School of Information Systems

Initiating and Assessing an e-Nudging Model for Higher Education in Saudi Arabia

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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.

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 HRE2017-0301

Signature:

Date:

23/11/2021

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Abbreviations

Active Video Watching System (AVW).

Digital Nudging Process Model (DINU).

Exploratory Factor Analysis (EFA).

Gulf Cooperation Council (GCC).

Grade Point Average (GPA).

Human Computer Interaction (HCI).

Information and Communication Technology (ICT)

Information system (IS).

Kaiser-Meyer-Olkin (KMO).

Learning Management System (LMS)

Maximum Likelihood (ML).

Principal Component Analysis (PCA)

Saudi Arabia (SA).

Thematic analysis (TA).

User Interface (UI).

User Experience (UX).

Published Works

1- Salihah Alotaibi, Tomayess Issa, Bilal Abu-Salih, S Zaung Nau. (2021). “Digital Nudging and Educational Barriers in Higher Education: Students Perspective in Saudi Arabia”. *The Computer & Education* (paper under consideration).

2- Salihah Alotaibi. (2020). “Initiating and Assessing e-nudging model for higher education in Saudi Arabia.” *17th International Conference on Web Based Communities and Social Media 2020* (paper related to my candidacy).

Abstract

Decisions related to education are complex and have long-term consequences. For higher education students, most of these decisions are made when students are young and with little academic experience; these decisions can potentially influence students to postpone the completion of academic tasks or make unwise decisions. Moreover, behavioral and cognitive barriers (e.g., lack of self-regulation, and limited attention) are likely to influence choices and impede the learning process. In this research, an e-nudging model is proposed for higher education, offering an early and low-cost support for universities to encourage students to make better education-related decisions in a digital environment (i.e., learning systems).

This PhD research has been conducted in Saudi Arabia (SA) in order to determine the key factors that need to be considered when designing a digital nudging model for students in universities. Until recently, to the best of the researcher's knowledge, no study has been conducted on the development and assessment of a digital nudging model for the education field. This research reveals that current nudging models are inadequate in that none of them meets all the requirements necessary to implement a successful digital nudging in learning management system (LMS) at the tertiary education level in SA. A theoretical model is needed to address the challenges associated with students' educational decisions in a digital environment. Although several types of studies have been conducted on nudging interventions in education, certain nudge studies in this field showed inconsistent results and, in some cases, the nudge had negative effects. This study aims to establish a relationship between digital nudging and the field of Information Systems (IS) by integrating Human Computer Interaction (HCI) and usability as key factors in the e-nudging model to assist designers to understand and guide students to make the most desirable choices. Furthermore, the proposed model includes behavioral, cognitive and environmental barriers in order to obtain a better understanding of student behavior in a digital environment, and how these barriers influence students' decisions.

For this research, a mixed-methods approach (an explanatory sequential design) was adopted, consisting of two phases. This allows qualitative data to provide a rich

explanation of statistical quantitative results by exploring in depth the research participants' views. To obtain quantitative data, in the first phase, two online surveys were conducted. Both surveys were designed using the Qualtrics platform. One survey targeted academics and IT staff. Participants were asked to assess each factor in the initial e-nudging model and suggest new factors that could influence the e-nudging model. The other survey was conducted among tertiary students, and sought to determine whether the e-nudging model would meet their requirements. In total, 375 participants were academics and IT staff, and 408 were students. Two statistical data analysis methods - Factor Analysis and Descriptive Statistics - were utilized to identify and filter factors in e-nudging model. IBM SPSS Statistics (version 26) and Excel 2016 software were used for data analysis. The survey of academics and IT staff yielded two new factors: training and support for both instructors and students, and awareness of e-nudge. The students' survey showed that 45.30% of university students are struggling to maintain attention and 29.66% have issues with memory. The outcomes of both surveys were used to improve the initial e-nudging model and develop the interview questions.

The online survey provided significant results to enhance the initial model; however, to address any gaps in the quantitative findings, the qualitative method utilizing semi-structured interviews was employed to examine the enhanced e-nudging model and confirm the factors that should be retained in the final e-nudging model. In this phase, interviews were conducted with twenty-five expert academics who were invited to give their perceptions about the e-nudging model. The data collected from interviews was analyzed using thematic analysis and NVivo 1.0 software. The analysis of the interview findings generated two new factors, namely "define students' barriers: behaviour, cognitive and environmental" and "ethics of e-nudge". The position of evaluation stage in the e-nudging model was changed to make the purpose and functionality of this stage clearer to the readers.

The interview outcomes were used to confirm the final e-nudging model, which is the main objective of this PhD research. The majority of participants (i.e., academics, IT staff and students) in both research phases understood the purpose of e-nudging and their comments reveal that e-nudging is an important way to assist students to improve their academic performance by steering their behaviours towards better decision-making.

