neck pain.
- Repetitive strain injury due to repeated right-hand actions when marking student assignments.

- Fatigue due to long work hours and inadequate breaks.

Effect on John's quality of work.

- Lower motivation and productivity due to pain and fatigue.
- Increased absenteeism due to experiencing health issues.

Risk control suggestions.

John's actions

- John needs to see a medical practitioner to have treatment to relieve the pain in his right hand. wrist and forearm.
- John may need to have several week's break from marking to rest the muscles and tendons in his right hand, wrist, and forearm.
- John needs to minimize repetitive hand movements and alternate between activities and tasks to reduce the strain on his right hand and wrist. John needs to keep his wrists straight or in a neutral position when marking and avoid holding an object, such as a pen, the same way for a long time. John also needs to take a 10-minute break every hour when doing repetitive work. He needs to consider if some assignments can be marked online and some by hand to vary the muscles used when marking. John needs to be aware that repeated computer mouse use without adequate break times can cause repetitive strain injury.

University actions

- More time and task variety should be provided for work. If John has assignments to mark for more than 120 students a semester, the number of units of study that John marks student assignments for should be reduced.

Environmental ergonomics

John's health effect.

- Stress
- Headache
- Itchy nose
- Nausea
- Lack of concentration.

Effect on John's quality of work.

- John gets distracted by the noise generated by other members of the shared office space and this causes lack of concentration and lower productivity.
- He is disturbed by other people in the office when conducting his online teaching which lowers the quality of his teaching.
- John has to be quite when other members in the office are conducting online teaching which limits the work that he can do.
- The university campus has a central heating, cooling and ventilation system, which generates temperatures that make working uncomfortable and cause loss of concentration and productivity.

Risk control suggestions.

John's actions

- When the room temperature is unsatisfactory John needs to report this to maintenance. Maintenance then needs to identify the cause of the problem and adjust the temperature so that it is comfortable for the room occupants.
- John needs to notify maintenance staff that there is an unpleasant odour coming from the carpet in his room and that the odour is made worse by lack of effective ventilation.
- John should use noise cancelling headphones when working in the office to avoid noise distraction.
- John needs to request to have a private room to use to do his online teaching in.

University actions

- When notified by John that the room temperature is unsatisfactory university maintenance staff should identify the cause of the problem and adjust the temperature so that it is comfortable for the room occupants.
- Maintenance staff should investigate the cause of the carpet odour when notified of this by John. The cause of the unpleasant odour should be removed, and this may mean removing and replacing the floor covering.
- The ventilation system needs to be checked by maintenance staff and the air flow increased so that the ventilation is comfortable for the room occupants.
- Maintenance staff should regularly check that the heating, cooling and ventilation system is working effectively.
- Educator are provided with a classroom when teaching on campus. Similarly, a classroom or a private room should be provided to educators by the University when they are teaching a class online.
- Teaching staff with ongoing employment should have an office space of their own to conduct their teaching and research work in. This will also give the educators a private space to talk to students in when this is required.

Cognitive ergonomic problem.

John's health effect.

- Stress
- Anxiety
- Burnout

Effect on John's quality of work.

- As John has not read the university policies and procedures, he does not always complete his work the correct way.
- John does not use the new technology supplied by the university as he does not understand how it works.

Risk control suggestions.

John's actions

- John needs to take the time to read the university policies and procedures that are related to his work so that he can use them. If there is anything that John is not sure about in the policies or procedures, he needs to ask his line manager to clarify this information so that he understands what to do.

- John needs to request that a member of the Information Technology (IT) Department staff to come to his office to show him how to use the new technology and to supervise him in using it if he still has problems with using this technology.

University actions

- The University should have an orientation program for all new staff in which the university policies, procedures and how to use them effectively are explained to staff. The staff need to be shown how to access these policies and procedures on the university internet site and hard copies of the most important policies and procedures should be given to the staff for their ongoing use.
- When new technology is provided for online teaching, there should be hands on use classes provided for the staff who are expected to learn to use this technology. Mentoring should also be provided for staff who require ongoing education to understand how to use this technology effectively. For staff who are not able to attend the on-campus classes there should be an online tutorial provided on how to use the new technology. Staff need to be notified about and sent the link for this online tutorial as it will also be a good revision tool for staff who attend the on-campus presentation.

Social ergonomic problems.

John's health effect.

- Lack of social interaction can cause adverse health consequences that can include poor physical health, higher rates of cardiovascular disease, sleepiness, reduced immune function, low self-esteem, pessimism, hostility, a decline in cognitive function, 50% increased risk of dementia, anxiety, depression, and suicide.

Effect on John's quality of work.

- John does not always know the level of students' understanding of a topic which makes his teaching less effective.

Risk control suggestions.

John's actions

- John needs to understand that online teaching is not the same as classroom teaching. Most of the students studying online are enrolled this way because they are unable to attend classes due to working at the time that the classes are held, or because of time differences, or distance.
- For the students who do attend the online classes John needs to ask these students to turn their cameras on so that he can see them and get to know them better. If students are unwilling to talk, they can type question answers and other information relevant to the class in the chat box as they may feel more comfortable communicating this way. At the end of each class John needs to ask questions to check that the students who attended the class understood the concepts that were presented.
- For students who will watch and listen to the classes after John has completed teaching, John needs to have an area on each unit's Blackboard (or which ever learning platform is used) where students can post questions to be answered by John if they require further information about what was presented in class, or their unit assignment work. This way all students can learn from John's answers. Frequently emailed questions to John can also have their answers emailed to the whole class if the answers provided will increase the students' understanding of the topic.

- John needs to be available to answer students' questions related to each unit of study that he teaches.
- When marking student assessments, if a lack of understanding of a concept is identified then John needs to revise this concept in his next online class and check that the students who do attend class understand and can use this concept.

University actions

- The university workload model must provide sufficient time for staff who teach online to have the time to answer students' questions after classes to ensure effective learning.

Case Study 2

Some possible answers.

Organisational Ergonomics

Mary's health effect.

- Stress
- Anxiety
- Sleep deprivation, which is linked to many chronic health problems, including heart disease, kidney disease, high blood pressure, diabetes, stroke, obesity, and depression.
- More prone to injuries.

Effect on Mary's quality of work.

Working extended hours due to various reasons like communicating with her students, dealing with inadequate internet may result in lack of sleep and family time. Lack of sleep can affect Mary's concentration. This may mean that Mary makes mistakes when teaching or marking students' work due to fatigue. Mary is also worried that if she does not answer all student communication she may not be employed in the future by the University and this anxiety is contributing to her lack of sleep.

Risk control suggestions.

Mary's actions

- Mary needs to let her line manager know that there was no specific time allotted for unit of study related communication with students and ask for extra paid hours to be provided for student communication as this communication is taking up many hours a day.
- Mary should call a technician to move her internet router off the floor and replace the router's antenna to reduce wireless interference and to change the wireless channel to improve her internet connectivity.
- If the above-mentioned does not help to improve the internet connectivity, Mary should try another internet provider as an option to solve the internet issue.
- During office hours Mary needs to let the University Technical Support Department staff know about the problems that she has been having with her internet and ask for their advice about solving these problems.
- Mary needs to understand that her employment is only for one semester and that future employment at the University will depend on whether there are enough staff or not with the required expertise to do the teaching.

University actions

- The University management staff should look at the amount of time per student allocated to staff who teach online classes and ensure that a satisfactory amount of communication time per student is included in the teaching and assignment marking time.
- There should be implemented a mentoring program and regular line management follow up system in place for educators new to online teaching to provide guidance and support with conducting the university work. A mentor may be able to assist Mary with finding more efficient ways of communicating with online students that takes less time.
- As online classes are also taught in the evening the University should provide technical support for staff who teach online in the evening and who require this support. This would include rearranging the times that technical support staff are employed to work to cover all teaching hours.

- When student numbers for the following semester are known the University management should let Mary know if she will be required to teach a unit of study again for the next semester.

Physical ergonomic factors

Mary's health effect.

- Back, neck and shoulder pain.
- More prone to develop a work related muscular skeletal disorder.

Effect on Mary's quality of work.

Mary's online teaching preparation and marking work is slowed down by her back, neck, and shoulder pain.

Risk control suggestions.

Mary's actions

- Under the Work Health and Safety Act Mary has the responsibility to take reasonable care of her own health and safety. See Safe Work Australia. (2023). Working from home. Worker information sheet https://www.safeworkaustralia.gov.au/doc/worker-information-sheet-working-home Mary needs to do this.
- Mary can request that the University provide her with an ergonomic assessment of her workstation, a hazard assessment of her workplace and work processes, and request implementation of risk control measures for hazards identified. Safe Work Australia (2023) has a Working from home checklist that can be used. https://www.safeworkaustralia.gov.au/doc/working-home-checklist
- If there is room in her house and she can afford it, Mary should purchase a suitable work desk and chair. See Safe Work Australia (2023) Setting up your workstation infographic https://www.safeworkaustralia.gov.au/doc/setting-your-workstation-infographic
- If the above is not possible Mary should ask her line manager if she can be allocated a workspace on campus with suitable furniture to use to do her online teaching, preparation and marking work.

University actions

- Under the Work Health and Safety Act the University has the responsibility to provide Mary with a safe and healthy workplace and work processes, and implement risk control measures if hazards are identified, even if Mary is working from home. See Safe Work Australia. (2023). PCBU information sheet: working from home. https://www.safeworkaustralia.gov.au/doc/pcbu-information-sheet-working-home This should be done.
- Mary should be provided with a workspace on campus for her university work if it is not possible for her to work safely from home.

Environmental ergonomic problem

Mary's health effect.

- Headache
- Eye strain
- Blurry vision

Effect on Mary's quality of work.

- The glare makes it difficult for Mary to see the computer screen and this slows her work.
- Poor lighting makes it difficult for Mary to see and concentrate on her work.
- Noise from her children makes it difficult for Mary to teach online effectively.

Risk control suggestions.

Mary's actions

- Mary should purchase and use correct lighting for her computer and other online teaching and marking work that is conducted at home.
- Mary should have blinds on the windows of her house to reduce afternoon sun glare.
- Mary should have a designated quiet area for online teaching. If this is not possible at home, then Mary's online teaching work should be conducted at the university campus.

University actions

- The University management should meet their duty of care under the workplace health and safety legislation.
- If Mary is unable to control the health and safety risks when working from home the University should provide Mary with a campus workspace that is safe and health for her to conduct her university work.

Cognitive ergonomic problem.

Mary's health effect.

- Stress
- Anxiety
- Burnout

Effect on Mary's quality of work.

Not having any training in online teaching work, not being shown how to locate online teaching related information, and not being provided with information on decision making and problem solving for online teaching would reduce the effectiveness and efficiency of Mary's work.

Risk control suggestions.

Mary's actions

- Mary needs to let her line manager know about the lack of her training related knowledge and ask for some paid training hours to be able to improve the effectiveness and efficiency of her work.
- Mary should ask her line manager for a mentor to guide her in understanding the university requirements and Mary's online teaching work.
- Mary should ask her line manager where to find training option through the university intranet if she is unable to attend the on-campus orientation.

University actions

- The University should provide orientation training for all staff. University staff should be paid to attend this training. Orientation education should be provided on campus for staff who can attend, and online for staff who are unable to attend on campus classes. A certificate of attendance that includes the subjects taught should be provided.
- When requested the University should provide a mentor for Mary for her first semester of online teaching.

Social ergonomic problems.

Mary's health effect.

- Depression
- Anxiety
- Stress
- Loneliness

Effect on Mary's quality of work.

Mary feels less productive and engaged in her teaching work due to her feeling of isolation.

Risk control suggestions.

Mary's actions

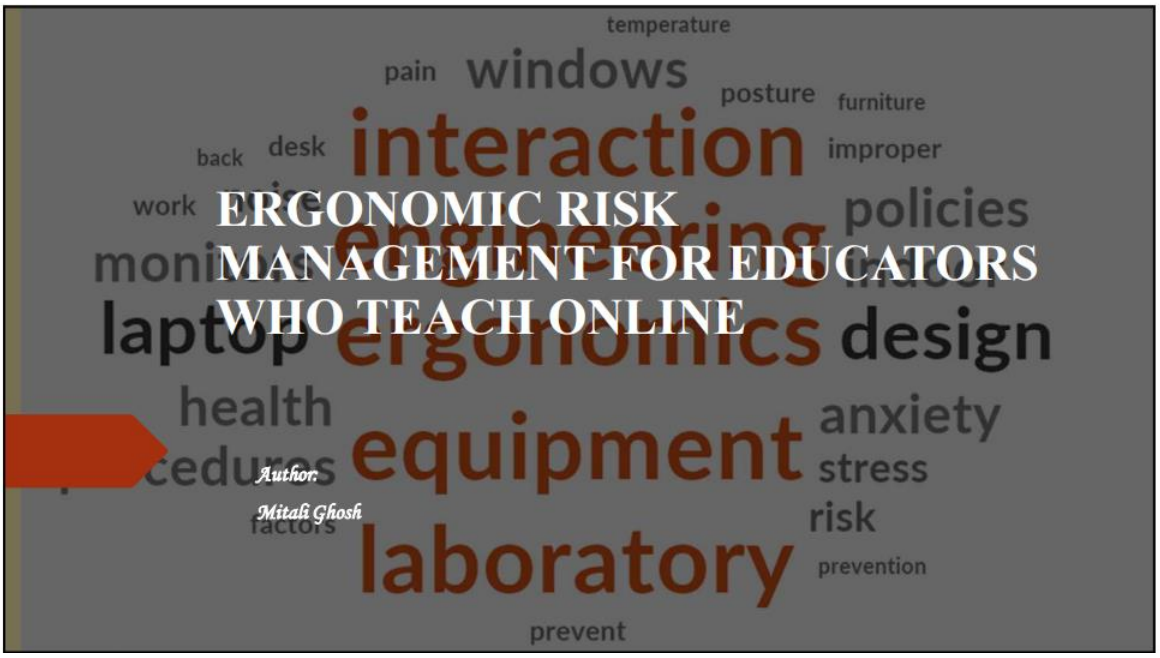
- Mary needs to ask her line manager for a mentor as this will provide her with a supportive colleague to work with.
- Mary can consider designing her class materials with more interactive components like quizzes, live discussion, group work, etc.
- Mary should tell students that the recorded online classes can be played multiple times if they would like this to improve their understanding of the course materials, particularly if they miss parts of the class due to a poor internet connection.
- Mary needs to limit the amount of time that she spends answering emails and post general study related information on the learning platform (such as Blackboard) for commonly asked questions so that all students have access to this information and do not have to email her individually to ask for the same information.
- For students struggling with English Mary can refer these students to the learning advisor to undertake English improvement classes. Mary can also put the students into study groups to support each other in their subject learning. At least one student in each group should have English as their first language.
- In class Mary needs to provide opportunities for students to demonstrate their understanding in practical situations of the information presented and then ask for student feedback on what they have learnt to check that they understand the required concepts.
- At the commencement of each new class Mary should revise the information from the previous class and check that the students understand the main concepts from their previous class.
- Mary needs to ask the students to turn on their video and mike if she wants to see and hear them.

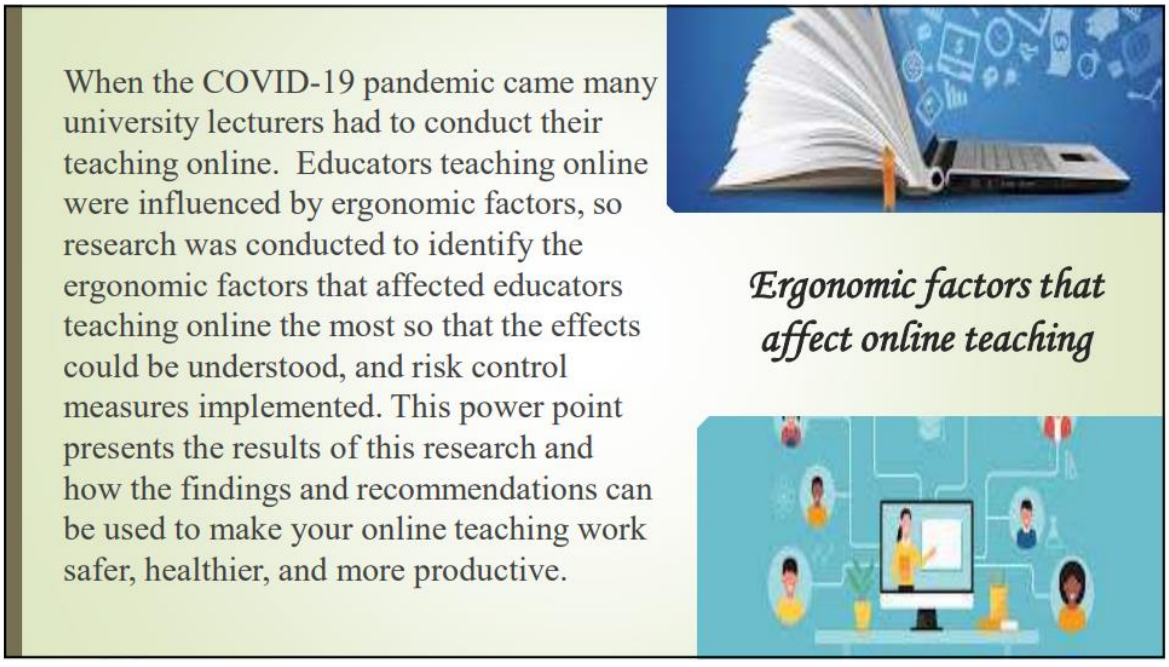
University actions

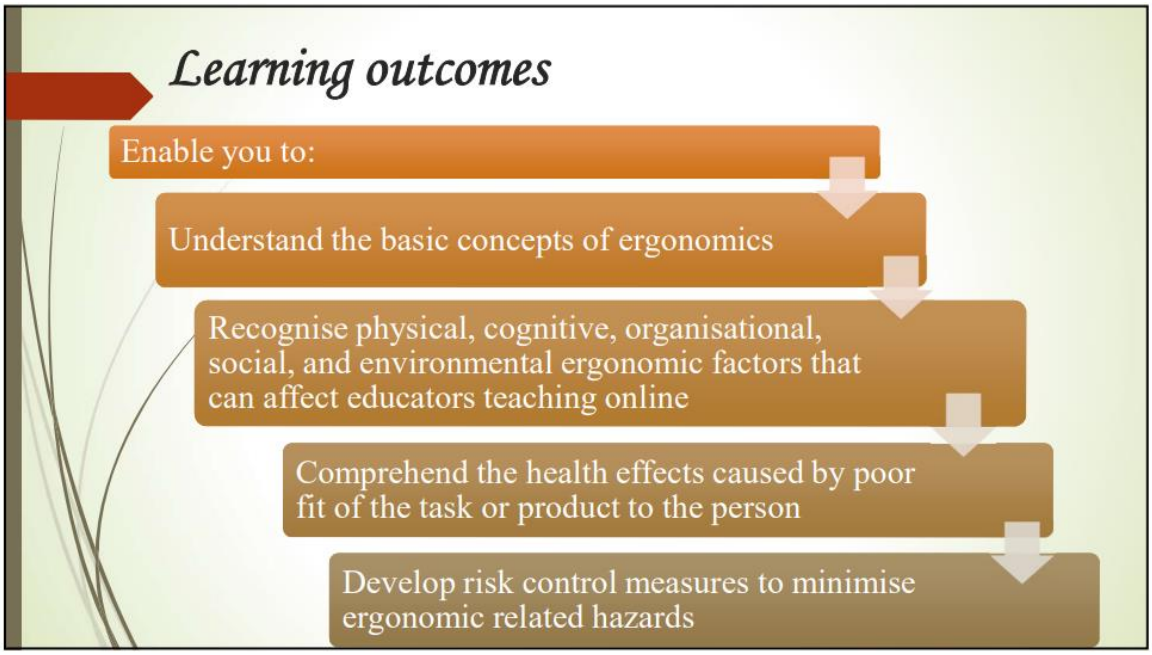
- University management should consider the time zones that most students live in, and their employment times when preparing the timetable.
- University should provide an experienced educators as a mentor for Mary so that Mary can get help when required for her online teaching work.

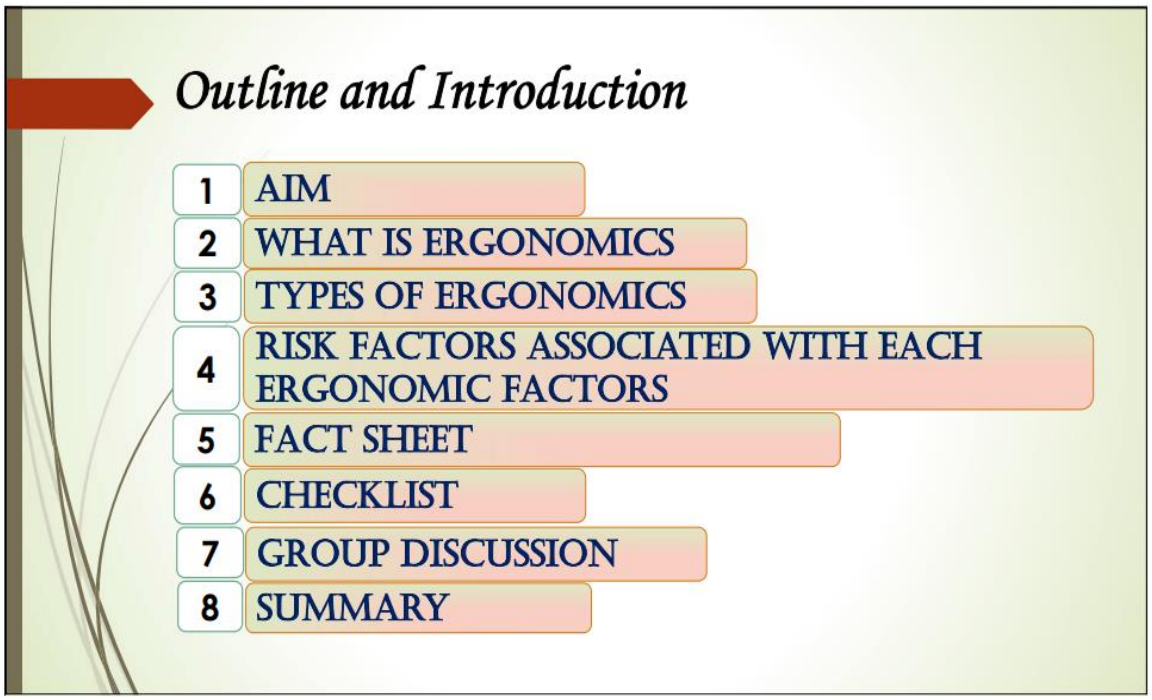
APPENDIX 18 ORIENTATION POWERPOINT PRESENTATION

(DOI: https://doi.org/10.5281/zenodo.10056622**)**





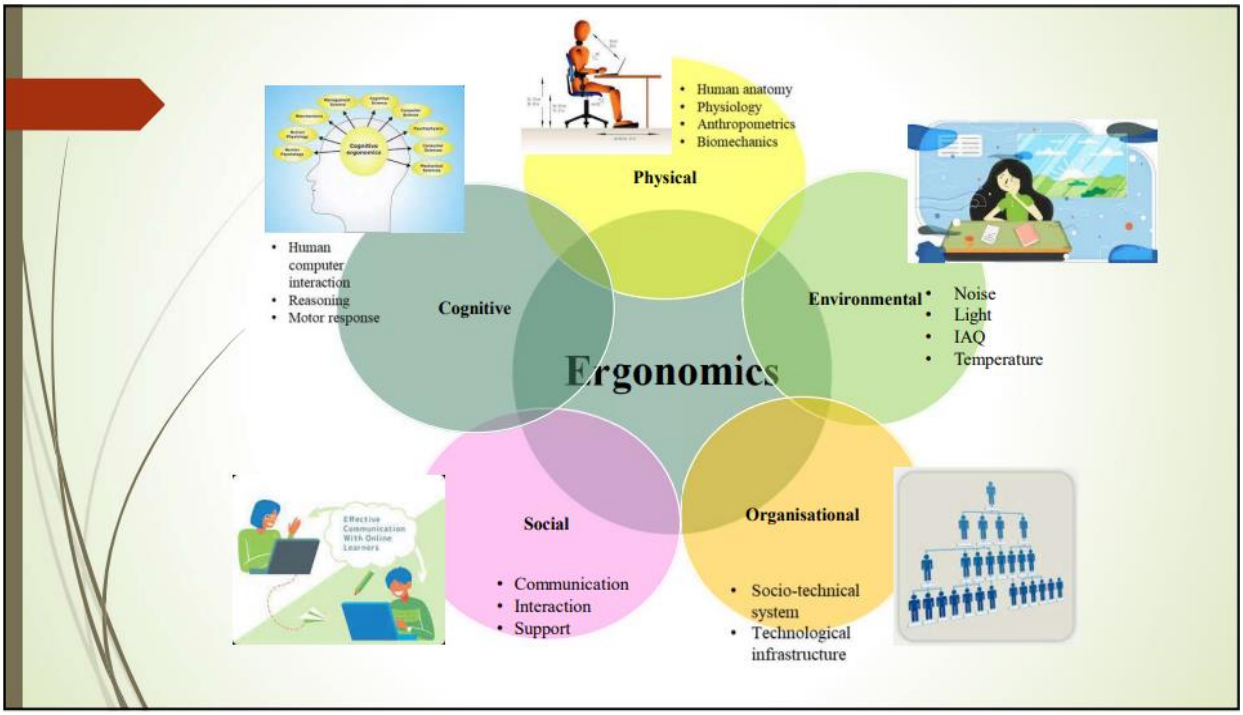

Learning outcomes
Enable you to:
Understand the basic concepts of ergonomics
Recognise physical, cognitive, organisational, social, and environmental ergonomic factors that can affect educators teaching online
Comprehend the health effects caused by poor fit of the task or product to the person
Develop risk control measures to minimise ergonomic related hazards