This PhD research faced several challenges, the main one being the covid-19 pandemic that affected the research process. For instance, it was impossible to conduct face-to-face interviews due to the social-distancing restrictions in the SA. Moreover, a large number of responses obtained in both phases (surveys and interviews) were incomplete due to the participant's lack of knowledge about some of the concepts related to the research (e.g., nudge which is an emerging concept), or possibly their lack of interest in voluntary surveys. Certain factors must be taken into account in order to design an effective digital nudge for students in SA higher education. It is an important to understand the current situation of the student. Usability and HCI are significant factors in this study, as between 25% to 34% of students face issues related to the LMS. Another important consideration is the ethics and transparency required to maintain the students' autonomy and to forestall any ethical complaints. In this regard, the research provides several avenues for future research. A useful avenue would be conducting experiments to implement digital nudge in Saudi Arabian universities following the proposed model. The experiments would be conducted to determine whether the model is comprehensive or whether additional factors need to be included. This PhD study can be re-conducted in other developing countries, especially the Gulf Cooperation Council (GCC) countries which share many common characteristics such as culture, religion, social mores, languages, and economic and financial systems.

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Chapter 1. Introduction

1.1 Introduction

This chapter discusses the research problem which involves the challenges facing tertiary students, and the academic environment that influences students' decisions. Section 1.2 briefly discusses the Saudi higher education system. Section 1.3 introduces the notion of digital nudging as an effective solution. The research objectives and research questions are presented in section 1.4 and section 1.5 respectively. Section 1.6 gives a brief description of the methodology applied in this research, and the significance of this study is explained in section 1.7. Section 1.8 emphasizes the need for more research on the usage of digital nudging which is yet to be established in Saudi universities, and indicates that this is the purpose of this study. The research design and research structure are outlined in section 1.9 and section 1.10, respectively. Section 1.11 summarizes the chapter.

1.2 Saudi Higher Education System

The first university in SA was established in 1957. After the number of the universities increased to seven universities, the saudi government established Ministry of High Education to deal exclusively with higher education. Some of ministry's responsibilities are formulating rules and regulations for all higher learning institutions, supervising the development of universities education, coordinating between universities in the field of scientific departments and degrees, and encouraging research (Alamri, 2011). In 2008 SA established A National Centre of E-learning & Distance Learning to enhance and support the growth of E-learning in Saudi universities (Alkhalaf, Drew, & Nguyen, 2013). Additionlly, the Saudi government allocated a large fund to support the growth of the education domain and provide new programs for education (Council, 2009). In 2009, the government esablished King Abdullah University of Science and Technology (KAUST). The university consider one of the largest project in the contry that aims to improve the learning environments by integrating a digital environment and technologies (Sallam, 2013). Additionlly, the Mistry of education instituted twenty-seven technical centers to improve teaching methods (Amoudi and Sulaymani (2014).

SA has made substantial investments in learning and teaching that have helped to develop the required infrastructure for the education sector. Despite that, SA's higher education sector is still lacking several essential components required to achieve higher levels of efficiency (Alnassar and Dow, 2013; Alamri, 2011). Students in higher education are facing major challenges during their study journey. These challeges were disscused in more detail in follwing section.

1.3 Research Problem

There has been a dramatic increase in the usage of Information and Communication Technology (ICT) as part of teaching practices in higher education sectors worldwide, as it has been found to improve the education environment and facilitate learning. Nevertheless, higher education students are facing major challenges during their study journey at university, evident in drop-out rates and poor academic achievements. In fact, the drop-out rate is 30% from universities and colleges in SA (Sulphey & Alkahtani, 2018) see section 2.3 for more details. Unfortunately, numerous students struggle to develop important academic abilities or skills such as self-control and self-directed learning (Brooker, Brooker, & Lawrence, 2017). For instance, students often think they can improve poor performance by making additional efforts near the end of the semester, not realising that it is near to impossible to compensate for poor marks or non-submission of assignments. Despite the additional effort made by the student, the early poor performance can cause worse performance later in the semester (Smith, White, Kuzyk, & Tierney, 2018).

Students are constantly required to make education-related decisions, some of which are complex especially when students are young and have limited academic experience (Damgaard & Nielsen, 2018). This complex situation may cause some students to defer the completion and submission of academic tasks, to make unwise or wrong decisions, or lose confidence (Castleman & Meyer, 2020). There is empirical evidence showing that individuals who are impatient are those more likely to drop out of school (Damgaard & Nielsen, 2018). In an online environment, many students find it hard to use the LMS

(Learning Management System) (Bradford, Porciello, Balkon, & Backus, 2007). For instant, instructors commonly receive questions about grades, as many students do not realize that their grades are available on the LMS (Smith et al., 2018). Hence, cognitive and behavioural factors together with learning system complexity can have a detrimental effect on students' academic achievements (Brooker et al., 2017; Clark, 2005).