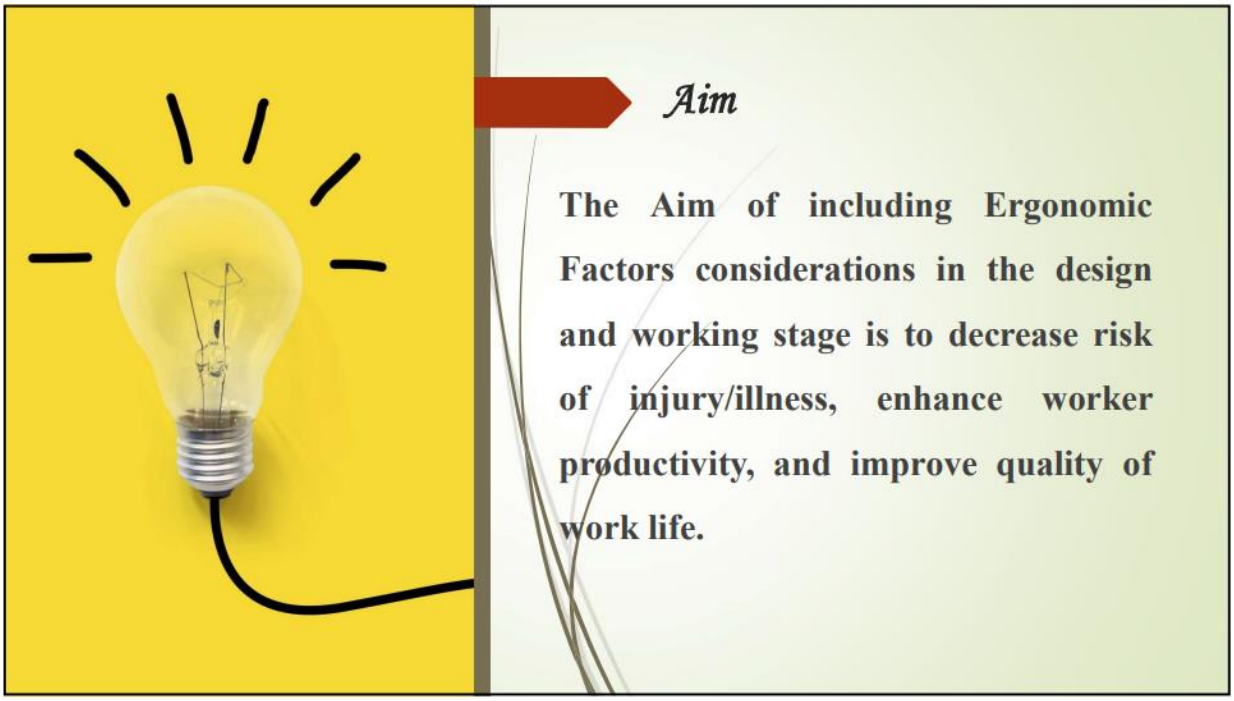

Outline and Introduction
1 AIM
2 WHAT IS ERGONOMICS
3 TYPES OF ERGONOMICS
4 RISK FACTORS ASSOCIATED WITH EACH ERGONOMIC FACTORS
5 FACT SHEET
6 CHECKLIST
7 GROUP DISCUSSION
8 SUMMARY

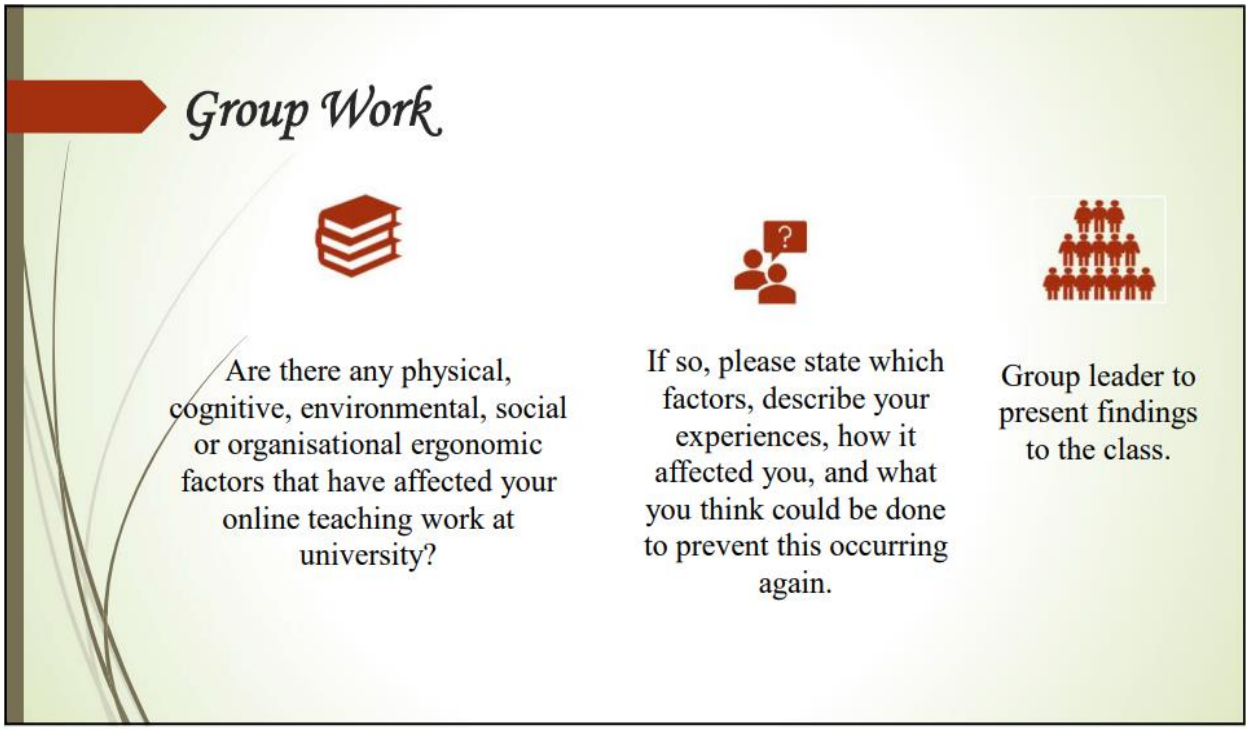
What is Ergonomics?

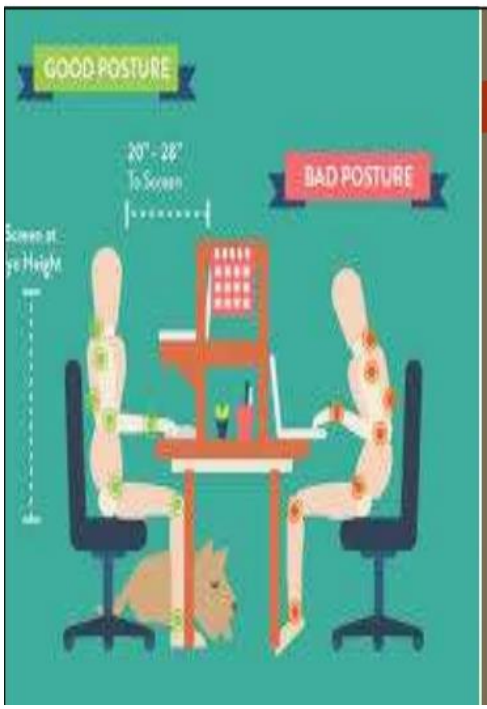
Ergonomics is fitting the task to the person and the product to the user. Five ergonomic factors are to be considered. They are

- **Physical (human anatomy fit related to physical activities conducted)**
- **Environmental (fitting the work environment to human needs)**
- **Organisational (factors controlled by the university, or other organisation employed at)**
- **Cognitive (how people think and process information)**
- **Social ergonomic factors (interaction with people)**




Aim
The Aim of including Ergonomic Factors considerations in the design and working stage is to decrease risk of injury/illness, enhance worker productivity, and improve quality of work life.


Group Work
Are there any physical, cognitive, environmental, social or organisational ergonomic factors that have affected your online teaching work at university?
If so, please state which factors, describe your experiences, how it affected you, and what you think could be done to prevent this occurring again.
Group leader to present findings to the class.



Physical Ergonomics

Physical ergonomics is cconcerned with human anatomical, anthropometric (includes height, reach, width of a person), physiological and biomechanical characteristics as they relate to physical activity. Includes considering working postures, manual handling, movement, and workplace layout.

Physical Ergonomics

1. Ergonomic factors need to be considered for human well-being, productivity, and injury prevention.
2. Long periods of sedentary work can cause obesity, diabetes, muscle weakness and stiffness.
3. Muscles need to be used regularly to maintain their strength.

Physical Ergonomics

The following physical ergonomic factors are responsible for developing a Musculoskeletal Disorder.

- Repetitive writing or computer work (Wrist and elbow pain, tingling, inflammation, carpal tunnel syndrome)
- Awkward body posture (Back pain)
- Stationary position (Shoulder discomfort)
- Prolonged time focusing on a computer monitor (Eye strain)
- Direct pressure under knee due to inadequate chair height (muscle strain and chronic lower back pain)
- Incorrect height of computer monitor (Neck and shoulder discomfort)
- Prolonged sitting with back straight (Back pain due to static muscle loading)

Physical Ergonomic enabling factors and Risk control Measures

- Correct keyboard position.
- Workstation with enough width and adjustable height.
- Fully adjustable chair
- Good posture.
- Ability to move to change position. No prolonged sitting or standing.
- Sit-to-stand desk to enable posture variation.
- Enough space for resources with the most used resources closest.
- Adequate work-related storage space with easy accessibility.
- Having an ergonomic assessment of university and home office provided by the organisation and ergonomic equipment and advice provided as required.

Environmental Ergonomics

Considers the environment in which people work and looks at fitting this to the person so they can work safely and productively.

Aspects of environmental ergonomics include temperature (heat, cold), the design of the physical environment, lighting, vision, noise, and vibration.

Environmental Ergonomic Factor

The following factors are responsible for environment related ill health

Noise (Stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, lost productivity).

Light (Eye strain. Eye discomfort (burning, headaches).

Temperature (Fatigue, heat and cold-related medical conditions).

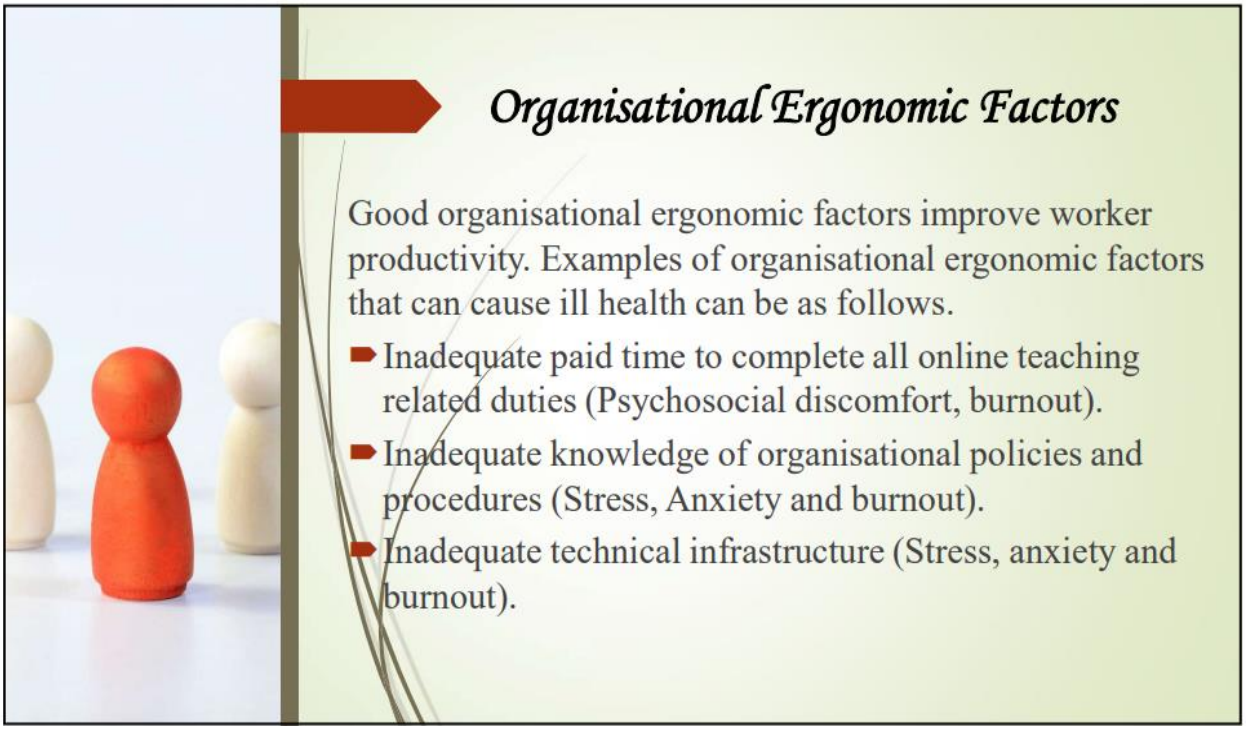
Ventilation and Indoor Air Quality (Dry throat and eyes, concentration disorders, fatigue, headaches, shortness of breath, poor sleep, drowsiness, dizziness, sick building syndrome).

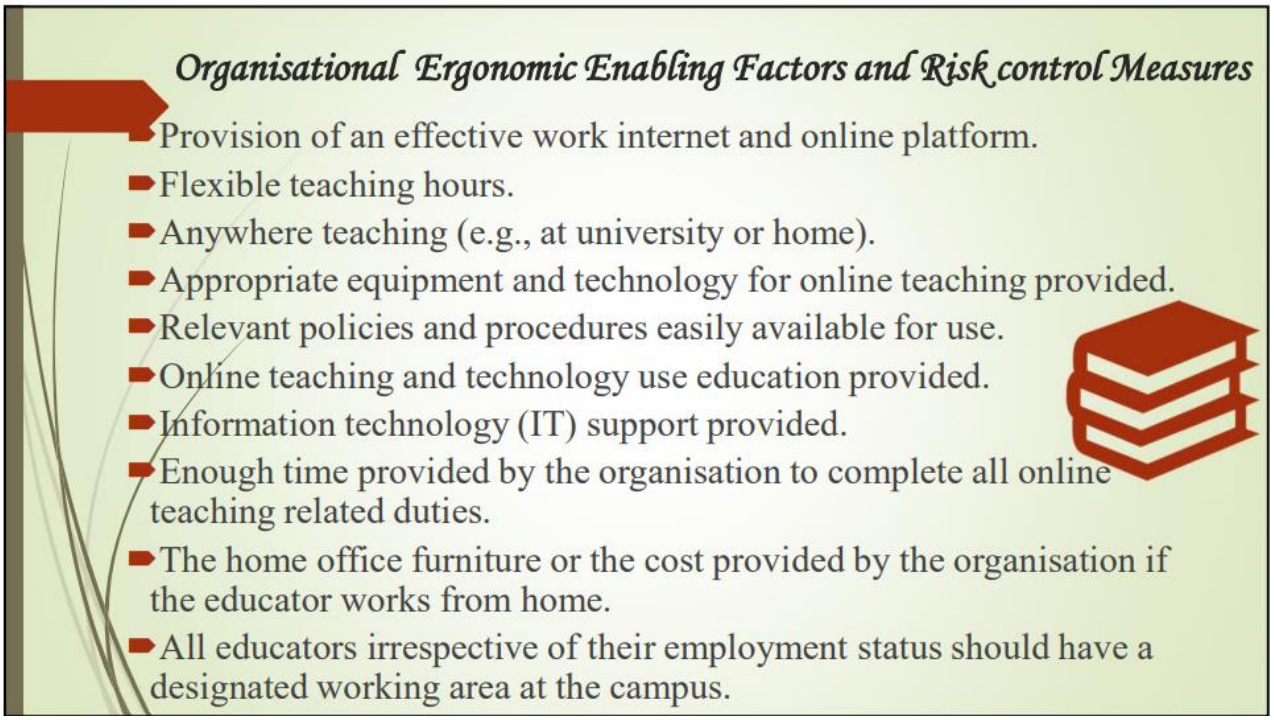
Environmental Ergonomic enabling factors and Risk control Measures

- Accessibility of both natural and artificial ventilation control systems
- Lighting control device
- Having Task light
- Suitable temperature control system
- Ventilation and air quality
- Room size
- Rooms with good acoustic and noise cancellation facility
- Matt finish worksurfaces
- Provision of having a separate quite place for online teaching

Organisational Ergonomics

Is the way that work is designed to meet the physical, cognitive, environmental and social requirements of people doing the work and the requirements of the organisation for products and / or service outputs. Includes work design, job redesign, job tasks and characteristics, job rotation, vertical and horizontal job enlargement, job enrichment, work characteristics, job satisfaction, amount of time allocated for work tasks, management, and factors controlled by the organisation.


Organisational Ergonomic Factors
Good organisational ergonomic factors improve worker productivity. Examples of organisational ergonomic factors that can cause ill health can be as follows.
Inadequate paid time to complete all online teaching related duties (Psychosocial discomfort, burnout).
Inadequate knowledge of organisational policies and procedures (Stress, Anxiety and burnout).
Inadequate technical infrastructure (Stress, anxiety and burnout).


Organisational Ergonomic Enabling Factors and Risk control Measures
Provision of an effective work internet and online platform.
Flexible teaching hours.
Anywhere teaching (e.g., at university or home).
Appropriate equipment and technology for online teaching provided.
Relevant policies and procedures easily available for use.
Online teaching and technology use education provided.
Information technology (IT) support provided.
Enough time provided by the organisation to complete all online teaching related duties.
The home office furniture or the cost provided by the organisation if the educator works from home.
All educators irrespective of their employment status should have a designated working area at the campus.

Cognitive Ergonomic Factors

Relates to how people think and process information. Includes learning, memory, attention, problem solving, motivation and perception. Needs to be considered when designing work tasks, allocating work tasks, designing equipment, placing equipment for use by people and when designing signs, online and printed information.

Cognitive Ergonomic Factor

Examples of cognitive ergonomic factors can cause ill health and decrease productivity can be as follows.

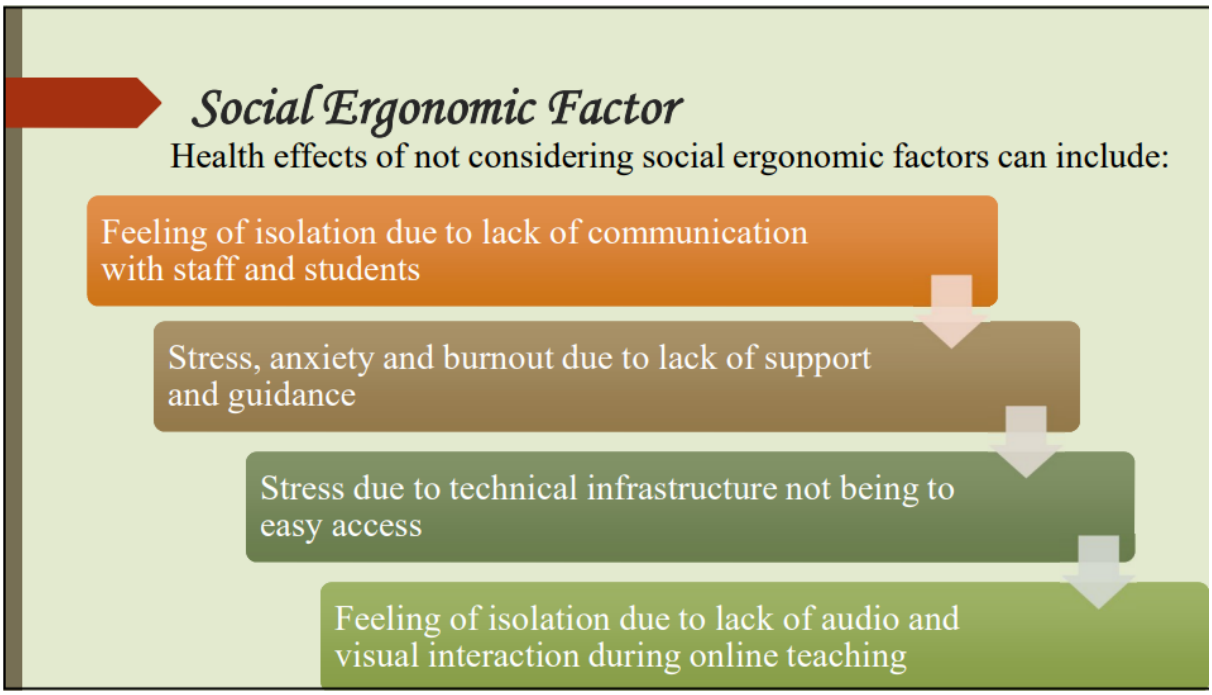
- Provision of inadequate information hinders decision making ability and can cause stress.
- Lack of effective training for new and existing online teaching related technologies can cause anxiety.
- Technical documents written in complex language can cause lack of understanding, stress and burnout.

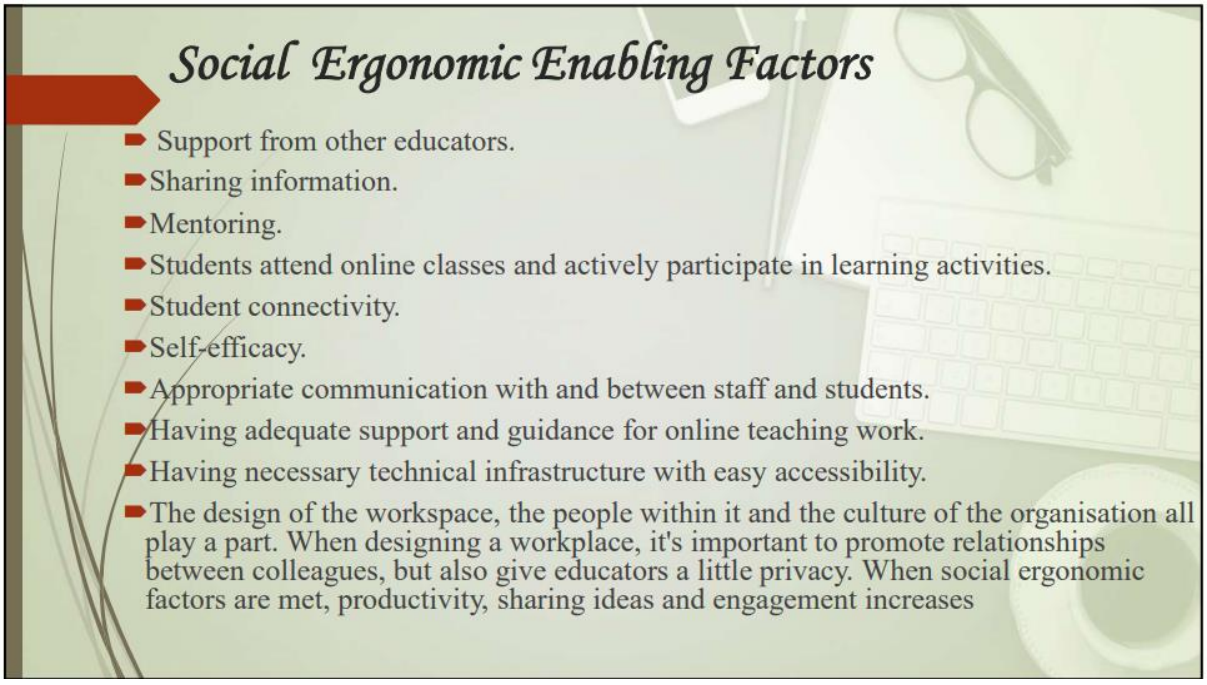
Cognitive Ergonomic enabling factors and Risk control Measures

- Provision of adequate information that is understood enables better critical thinking skills and decision making.
- Online teaching technology logical, easy to understand and use.
- Mentoring.
- Education provided on the use of policies and procedures. Policies and procedures are easy to locate and use.
- Accessibility to training on new and existing online teaching related technologies.
- Technical documents written in simple language.
- Have provision for a work break in every hour

Social Ergonomic Factor

Considers people's social needs at work as well as human potential and limitations. Includes meeting people's social needs, group work, socially caused stress [e.g., bullying, lack of privacy], hours of work, workplace culture, relationships, and communication.


Social Ergonomic Factor
Health effects of not considering social ergonomic factors can include:
Feeling of isolation due to lack of communication with staff and students
Stress, anxiety and burnout due to lack of support and guidance
Stress due to technical infrastructure not being to easy access
Feeling of isolation due to lack of audio and visual interaction during online teaching


Social Ergonomic Enabling Factors
Support from other educators.
Sharing information.
Mentoring.
Students attend online classes and actively participate in learning activities.
Student connectivity.
Self-efficacy.
Appropriate communication with and between staff and students.
Having adequate support and guidance for online teaching work.
Having necessary technical infrastructure with easy accessibility.
The design of the workspace, the people within it and the culture of the organisation all play a part. When designing a workplace, it's important to promote relationships between colleagues, but also give educators a little privacy. When social ergonomic factors are met, productivity, sharing ideas and engagement increases

Why it is important to consider ergonomic factors?