Digital nudging intervention is one means by which students can be helped to make better educational decisions to improve their academic performance and reduce dropout rates in university. Digital nudging is an emerging technique which is receiving more attention in education research and other fields. A nudge is any soft alert that steers human behaviour without restricting any options, and helps people to make better decisions when choosing among several options (Thaler & Sunstein, 2008). This research focuses on digital nudging, that is, nudging that occurs in a digital environment. This study proposes an e-nudging model for higher education in SA, with the aim of assisting students to make better education-related decisions in a digital environment (i.e., LMS).

1.4 Research Objectives

The main objective of this research is to create and assess an e-nudging model for higher education in SA. The purpose of this research is to integrate a digital nudging technique effectively in the learning management system and assess the digital nudging interventions in terms of tertiary students' requirements and improved academic performance. The research objectives are explained in more detail in section 3.3. To achieve the main objective, the following sub-objectives have been established:

- To identify the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia
- To assess the perceptions of university expert academics towards the e-nudging model for Saudi Arabia higher education.
- To evaluate if the e-nudging model will meet the requirements of students.

1.5 Research Questions

This study explores and expands the concept of nudging and adapts it to suit the education field. Also, the study seeks to obtain a deeper understanding of the factors that influence the creation of an e-nudging model for higher education in SA. The following questions will be addressed in order to fulfill the research's objectives:

- What are the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia?
- What are the perceptions of university expert academics regarding the e-nudging model for Saudi Arabia higher education?
- How can an e-nudging model meet the requirements of students?

1.6 Overview of Research Methodology

The purpose of this research is to create and assess e-nudging model for the higher education sector in SA. The e-nudging factors and their relationships will be examined in order to improve the initial model and produce an effective e-nudging model that can assist stakeholders to adopt this emerging technique successfully in the tertiary education sector. There are three types of educational barriers: behavioural, cognitive and environmental. It is important to understand the impact of these on students' decision-making so as to design successful e-nudging interventions that improve students' decision-making which will subsequently improve their academic achievements.

The research methodology applied in this research is the mixed-methods approach (an explanatory sequential design). The first (quantitative) stage of the research involves two online surveys (one of academics and IT staff, and the other of students). The academics and IT staff's survey conducted to assess the initial model derived from the literature review, and to yield new factors that influence the effectiveness of the e-nudging model. The students' survey examined the current barriers (behavioural, cognitive, and environmental) that hamper students' educational achievement. In the second stage, qualitative data will be gathered from semi-structured interviews conducted with expert academics. The purpose of the interviews is to evaluate the enhanced e-nudging model factors and obtain perceptions of the interviewees regarding the e-nudging model. The qualitative data will be used to confirm the survey findings and discover other factors that will improve the initial model. Participants will be sourced from public and private universities in SA.

1.7 Brief of Research Significance

The research will make a contribution in terms of theoretical and practical significance, as explained in section 3.2. Theoretical significance is that it will help to build and foster the relationship between digital nudging and the field of Human Computer Interaction (HCI) and Information Systems (IS) in general. A clear understanding of the behavioural, cognitive and digital environment is essential to help the designer to understand how to steer (i.e., nudge) the user to make a desirable choice. Therefore, digital nudging adds a new dimension to user interface (UI) and user experience (UX) design. This research contributes to academic knowledge about behavioural, cognitive and environmental challenges that have a negative effect on students' academic performance, and facilitates the design and integration of successful digital nudging in the LMS. In terms of practical application, the primary research goal is to establish a set of key factors which would facilitate the successful implementation of digital nudging in LMS for the higher education sector in SA. The main outcome of this study will be an e-nudging model for higher education in the SA. This model will provide the foundation for stakeholders to effectively establish and implement the e-nudging model in the Saudi education system. Ultimately, the availability of this new e-nudging model may benefit students and academic staff in SA and the Gulf Cooperation Council (GCC) countries as they share many common characteristics such as culture, religion, social mores, languages, and economic and financial systems.

1.8 The Research Purpose

Mainly, this research aims to develop an e-nudging model for the higher education field in SA.

Recently, nudge theory has begun to be widely applied in different areas such as charity/donation drives, health, security, shopping and utility consumption (i.e., water and electricity). The nudging techniques have received more attention in education research and some studies have reported significant results. The impact of nudging can extend beyond psychological barriers. Nudging techniques can provide inexpensive and timely solutions for all students during a semester, and the university can alleviate the pressure placed on students by their having to make choices and decisions (Thaler & Sunstein, 2008).

The amount of research conducted on the use of nudging in education has greatly increased in recent years. Until recently, to the best of the researcher's knowledge, no study has been conducted on the creation, implementation and evaluation of a digital nudging model in Saudi Arabian universities. Furthermore, no current digital nudging model appropriately identifies the environmental factors that affect the user's behaviour. Also, none of the previously proposed models has an evaluation step after each developmental phase. Additionally, some of the processing steps and factors were omitted in some models, and none of these models considers the HCI, usability and navigation when designing digital nudging.

This research aims to identify key factors that would underpin the successful implementation of digital nudging in LMS for higher education in SA, create and assess the proposed e-nudging model, the relevant factors and how they influence the effectiveness of digital nudging in a learning system to improve students' academic achievements.

This research presents a new e-nudging model based on the data obtained from the research participants. The stages and its core factors are identified for this model. It is anticipated that the research outcomes will provide both research and social benefits. The research can integrate the different aspects of digital nudging and encourage further research on this topic. The final model provides a foundation for decision makers to effectively establish and apply the e-nudging model in the Saudi education system and those of the Gulf Cooperation Council (GCC) countries.

1.9 Research Design

An explanatory sequential design, mixed-methods approach was applied to address the research objectives and answer the research questions. The approach consisted of two phases: a quantitative phase, followed by a qualitative phase. The quantitative phase comprised an online survey to assess e-nudging model and understand educational barriers. The quantitative findings were used to refine the initial e-nudging model. After that, qualitative data was collected via semi-structured interviews to confirm the key factors and obtain the opinions and attitudes of academic experts regarding the refined model. The final outcome was an e-nudging model that is appropriate for the higher education sector in SA. Figure 1.1 presents the design adopted for this research.

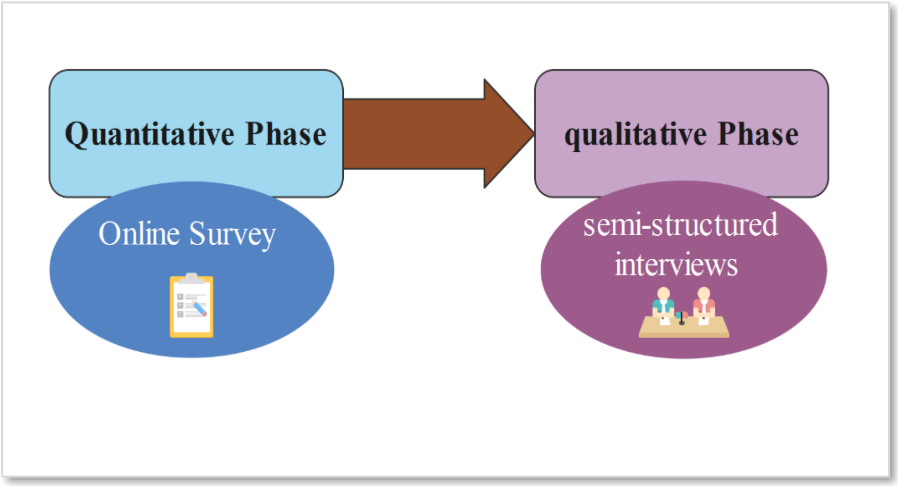


Figure 1.1: Research design (prepared by the researcher).

The significant advantage of using a sequential mixed-methods approach is that it provides a rich explanation of statistical quantitative results and a comprehensive picture and in-depth analysis due to the qualitative data confirming the quantitative results sub-section

3.4.3.3. This permits the researcher to validate, strengthen the findings and generalize the results.

1.10 Thesis Structure

The structure of the thesis contains six chapters illustrated in Figure 1.2.