Ergonomics can improve the health of the employees by reducing work-related injuries, most often caused by strains and over-exertion. Ergonomic workstations can help individual feeling less mind and body tension as the height of the workstation adjusted according to individuals body structure.

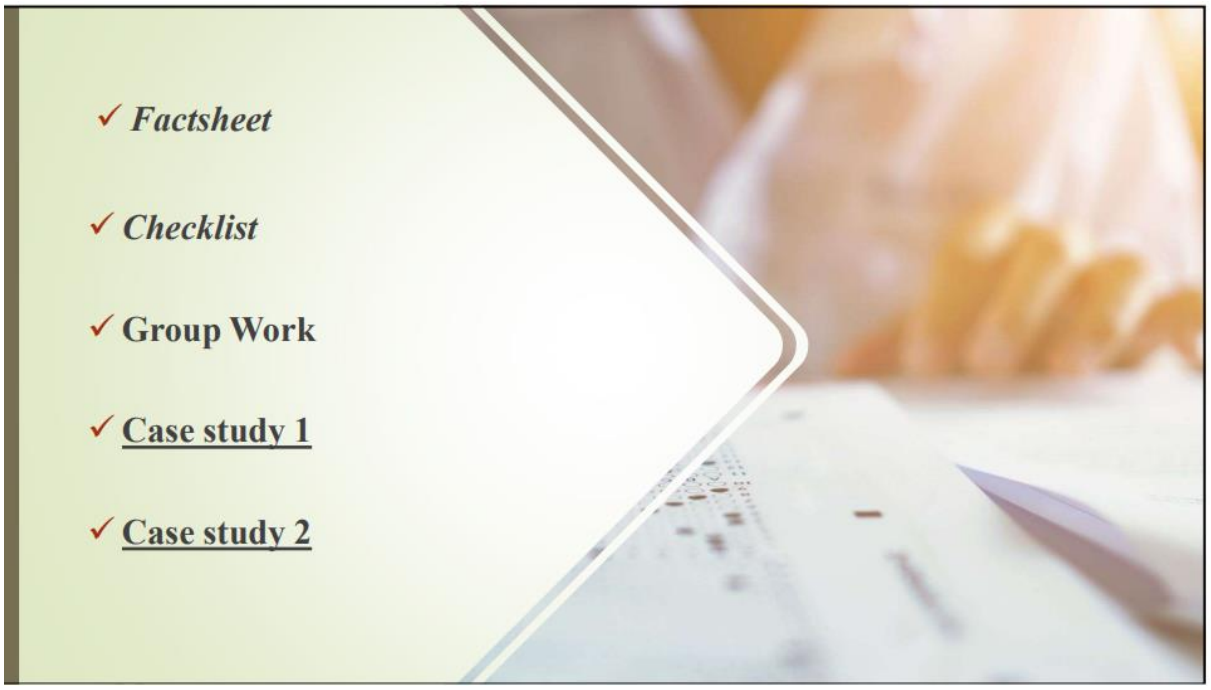
Implementing ergonomic interventions can reduce the risk factors that lead to discomfort like fatigue and other MSDs eventually helps to improve productivity, efficiency and employee satisfaction.

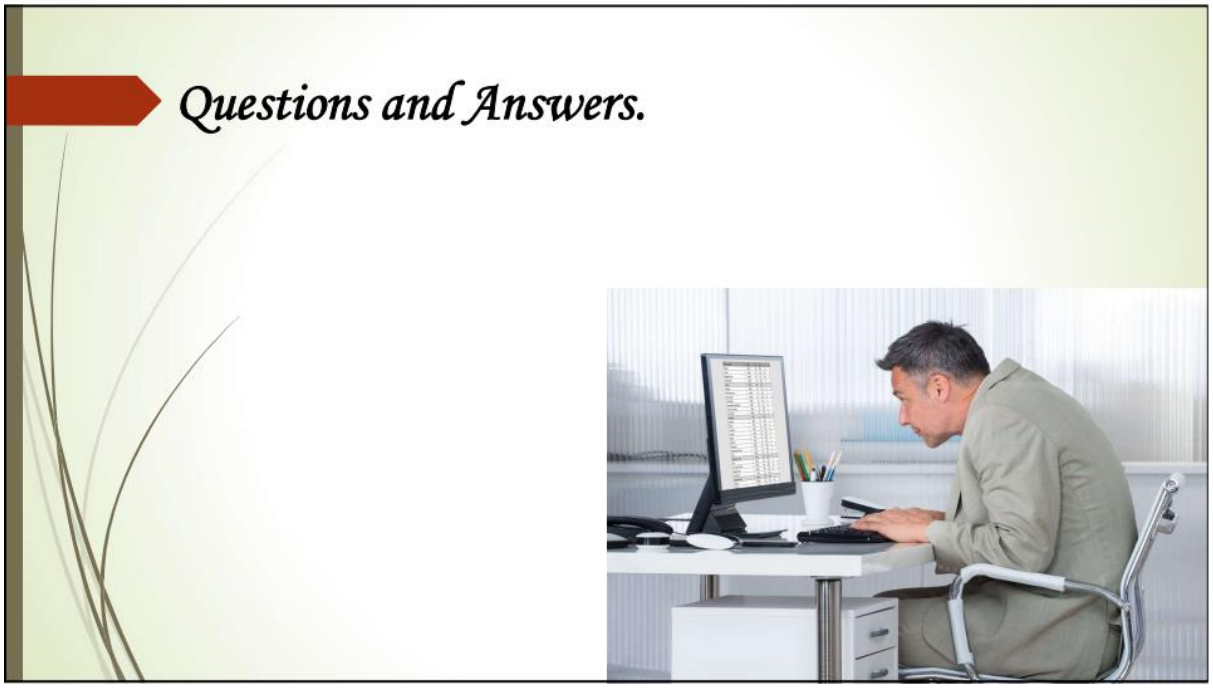
Better organizational and cognitive ergonomics can reduce mental stress, burnout and anxiety and improve efficiency and productivity.

Social ergonomic factors helps to reduce feeling of isolation in online teaching thus improves motivation

Learning outcome achievement

- What are the basic concepts of ergonomics?
- What physical, cognitive, organisational, social, and environmental ergonomic factors that can affect educators teaching online?
- What health effects can be caused by poor fit of the task or product to the person who conducts online teaching?
- What risk control measures can be used to minimise ergonomic related hazards?


✓ Factsheet
✓ Checklist
✓ Group Work
✓ Case study 1
✓ Case study 2


Questions and Answers.

APPENDIX 19 WCE-2023 CONFERENCE POWERPOINT PRESENTATION

The Organizing Committee of The 5th World Congress of Education (WCE) Presents This Certificate of Participation To

Ms. Mitali Ghosh

For your active participation and invaluable contribution with an Online Video Speech by titled "An Evaluation of Tertiary Educators' Perception of Online Teaching Related Ergonomic Factors for Mining and Other Educators" in WCE-2023 held on November 15-17, 2023 at Hotel emisia Sapporo, Sapporo, Japan.

Xiaodan Mei, Ph.D.
Executive Chair

Curtin University

An Evaluation of Tertiary Educators' Perceptions of Online Teaching Related Ergonomic Factors for mining and other educators

Conference Presentation

Mitali Ghosh

Curtin University- WASM: Minerals, Energy and Chemical Engineering (WASM-MECE)

1

Outline

- Research Background
- Objectives
- Literature Review Findings
- Materials and Methods
- Findings of Qualitative Analysis
- Findings of Quantitative Analysis
- Recommendations
- Risk management tools

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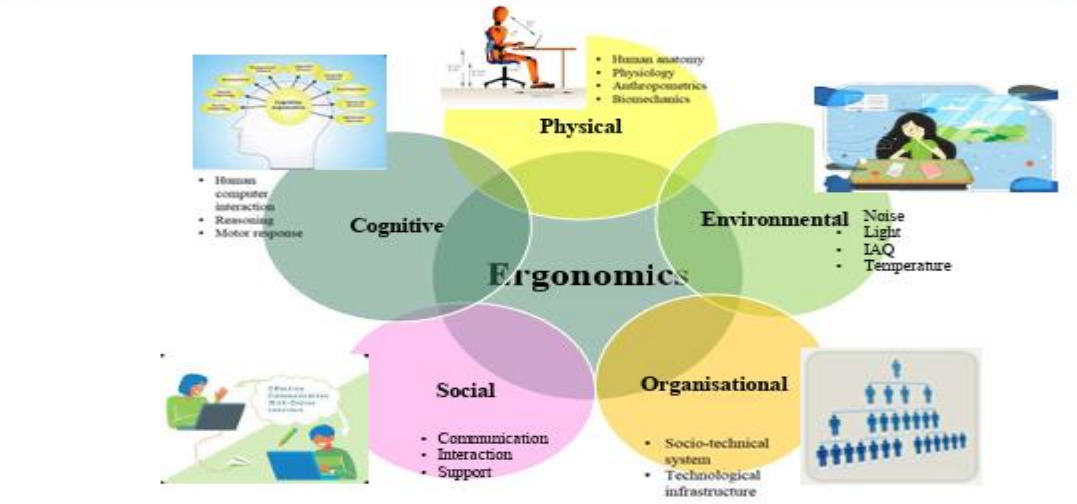
2

Ergonomic Factors



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Research Problem

In this digital communication age, with COVID-19 restrictions that came into place in many universities worldwide after March 2020, universities are using online communication as a pedagogical method of teaching and student learning. As a result, there was a need to evaluate the ergonomic factors that affect educators who provide online student educations.

Research Significance

To date and knowledge, there has been no known previous research published that identifies the influence of ergonomic factors on university educators teaching online especially in minerals and mining engineering. This research will potentially provide valuable insight into the perceptions of educators of how five ergonomic factors impact their online teaching. It is expected that the findings will assist with identifying factors that facilitate, and factors that are barriers, to online teaching and if years of online teaching experience influences the effect of ergonomic factors. Research results will add to ergonomic and online minerals and mining engineering ergonomic theoretical knowledge.

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Research Aim and Objective

The Aim of this study was to identify and assess ergonomic factors that affected educators' experience with online teaching.

Based on the research aim the objectives were to identify the:

1. Ergonomic factors that were perceived by university educators to facilitate the provision of online teaching for minerals and mining engineering.
2. Ergonomic factors that were perceived by university educators to be a barrier to providing online teaching.
3. The differences in perceived factors between engineering and other academics.
4. Causal relationship of five ergonomic factors towards experience in online teaching.

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Literature Review Findings

- Online education gained popularity due to its flexibility.
- COVID-19 outbreak forced the education system to digitalise.
- All educators irrespective of their employment type, have been reported as struggling between the allocated time [an organisational ergonomic factor] and the real-time spent providing online education which can increase stress .
- Factors related to five ergonomic factors were also affecting online educators.

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Research Methodology

Phase 1

- The questions for the Focus Group were developed by reviewing and analysing published Literature.
- Recruiting the focus group participants for 4 mini online focus group discussions with total of 12 participants.
- 6 participants with >3 years of online teaching experiences and 6 participants with ≤3 years of online teaching experience
- Analysing the focus groups responses using NVivo 12 to identify common themes to inform phase 2.

Phase 2

- Developing the questionnaire for main study
- Conducting the Pilot Study and
- Reviewing the questionnaire

Phase 3

- Conducting the survey using a questionnaire administered through Qualtrics for data collection

Phase 4

- Analysing the questionnaire quantitative data through Excel and Statistical Package for Social Science (SPSS) using analytical statistics

Phase 5

- Analysing the questionnaire qualitative data using NVivo 12 to identify common themes.

Figure 3 Flow Chart for Study Methodology

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Focus Group Findings

The most important facilitating factors recommended by Most and Lesser Experienced Educators

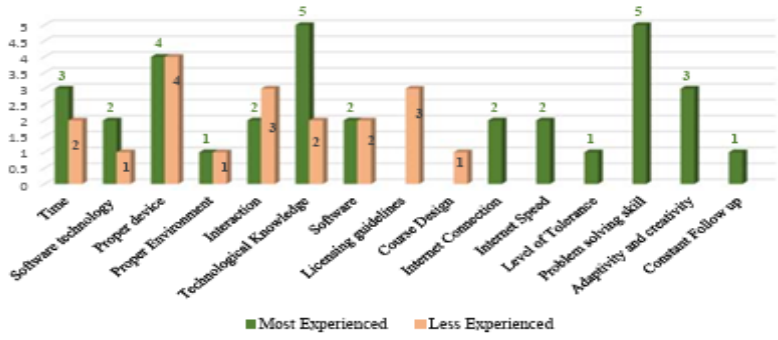

Figure 4 Graphic representation of The most important factors recommended Most Experienced and Lesser Experienced Educators

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Focus Group Findings

Factors affecting as a barrier in online teaching by Most and Lesser Experienced online educators

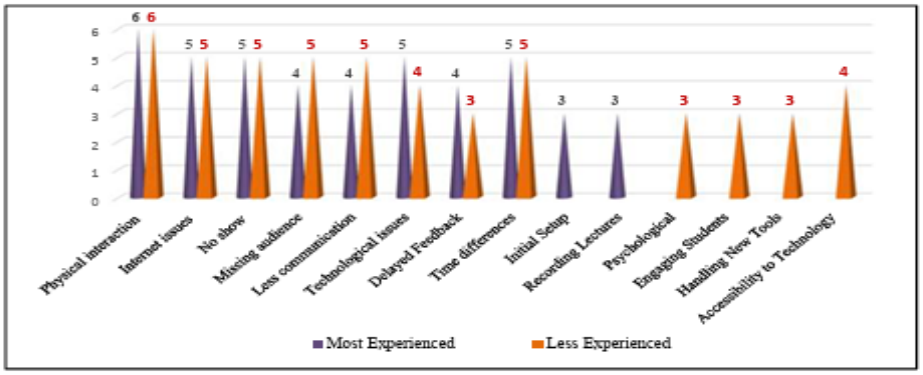

Figure 5 Graphic representation of the barriers for online teaching identified by Most Experienced and Lesser Experienced online educators

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Study Material and Methods

Mixed Method Design

Data Collection

- Questionnaire uploaded in Qualtrics survey tools.
- Sent links to the prospective participants.
- Data collected between 17-03-2021 and 19 -11-2021
- Total 121 completed data used for the study.