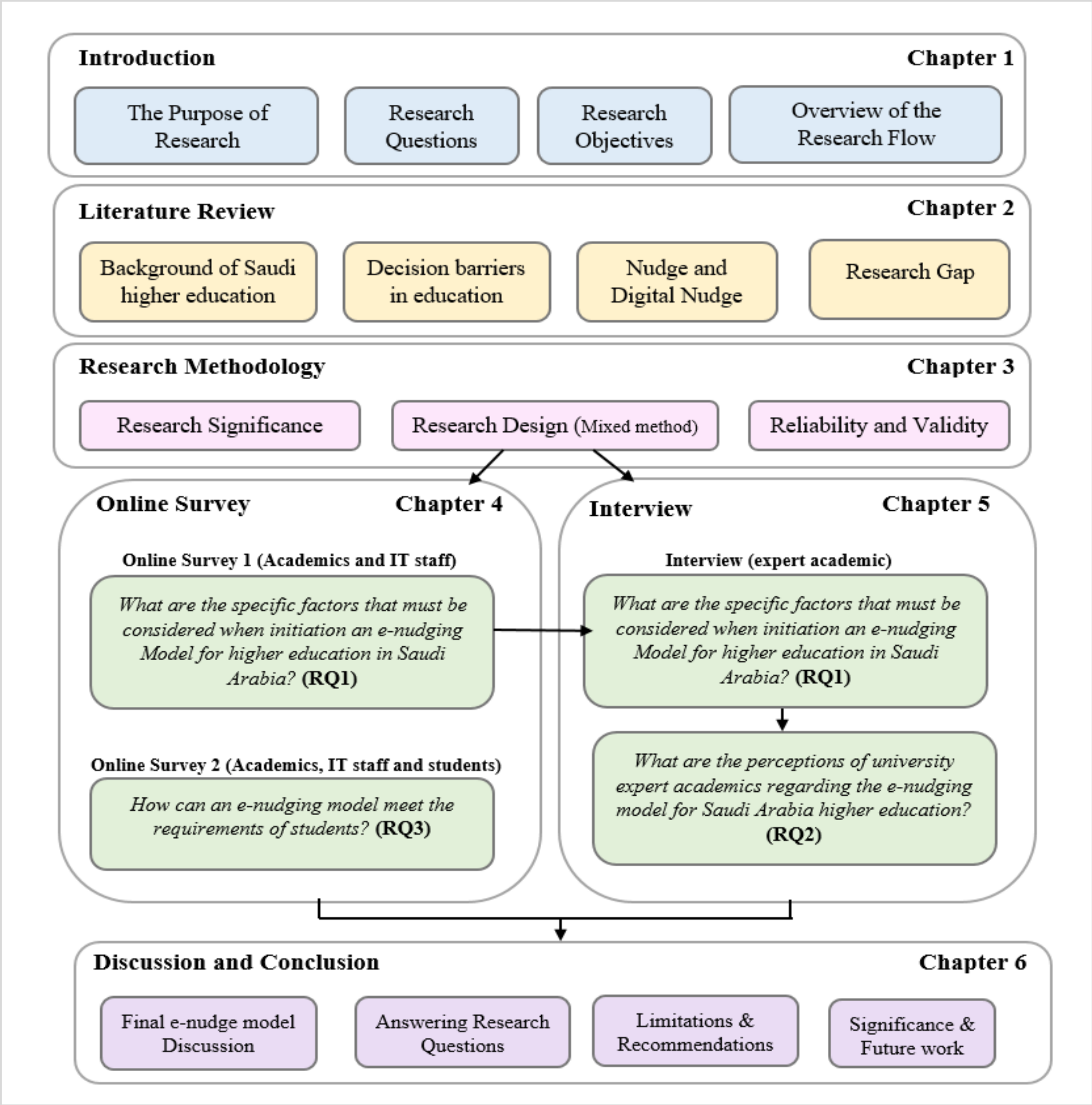


Figure 1.2: Thesis structurer (prepared by the researcher).

The research flow and process are shown in Figure 1.3 below. The research design comprises six phases. A rich and coherent literature review was conducted of studies that are relevant to the background of SA higher education, nudge theory and digital nudging, and barriers to education-related decision-making.

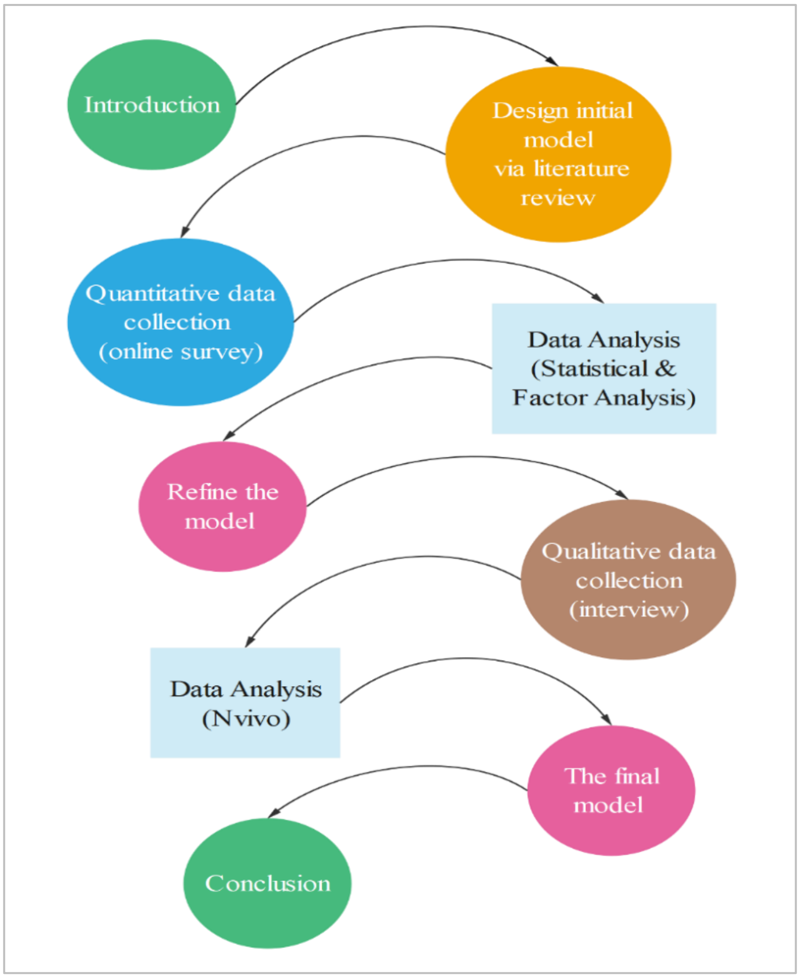


Figure 1.3: Research flow (prepared by the researcher).