Quantitative Data Analysis

Procedures
- Descriptive statistics (frequency and percentages)
- Logistic regression model using SPSS (v29)
- COR, AOR and confidence levels
- Discussion

Qualitative Data Analysis

Procedures
- Open coding
- Merging nodes into theme using NVivo 12
- Themes and quotes
- Discussion

Conclusion and Recommendation

Procedures
- Conclusion were discussed from the findings of both quantitative and qualitative analysis.
- Recommendations made, Revised models, Factsheets and a PowerPoint presentation with narration prepared.

Figure 6 Visual representation of Mixed Method Approach

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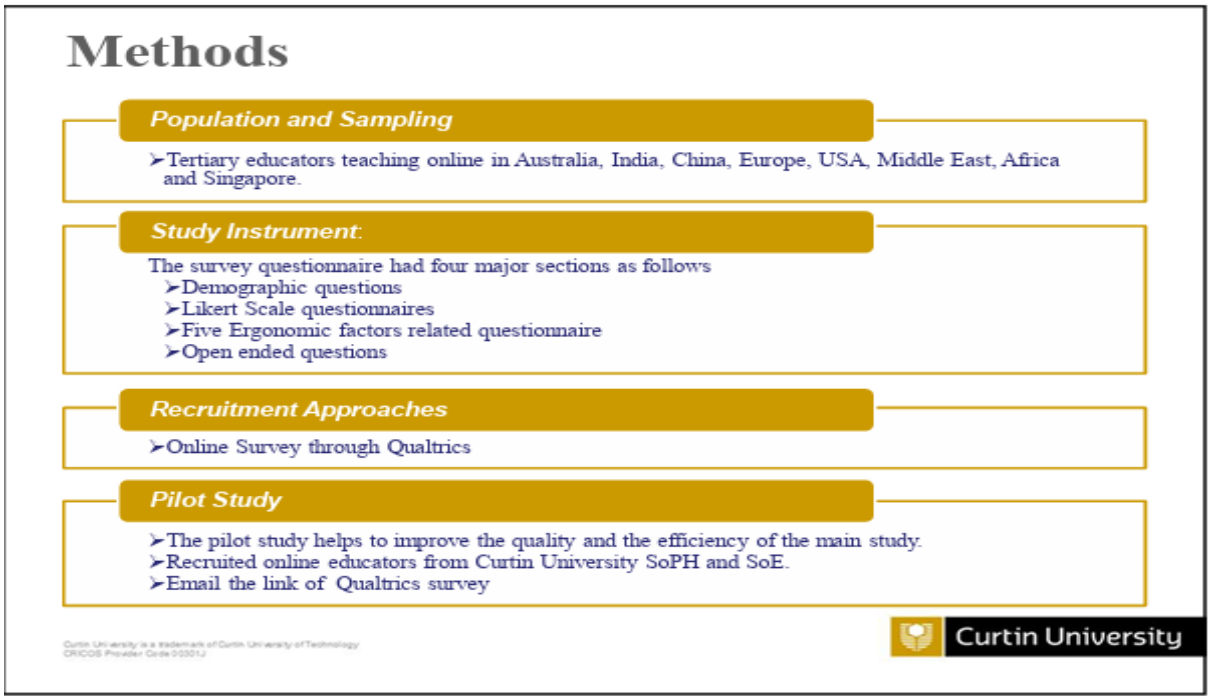
Methods
Population and Sampling
➢Tertiary educators teaching online in Australia, India, China, Europe, USA, Middle East, Africa and Singapore.
Study Instrument:
The survey questionnaire had four major sections as follows
➢Demographic questions
➢Likert Scale questionnaires
➢Five Ergonomic factors related questionnaire
➢Open ended questions
Recruitment Approaches
➢Online Survey through Qualtrics
Pilot Study
➢The pilot study helps to improve the quality and the efficiency of the main study.
➢Recruited online educators from Curtin University SoPH and SoE.
➢Email the link of Qualtrics survey
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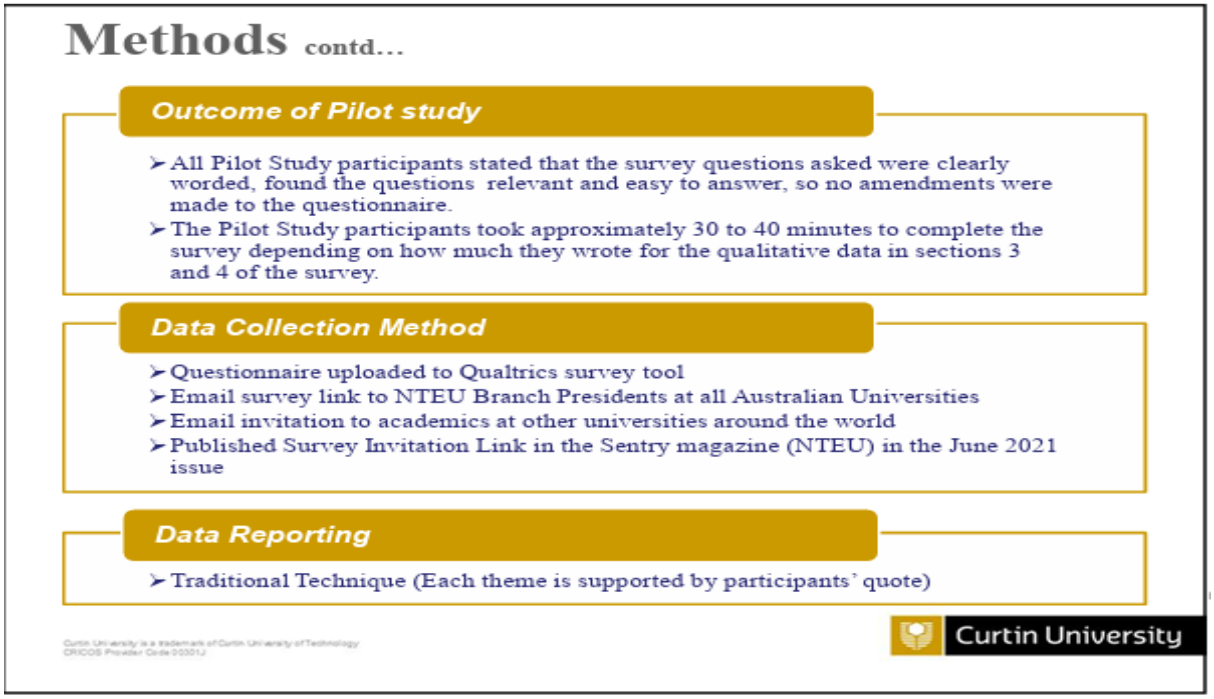
Methods contd...
Outcome of Pilot study
➢All Pilot Study participants stated that the survey questions asked were clearly worded, found the questions relevant and easy to answer, so no amendments were made to the questionnaire.
➢The Pilot Study participants took approximately 30 to 40 minutes to complete the survey depending on how much they wrote for the qualitative data in sections 3 and 4 of the survey.
Data Collection Method
➢Questionnaire uploaded to Qualtrics survey tool
➢Email survey link to NTEU Branch Presidents at all Australian Universities
➢Email invitation to academics at other universities around the world
➢Published Survey Invitation Link in the Sentry magazine (NTEU) in the June 2021 issue
Data Reporting
➢Traditional Technique (Each theme is supported by participants' quote)
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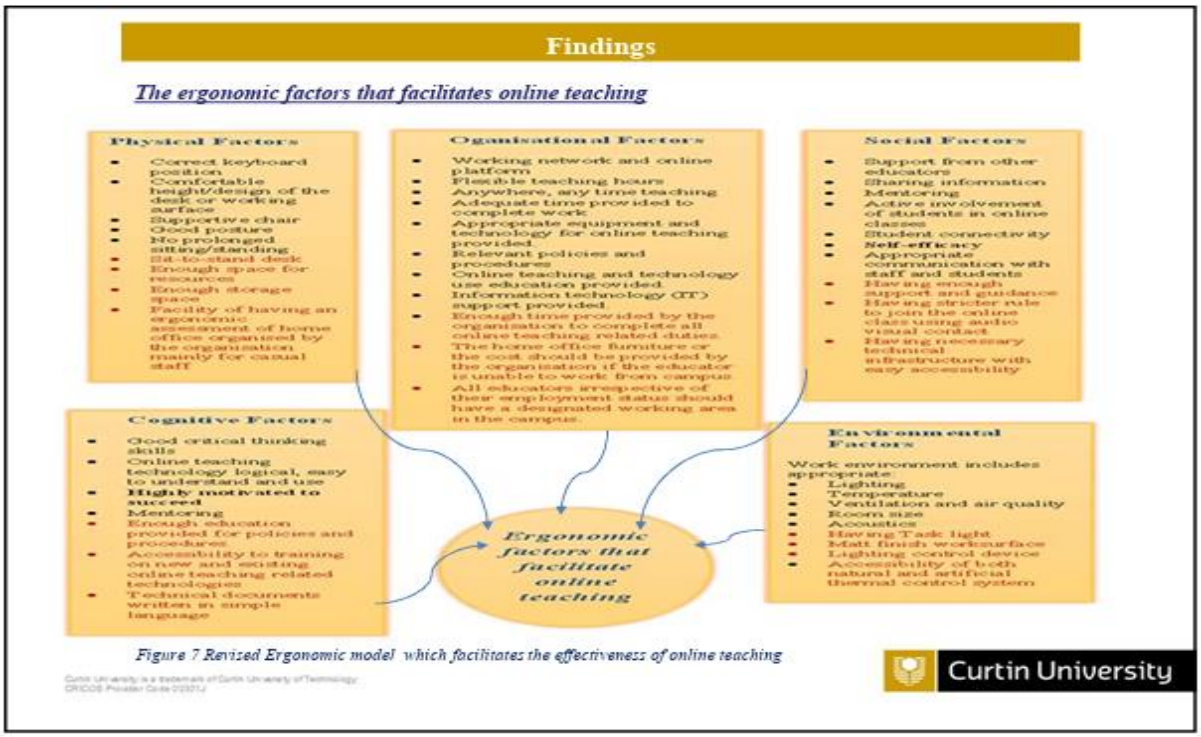
Findings
The ergonomic factors that facilitates online teaching
Physical Factors
Correct keyboard position
Comfortable height/design of the desk or working surface
Supportive chair
Good posture
No prolonged sitting/standing
Sit-to-stand desk
Enough space for resources
Enough storage space
Facility of having an ergonomic assessment of home office organised by the organisation mainly for casual staff
Organisational Factors
Working network and online platform
Flexible teaching hours
Anywhere, any time teaching
Adequate time provided to complete work
Appropriate equipment and technology for online teaching provided
Relevant policies and procedures
Online teaching and technology use education provided
Information technology (IT) support provided
Enough time provided by the organisation to complete all online teaching related duties
The home office furniture or the cost should be provided by the organisation if the educator is unable to work from campus
All educators irrespective of their employment status should have a designated working area in the campus
Social Factors
Support from other educators
Sharing information
Mentoring
Active involvement of students in online classes
Student connectivity
Self-efficacy
Appropriate communication with staff and students
Having enough support and guidance
Having stricter rule to join the online class using audio visual contact
Having necessary technical infrastructure with easy accessibility
Cognitive Factors
Good critical thinking skills
Online teaching technology logical, easy to understand and use
Highly motivated to succeed
Mentoring
Enough education provided for policies and procedures
Accessibility to training on new and exiting online teaching related technologies
Technical documents written in simple language
Environmental Factors
Work environment includes appropriate:
Lighting
Temperature
Ventilation and air quality
Room size
Acoustics
Having Task light
Matt finish worksurface
Lighting control device
Accessibility of both natural and artificial thermal control system
Ergonomic factors that facilitate online teaching
Figure 7 Revised Ergonomic model which facilitates the effectiveness of online teaching
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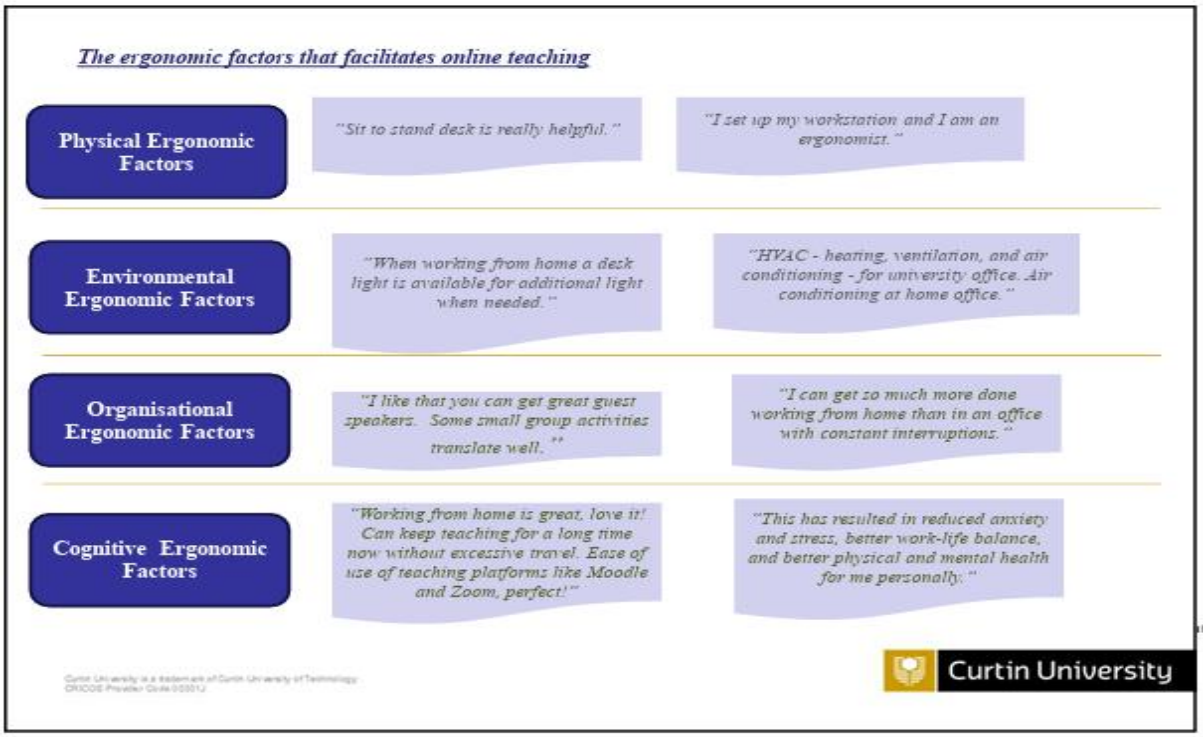
The ergonomic factors that facilitates online teaching
Physical Ergonomic Factors
"Sit to stand desk is really helpful."
"I set up my workstation and I am an ergonomist."
Environmental Ergonomic Factors
"When working from home a desk light is available for additional light when needed."
"HVAC - heating, ventilation, and air conditioning - for university office. Air conditioning at home office."
Organisational Ergonomic Factors
"I like that you can get great guest speakers. Some small group activities translate well."
"I can get so much more done working from home than in an office with constant interruptions."
Cognitive Ergonomic Factors
"Working from home is great, love it! Can keep teaching for a long time now without excessive travel. Ease of use of teaching platforms like Moodle and Zoom, perfect!"
"This has resulted in reduced anxiety and stress, better work-life balance, and better physical and mental health for me personally."
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The ergonomic factors that facilitates online teaching