From the literature review, a research gap was identified and a set of factors related to the research objectives was established, informing the design of the initial e-nudging model. The initial model was tested via the online surveys. The data analysis was conducted using IBM SPSS Statistics software (version 26). The results were used to refine the initial model. Then, qualitative data were collected via semi-structure interviews, and analysed using NVivo software (version 1.0) to confirm the factors constituting the final model.

The thesis has structured in following chapters:

- **Chapter 1: Introduction**

  This chapter briefly discusses the background of the topic, the research problem, and the purpose of the research. The chapter also gave an overview of research significance, the research objectives and research questions, and the research method.
- **Chapter 2: Literature Review**

  This chapter provides a rich review of recent studies on nudging and digital nudging. The chapter discusses the behavioral, cognitive and environment factors that can prevent students from making positive education-related decisions. The chapter gives the background of SA's higher education sector. The research gap is identified and set of key factors to be considered for the initial e-nudging model is established. The outcome is the initial e-nudging model.
- **Chapter 3: Research Methodology**

  This chapter begins with a description of the theoretical and practical contributions made by this research. Then, the primary and secondary research questions are formulated. The chapter discusses the research design and justifies the choices made regarding the way that the research is conducted. Then, the data analysis techniques and procedures are presented in detail. Finally, the chapter discusses the research ethic and risks. The outcome is the research methodology design.
- **Chapter 4: Online Survey Data Collection and Analysis**

  This chapter discusses the development and distribution of the online surveys and the targeted participants. The online surveys were developed using the Curtin Qualtrics platform. The results of the data analysis were used to refine the initial model. The chapter concludes with a summary of the amendments made to the initial e-nudging model for higher education in SA to produce a refined model.
- **Chapter 5: Interview Data Collection and Analysis**

  This chapter discusses the development of the semi-structured interview phase, and the targeted participants. The Curtin Qualtrics platform was utilized for the development and distribution of the interview information. The collected data is analysed and presented, and the results are discussed. The outcome is the final e-nudging model.

- **Chapter 6: Research Finding and Conclusions**

  This chapter concludes the thesis. It presents the research outcomes and contributions, acknowledges the research limitations, recommendations and offers suggestions for future research in the area of e-nudging and its application in education.

1.11 Chapter 1 Summary

The chapter introduces the research topic. The main goal of this research is to design an effective e-nudging model for the higher education sector in AS. To achieve this, the initial model was designed based on the literature review. Then, by means of a mixed-methods approach, the model was evaluated and refined. This chapters also gives an overview of the significance and objectives of this research, together with the research questions, purpose and methodology.

The next chapter provides a comprehensive, coherent review of the literature related to the research topic in order to identify research gaps and determine the key factors to be included in the design of an initial e-nudging model for SA’s higher education sector. This model will be assessed via a mixed methods approach. The final model is the main outcome of this research.

Chapter 2. Literature Review

2.1 Introduction

The previous chapter briefly referred to the challenges or barriers faced by students in higher education and an academic environment. The research objectives, research questions and research significance were presented, as well as the scope and purpose of the research. Finally, the chapter outlined the research design and research structure.

Section 2.2 of this chapter explains the scope of the literature review. Section 2.3 gives the background of higher education in SA, focusing in particular on the factors that cause students to perform poorly or to drop out of university. The importance of digital nudging in higher education in SA is explained in sub-section 2.3.1. This is followed in section 2.4 by a detailed discussion of the poor education-related decisions made by students and how these have detrimental effects on students' academic performance. However, this issue can be resolved by the integration of digital nudging in the LMS. The chapter presents overview of nudge theory and a detailed discussion of digital nudge in section 2.5 and section 2.6 respectively. These sections define the nudge concept, considers its implications for the education field, and examines the current usage of nudge interventions in higher education, in particular the digital nudge. It considers findings that show the advantages of nudging, and how students' academic performance is impacted by implementing digital nudge intervention in higher education. In section 2.7 various current nudge models are explained and summarized. The chapter discusses the research gap in section 2.8 and presents the initial e-nudging model for higher education in SA in section 2.9. The covid-19 impact on education is discussed in section 2.10. The chapter is summarized in section 2.11.

2.2 Scope of the Literature Review

The literature review aims to provide the theoretical background to the nudge theory in the education context. For the literature review, scholarly contributions relevant to the research questions and research objectives were analysed. A review was undertaken of 132 articles sourced from electronic books, books chapters, journals, conference papers, conference proceedings, and web articles published from 2003 to 2021. Although the reviewed articles are related to several disciplines, they are relevant to this research as they deal with nudge, education, psychology and behavior, interface design, IS and other related domains. The databases of Science Direct, Pro quest, Scopus ACM Digital Library and Springer Link were used in the main, although some of the studies were obtained from other sources. Only articles published in English were considered.

This research adopted Cooper (1988) taxonomy for literature reviews, which categorizes them according to focus, goal, perspective, coverage, organization, and audience. These are explained bellow:

- **Focus:** the material reviewed is of the utmost interest or importance to the reviewer. There are four areas most reviewers focus on: research outcomes, research methods, theories, and practices or applications.
- **Goal:** is to integrate past literature that is relevant to the issue being researched. Additionally, the other goals can be criticism or identification of central issues to a field.
- **Perspective:** is how the reviewer's point of view influences the discussion of the literature. The reviewer's perspective can be a neutral representation or the espousal of a certain position.
- **Organising:** is how the material is organized: a historical, conceptual, or methodological structure.
- **Audience** determines the writing style of the reviewer. The reviews can be written for groups of specialized researchers, general researchers, practitioners, policy makers, or the general public.
- **Coverage:** is the scope of the search and the literature that will be included in the review. This also includes how the reviewer make decisions about the quality of the material and its suitability for his work. There are four distinct categories:
  1- Exhaustive: all or most of the literature on the topic is considered.
  2- Exhaustive with selective citation: relevant sources are articles published in journals, but not conference papers.

3- Representative: includes only a sample and makes inferences about the entire group of articles from that sample.

4- Central: reviews only the central or pivotal literature on the topic.

Cooper’s taxonomy adopted for this research is depicted in Figure 2.1, and the categories that characterize the literature review for this research are highlighted in pink.

Characteristic	Categories			
Focus	Research outcomes	Research methods	Theories	applications
Goal	Integration	Criticism		central issues
Perspective	Neutral representation		Espousal position	
Organising	Historical	Conceptual		Methodological
Audience	Specialized scholars	General scholars	Practitioners/policymakers	General public
Coverage	Exhaustive	Exhaustive & selective citation	Representative	Central / pivotal

Figure 2.1: Taxonomy of literature review (prepared by researcher) adopted from (Cooper, 1988).

The following shows the application of Cooper’s taxonomy in this literature review:

- **Focus**: is on research outcomes, research methods, theories, and applications.
- **Goal:** integrates the findings in reviewed articles with an emphasis on the main factors that influence nudging adoption and implementation in education.
- **Perspective:** digital nudging is an emerging concept and a relatively new approach in the education field, especially in SA. This research aims to develop e-nudging model that is suitable for the SA in higher education context. The perspective is not neutral, but nor does it take a certain stance. It takes in account the various aspects of digital nudging prior to developing the model.
- **Organising:** the conceptual structure is based on key factors.
- **Audience:** the research will be valuable to various scholars, the IS community and stakeholders and decision-makers in universities, and in education and other government departments.

- **Coverage**: Most of the analysed articles are highly relevant to the issue of nudging in higher education domain.

In total, 87 articles on nudge and higher education, and nudge model reviews, were examined. The screening process is shown in Figure 2.2. The review included only those articles that pertained to nudge or digital nudging in higher education, and that focused on four techniques used for intervention. More details are given in section 2.5.5. In fact, only six nudge models were found as digital nudge did not appear until 2016 (see section 2.7 for further details about models).