Social Ergonomic Factors

"The auditory contact through Collaborate and Zoom allow me to work more effectively as I have a hearing disability."

"My class platform allows interaction though camera, oral as well as board sharing."

Figure 8 Most frequent words by word cloud

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Findings

Ergonomic factors that were perceived as a barrier in providing online teaching

Physical Factors

- Prolonged sitting in one place
- Bad Posture
- Incorrect setup of workstation
- Long hours working with computer.
- Non-ergonomic chair
- Inadequate height/design of the desk or working surface
- Lack resources storage space.
- Inadequate width of the workstation

Environmental Factors

Inappropriate:

- Noise
- Inadequate light
- Temperature
- Poor air quality
- Poor ventilation
- Acoustics
- Smell from the old carpet.
- Glare

Organisational Factors

- Lack of infrastructure
- Difficulty obtaining software and hardware
- Inadequate maintenance
- Lack of training
- Ineffective policies and procedures
- Inconsistent power supply
- Lack of information on decision making and problem solving
- Limited access to technology
- Inadequate technological support
- Inadequate paid work time.

Cognitive Factors

- Technology difficult to use.
- Lack of computer training
- Lack of developmental training and support of educators teaching
- Locating the online teaching related information
- The complex language in technical documents
- Concentrating on screen-based work for more than 60 minutes without break
- Lack of information on decision making and problem solving for online teaching

Social Factors

- Inappropriate student-student interaction
- Lack of student-teacher interaction
- No show of the student
- Presence of children or other family members while teaching online
- Feeling of isolation
- Receiving inadequate support and guidance from the university
- Language barriers
- Cultural differences

Ergonomic factors that are a barrier to online teaching

Figure 9 Revised Ergonomic model of the barriers which hinders the effectiveness of online teaching

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Ergonomic factors that were perceived as a barrier in providing online teaching

Physical Ergonomic Factors

- *"Sitting at a desk for prolonged periods - preparing material."*
- *"The university has not assessed homework stations. There was some form of self-assessment but without knowing how this should really look it is difficult to judge."*
- *"Online teaching work causes eye discomfort and blurry vision, headaches, etc."*
- *"Desk is not adjustable."*

Environmental Ergonomic Factors

- *"Office has workstations for 7 staff members, but all are not in the office at the same time. We try to leave the office when someone is doing online teaching as any noise made can be heard by the students so online teaching difficult."*
- *"Family around especially in afterhours time when I have to teach."*
- *"The afternoon sun is very bright, and glare is a problem."*

Organisational Ergonomic Factors

- *"There needs to be more time allocated for Collaborate meetings for moderation so to ensure equity in the process. Are lecturers even paid for the moderation process?*
- *"Workload time for feedback is inadequate so mainly having to use checklists for feedback."*

Cognitive Ergonomic Factors

- *"LMS procedures are very confusing when reading technical manuals. I'd rather attend hands-on training."*
- *"Policies are available, but no one discusses why we need them or how to use them for teaching purposes etc."*

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Ergonomic factors that were perceived as a barrier in providing online teaching

Social Ergonomic Factors

- *"Lack of personal interaction with students."*
- *"Self-learned. No guidance was provided except suggestions to use certain platforms."*
- *"Being employed for a couple of hrs a week and expected to read emails constantly etc etc etc is totally ridiculous. People do it because they are passionate and loyal but it is really unfair."*
- *"Many of my students struggle with English and misinterpret information even after multiple explanations and demonstrations."*

Figure 10 The most frequent word as a barrier to the online teaching by Word Cloud

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Findings contd…

Factors that facilitates online teaching

- Flexibility of being able to teach from anywhere option
- Save travelling time
- Reduce travelling cost
- Less distraction

Factors that hinders online teaching

- Lack of allotted time for carrying out teaching related duties
- Feeling of isolation due to lack of physical interaction with students and colleagues
- Not able to comprehend the level of understandability of each student due to lack of visual interaction
- Noise and other distractions due to having other family members at home especially children
- Lack of support and guidance
- Experiencing physical discomfort of not having a good ergonomic workplace setup
- Feelings of burnout, stress and anxiety due to not having adequate technological knowledge or training

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Findings cont…..

The differences in perceived factors between engineering and other academics

Educators teaching engeenering subjects online

- Had access to lighting control device (environmental ergonomic factor)

Educators teaching other subjects online

- Struggling to finish all their marking and providing feedback while online teaching within the allotted time (organisational ergonomic factor)
- Struggling to finish all their online teaching related work within the allotted time (organisational ergonomic factor)
- Struggling to have good audio-visual contact through the internet with students (social ergonomic factor)

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Findings Cont.....

Years of experience in online teaching and ergonomic factors

Educators with more than 3 years of online teaching experience

- Inadequate accessibility to resources (physical ergonomic barrier)
- Inadequate resources storage space (physical ergonomic barrier)
- Distracted by the surrounding noise (environmental ergonomic barrier)
- Inadequate access to natural light(environmental ergonomic barrier)
- Exposed to poorer air quality (environmental ergonomic barrier)
- Inadequate access to lighting control devices (environmental ergonomic barrier)
- Did not have matt finish worksurface to reduce the glare (environmental ergonomic barrier)
- Difficulty with the understandability of related documents (cognitive ergonomic factor)
- Receive less training for technology and other areas (organisational ergonomic factor)
- Affected by language barrier (social ergonomic barrier)
- Lack of support and guidance received (social ergonomic factor)
- Inadequate technical infrastructure (organisational ergonomic factor)

Educators with less than 3 years of online teaching experience

- Struggling to finish all their online teaching related work within the allotted time (organisational ergonomic factor)

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Suggestions for future improvements

Adequate support and guidance from the university will help to improve the productivity, physical and mental health of the educators teaching online, thus, improving the effectiveness of online teaching. The following are recommended.

- Educators should receive professional help to setup their working area if they were teaching online from outside of university campus.
- There should some reimbursement option provided by the university for obtaining the recommended furniture.
- It is preferable that all the educators have a designated workspace in the campus especially for the casual staff to be able to work from university if required.
- More training should be available for professional development of the educators with emphasis on the technological tools required for content development, updating existing content, and sharing contents with students.

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Suggestions for future improvements (continued)

- Education should be provided by the university on policies and procedures in detail and these should be easily accessible for the educators teaching online.
- All the time required for any types of work-related training should be paid.
- Technological training for students should be implemented as in some instances the educators were required to fix technology related problems faced by students while teaching online which disrupts the whole class as well as the educators being required to spend more time than allotted for the class.
- Increase the allotted paid times for online teaching preparation, checking assignments, providing feedback and other online teaching work.

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Research out come educational tools available

1. Fact sheet.
2. Checklist.
3. Power point presentation on ergonomic risk management for educators who teach online.
4. Narrated power point.
5. Case studies.
6. Case studies answers.

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Reference

Creswell, J. W., & Creswell, J. D. (2017). *The (5th ed.)*. SAGE.
https://play.google.com/store/books/details/John_W_Creswell_Research_Design?

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IF YOU HAVE ANY QUESTIONS ABOUT THIS RESEARCH AND ITS FINDINGS, PLEASE EMAIL MITALI GHOSH

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ngiyabonga
teşekkür ederim
gracias
dank je
tapadh leat
спасибо
bedankt
dziękuję
hvala
mauruuru
obrigado
sukriya
kop khun krap
go raibh maith agat
mochchakkeram
arigatō
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APPENDIX 20 THE ARTICLE SUBMITTED TO NTEU JOURNAL

IMPROVING THE COMFORT, SAFETY, AND PRODUCTIVITY OF EDUCATORS WHO CONDUCT ONLINE TEACHING

Mitali Ghosh

Online teaching has become a more common way teaching in tertiary education in the last two decades. With the support of the National Tertiary Education Union (NTEU) and its members, research was conducted to evaluate tertiary educators' perception of online teaching related ergonomic factors. Ergonomics is related to fitting the task to the person and the equipment to the person using it. In this research 5 ergonomic factors were considered. They were physical, cognitive, social, environmental, and organisational ergonomic factors. The aim of this mixed method research was to identify and assess ergonomic factors that affect educators' experience with online teaching. Four mini focus groups (with 12 participants) and an online questionnaire completed through Qualtrics by 121 participants, were used to collect data. Both qualitative and quantitative data was collected and analysed.

Table 1. Ergonomic factors that affected educators providing online teaching.

Factor	Facilitate online teaching	Hinder online teaching
Physical	An ergonomically designed chair and workstation. Having a sit to stand desk.	Prolonged sitting in a non-adjustable chair, using an unsuitable workstation. Lack resources storage space.
Environmental	Soundproof room with adequate light, ventilation, air quality, and temperature.	Noise and other distraction due to working in a shared office or at home. Glare or inadequate light.
Organisational	Flexibility such as the flexibility of being able to conduct teaching from anywhere at any time. Adequate paid time allotted to performing all online teaching related duties and for undertaking any work-related training required. Having appropriate equipment and technology for online teaching provided.	Inadequate time, as most of the educators identified that the time allocated for • Preparing online teaching related work including preparing new or updating existing course material, • Preparing, and conducting assessment, • Providing feedback, and • Moderating work was less than the actual time required Lack of infrastructure. Difficulty obtaining software and hardware. Inadequate maintenance or updating of equipment. Lack of training. Ineffective policies and procedures. Inconsistent power supply. Lack of information for decision making and problem solving. Limited access to technology. Inadequate technological support.
Cognitive	Having the necessary technical infrastructure and support with easy accessibility and online teaching technology logical, easy to understand and use. Technical documents written in simple language. Accessibility to training on new and existing online teaching related technologies.	Technology difficult to use. Lack of developmental training and support for teaching. Difficulty locating online teaching related information. Complex language in technical documents. Concentrating on screen-based work for more than 60 minutes without break. Lack of information on decision making and problem solving for online teaching.
Social	Support from other educators. Active involvement of students in online classes.	Feeling of isolation. Student language barrier. Inappropriate student-student interaction. No show of the student for class. Receiving inadequate support and guidance from the university.

The research results identified that online educators who were casual staff reported being provided with less time for teaching development, marking, and providing student feedback. Casual staff reported having a better work chair and greater ability to communicate with students than online educators with fixed term and ongoing employment.

Health effects resulting from inadequate ergonomic factors included back, shoulder and neck discomfort, anxiety, burnout, stress, technostress and feelings of isolation. The reason for experiencing above mentioned psychological discomfort resulted from inadequate technological knowledge, non-availability of proper technical infrastructure, issues experienced due to poor internet options, the changing role of the educators was another major challenge related to the online educational platform), working extra unpaid hours required for completing extra workload resulted in stress and anxiety within the online educators.

Recommendations

Recommendations made were to allow educators teaching online to:

1. Receive professional help to setup their working area and be reimbursed if required to buy ergonomic furniture for online teaching work to improve physical ergonomic factors.
2. Have a designated workspace at the campus, including the casual staff, to be able to work from the university if required.
3. Have an increase in the allotted paid times for online teaching preparation, checking assignments, providing feedback and others work related to online teaching provided to improve organisational ergonomic factors.
4. Have training available for professional development including for technological tools required for content development, updating existing units of study, and sharing information with students to improve cognitive ergonomic factors. Education should be provided by the university on policies and procedures, and these should be easily accessible. All the time required for university work related training should be paid time. To improve cognitive ergonomic factors for students more technological training for online education students should be provided as in some instances educators were required to fix technology related problems faced by any students while teaching online which disrupted the whole class and required the educators to spend more teaching time than allotted.
5. To improve social ergonomic factors it was recommended that there should be compulsory hours defined for the students to attend collaborative and other online classes with their audio-visual system on to be able to get more interaction with educators which will enhance educator and student motivation and reduce feelings of isolation.

Research outcomes

Based on the findings of this research a fact sheet (https://doi.org/10.5281/zenodo.10056559), a checklist (https://doi.org/10.5281/zenodo.10056572), a power point presentation (https://doi.org/10.5281/zenodo.10056622), case studies (https://doi.org/10.5281/zenodo.10056595), and questions answers (https://doi.org/10.5281/zenodo.10056604) have been developed by the researcher and are available through the above web links to provide education and orientation information for ergonomic risk management for educators who teach online. If you would like more information about this research and its findings, please contact Mitali Ghosh on Email: mitali.ghosh@postgrad.curtin.edu.au

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APPENDIX 21 LIKERT SCALE QUESTIONNAIRE FINDINGS

Table 19

Likert questionnaire results

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
1	I prefer teaching online due to its flexibility	24	20%	35	29%	26	22%	22	18%	13	11%
		Total Agree = 49%						**Total Disagree = 29%**			
2	I did not choose to teach online	18	15%	29	24%	28	23%	21	17%	24	20%
		Total Agree = 39%						**Total Disagree = 37%**			
3	Online teaching and learning are integrated into the university's educational structure.	35	29%	53	44%	17	14%	15	12%	0	0%
		Total Agree =73%						**Total Disagree = 12%**			
4	I find the online teaching environment allows me to pace my teaching to reduce work	22	13%	28	23%	29	24%	25	21%	16	13.20%
		Total Agree = 36.30%						**Total Disagree = 33.90%**			
5	I can avoid/minimise travel time	19	16%	44	36%	25	21%	26	22%	6	5%
		Total Agree = 52%						**Total Disagree = 27%**			
6	Able to use a variety of strategies to assess a student	19	16%	44	36%	25	21%	26	22%	6	5%
		Total Agree = 52%						**Total Disagree = 27%**			
7	It is easy to share ideas with other teachers in the online setting.	13	11%	38	31%	26	22%	34	28%	9	7%
		Total Agree = 42%						**Total Disagree = 36%**			
8	I can balance work and personal commitments while teaching online	30	25%	49	41%	13	11%	21	17%	7	6%
		Total Agree = 65%						**Total Disagree = 23%**			
9	I have no problems with online teaching	30	25%	31	26%	22	18%	27	22%	9	7%
		Total Agree = 50%						**Total Disagree = 30%**			
10	Encounter unstable internet access during class time	19	16%	44	36%	22	18%	23	19%	12	10%
		Total Agree = 52%						**Total Disagree = 29%**			
11	The technology involved in online teaching can be confusing	11	9%	34	28%	19	16%	39	32%	17	14%
		Total Agree = 37%						**Total Disagree = 46%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
12	Online teaching takes more time than classroom teaching	21	17%	30	25%	24	20%	29	24%	16	13%
		Total Agree = 42%						**Total Disagree = 37%**			
13	It is hard to motivate and engage students in an online teaching platform	35	29%	52	43%	16	13%	9	7%	8	7%
		Total Agree = 72%						**Total Disagree = 14%**			
14	The absence of face-to-face interaction with students is a disadvantage	53	44%	35	29%	16	13%	7	6%	9	7%
		Total Agree = 73%						**Total Disagree = 13%**			
15	The temperature in my workplace is sometimes too hot or too cold when I am doing online teaching work	6	5%	23	19%	34	28%	23	19%	6	5%
		Total Agree = 24%						**Total Disagree = 24%**			
16	The Blackboard system enhances my sense of isolation from students and co-workers	23	19%	38	31%	27	22%	16	13%	16	13%
		Total Agree = 50%						**Total Disagree = 26%**			
17	Some students do not have adequate technological skills as are required for studying online	25	21%	53	44%	14	12%	18	15%	10	8%
		Total Agree = 65%						**Total Disagree = 23%**			
18	My workstation furniture is uncomfortable to use for online teaching	10	8%	23	19%	28	23%	31	26%	28	23%
		Total Agree = 27%						**Total Disagree = 49%**			
19	There is often too much noise in my workplace for me to concentrate	5	4%	23	19%	19	16%	36	30%	37	31%
		Total Agree = 23%						**Total Disagree = 60%**			
20	At times there is inadequate ventilation in my work environment	3	3%	18	15%	17	14%	41	34%	41	34%
		Total Agree = 17%						**Total Disagree = 68%**			
21	The allotted time is not adequate to develop a new	29	24%	37	31%	24	20%	15	12%	15	12%
		Total Agree = 55%						**Total Disagree = 25%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
	online course or unit of study										
22	There is inadequate technical support for online teaching	16	13%	32	26%	17	14%	30	25%	25	21%
		Total Agree = 40%						**Total Disagree = 46%**			
23	Online teaching technologies are not very user friendly which makes teaching online difficult	9	7%	31	26%	25	21%	34	28%	21	17%
		Total Agree = 33%						**Total Disagree = 46%**			
24	I look for new technology to enable online teaching innovations	15	12%	66	55%	25	21%	8	7%	6	5%
		Total Agree = 67%						**Total Disagree = 12%**			
25	Sometimes it is very challenging to cope with the constant change/upgrading of the software	17	14%	41	34%	25	21%	28	23%	9	7%
		Total Agree = 48%						**Total Disagree = 31%**			
26	It is very stressful when there is a computer software failure during class	40	33%	56	46%	15	12%	6	5%	3	3%
		Total Agree = 80%						**Total Disagree = 8%**			
27	The software and technologies available assist me with online teaching and student engagement	14	11.60%	74	61.20%	20	16.50 %	11	9.10%	1	0.80%
		Total Agree = 73%						**Total Disagree = 10%**			
28	The university offers software education before adoption of each new online software	14	12%	39	32%	27	22%	27	22%	13	11%
		Total Agree = 44%						**Total Disagree = 33%**			
29	There is inadequate time and support to learn about new technologies available for online teaching	15	12%	52	43%	28	23%	18	15%	7	6%
		Total Agree = 55%						**Total Disagree = 21%**			
30	Technical skills prerequisite is not clearly identified before	12	10%	49	41%	30	25%	22	18%	7	6%
		Total Agree = 50%						**Total Disagree = 24%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
	beginning online teaching										
31	Teaching online enables me to use innovative student learning assessment practices	14	12%	48	40%	36	30%	14	12%	8	7%
		Total Agree = 51%						**Total Disagree = 18%**			
32	There is little or no opportunity to observe other educators using technology for online teaching prior to committing to teach online	22	18%	60	49%	17	14%	17	14%	4	3%
		Total Agree = 67%						**Total Disagree = 17%**			
33	Support is provided by the university during and after the adoption of new technology for online teaching	10	8%	17	14%	23	19%	57	47%	13	11%
		Total Agree = 22%						**Total Disagree = 58%**			
34	There is not enough training and assistance available for the teachers who are in the transition from classroom (face-to-face) teaching to online teaching	17	14%	38	31%	30	25%	25	21%	10	8%
		Total Agree = 45%						**Total Disagree = 29%**			
35	An active peer-mentoring program for online university teaching and using online technology is available	7	6%	32	26%	32	26%	37	31%	12	10%
		Total Agree =32%						**Total Disagree = 41%**			
36	I felt challenged when required to learn how to use new online software and this made my online teaching less effective	7	6%	36	30%	24	20%	36	30%	7	6%
		Total Agree = 36%						**Total Disagree = 36%**			
37	I have adequate computer skills to successfully manage online teaching	37	31%	63	52%	15	12%	5	4%		%
		Total Agree = 83%						**Total Disagree = 4%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
38	The technologies involved in online teaching can sometimes be confusing, so I do not use unfamiliar technology when teaching online	9	7%	54	45%	20	17%	25	21%	12	10%
		Total Agree = 52%						**Total Disagree = 31%**			
39	Online teaching methods need to be adapted to meet the needs of culturally and intellectually diverse student groups	31	26%	60	50%	23	19%	4	3%	2	2%
		Total Agree = 75%						**Total Disagree = 5%**			
40	Online teachers have the responsibility to be aware of their students' online skills; for example, mature aged students who are new to studying online at a university	26	22%	70	58%	14	12%	10	8%		
		Total Agree = 79%						**Total Disagree = 8%**			
41	As online students become more culturally diverse, the teacher's job becomes increasingly challenging and time consuming	28	23%	50	41%	30	25%	11	9%	1	1%
		Total Agree = 64%						**Total Disagree = 10%**			
42	Some online students are good communicators, engage well with the educator and other students to promote online discussion and student subject learning	32	26%	70	58%	15	12%	3	3%		
		Total Agree = 84%						**Total Disagree = 3%**			
43	Language barriers can affect my ability to interact with students who do not have English as their first language	14	12%	53	44%	26	22%	18	15%	9	7%
		Total Agree = 55%						**Total Disagree = 22%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
44	Some online students require a lot of explanation to understand simple concepts and I am not provided with enough work time to be able to teach at this level	26	22%	40	33%	28	23%	23	19%	3	3%
		Total Agree = 55%						**Total Disagree = 22%**			
45	When dealing with students I sometimes misinterpret different communication styles as behaviour problems	3	3%	27	22%	32	26%	49	41%	9	7%
		Total Agree = 25%						**Total Disagree = 48%**			
46	I find it challenging when university students, enrolled to study online, do not have the technology to use for online learning.	18	15%	58	48%	31	26%	11	9%	2	2%
		Total Agree = 63%						**Total Disagree = 11%**			
47	Are you involved in the supervision of online students?	**Yes**		**39**				**No**		**82**	
48	I teach students in countries where there are technology restrictions that make online teaching difficult	9	7%	30	25%	51	42%	20	17%	10	8%
		Total Agree = 32%						**Total Disagree = 25%**			
49	I have enough work time allocated by the university to supervise research students who are off campus and studying online	6	15%	10	26%	9	23%	9	23%	5	13%
		Total Agree =41%						**Total Disagree= 36%**			
50	There are not always adequate resources available for me when supervising	4	10%	16	41%	6	15%	9	23%	5	13%
		Total Agree = 51%						**Total Disagree= 36%**			

SL	Question	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
		F	%	F	%	F	%	F	%	F	%
	research students who are off campus and studying online										
51	Miscommunication is more likely to occur when supervising research students who are off campus and studying online than when supervising research students studying on campus	7	18%	17	44%	8	21%	3	8%	5	13%
		Total Agree = 62%						**Total Disagree = 21%**			