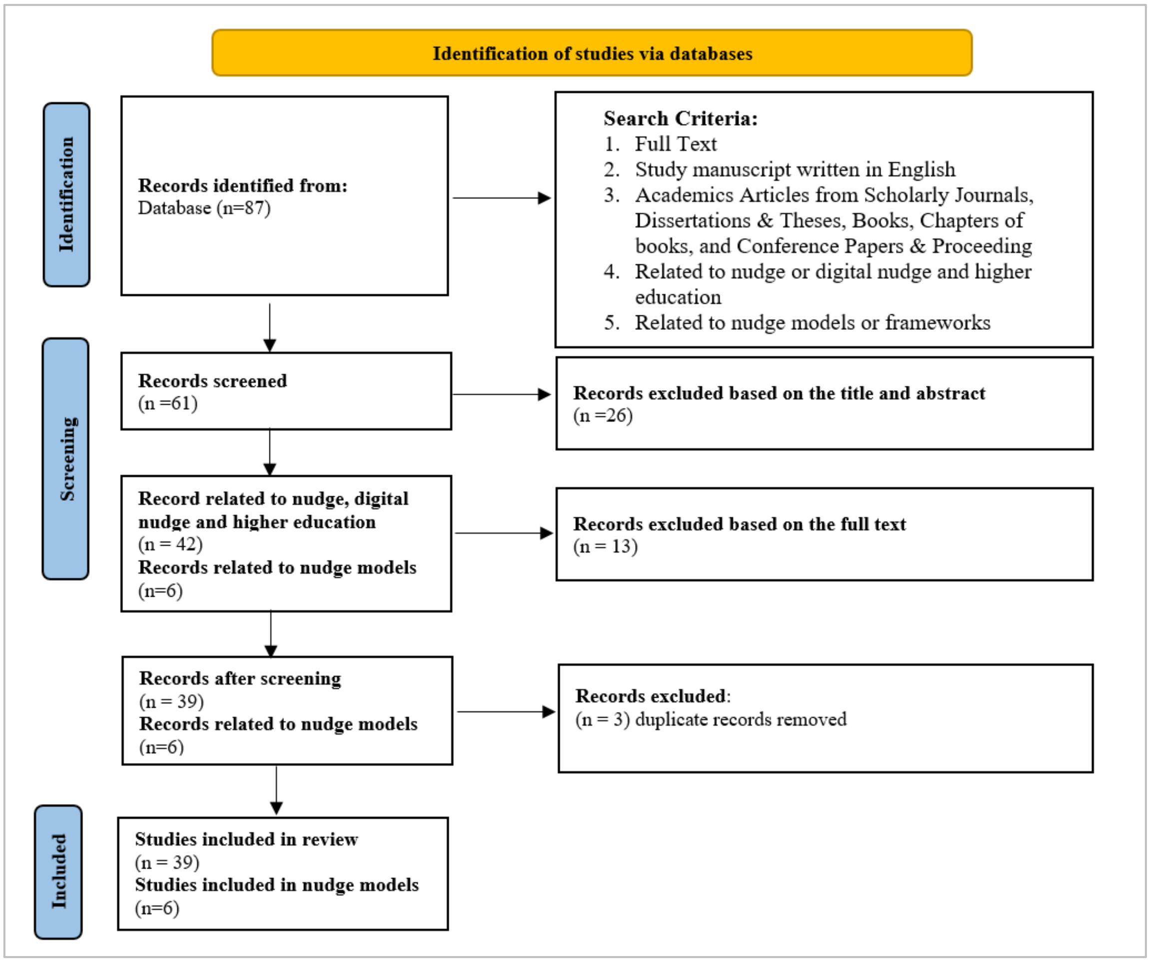


Figure 2.2: Information flow of the screening process for nudging and higher education and nudging models (prepared by the researcher) adopted from PRISMA Flow Diagram (Page MJ et al., 2021).

Moreover, in this research a systematic review in sub-section 2.5.4 has conducted in order to show an estimation of the number of studies examined nudge intervention techniques in education or any other research field.

2.3 Background of Saudi Higher Education

Universities play a significant role in the human development process. Universities provide a high level of academic knowledge, educational skills, and learning experience to students, allowing them to make a more positive impact on society and the economy. In SA, a technology transfer revolution is taking place in different fields to establish the country as an innovative knowledge-based economy (Alshumaimri, Aldridge, & Audretsch, 2010). By the year 2030, the SA government aims to have five universities ranked among the top 200 universities according to the international ranker. In order to achieve Prince Muhammed bin Salmman's vison for the Kingdom, the higher education system needs to utilize the benchmark strategy to address the challenges that face universities, and improve their performance, reputation, and quality outcomes in the coming five years (Alharbi, 2016). SA's higher education sector is still lacking several essential components required to achieve higher levels of efficiency. SA has made substantial investments in learning and teaching that have helped to develop the required infrastructure for the education sector. However, with rising costs and the reduction in oil revenues, it is unlikely that the government will be able to provide more funding for education. Hence, behavioural interventions are a crucial tool for bringing about necessary reforms in the education field. These interventions have proven to be effective in several countries (Sulphey & Alkahtani, 2018).

Alnassar and Dow (2013) and Alamri (2011) discussed several major challenges faced by the education system in SA, all of which have impacts on learning and teaching outcomes. These challenges include: a reluctance to develop and improve teaching methods, a lack of encouragement of students' critical thinking and self-learning, and the lack of motivation of both instructors and students. Despite the importance of universities and their benefits, many students perform poorly or decide to drop out of university. In fact, the drop-out rate from universities and colleges in SA is 30%. This high rate is attributed to a combination of factors and there is an urgent need to address this issue (Sulphey & Alkahtani, 2018). These factors are:

- **Lack of student interest**: Students can lose interest in learning and in their studies. Students' level of independent thinking is often below what is required. In part this is because in Saudi society, the younger generation can be immature and more dependent on the family due to the unique Saudi social structure. This can contribute to students' lack of interest in learning (Sulphey & Alkahtani, 2018).
- **Poor attendance:** As anticipated by the previous point, the lack of interest in studies can lead to students attempting to avoid their classes. As a result, students face possible disqualification from examinations. Later on, this will result in a deterioration of students' academic performance and ultimately their dropping out of courses and/or college (Sulphey & Alkahtani, 2018). Fadelelmoula (2018) found that attendance has a positive effect on students' academic performance; thus, a strict attendance policy is important to increase student numbers in classes.
- **Delayed assignment submission: A** lack of interest or time management skills results in assignments being overdue or not completed. This affects students' grades which leads to increased drop-out rates (Sulphey & Alkahtani, 2018). In addition, some studies found that Saudi students are negatively influenced by scheduling issues (Khan, 2011).

2.3.1 Why Digital Nudge in SA?

There are other problems that are not immediately evident in Saudi higher education environments but are associated with the above mentioned challenges and could reduce the quality of education. Generally, students in higher education face a series of complicated decisions. Most of these decisions are made when students are young and have little academic experience. Poor decisions can potentially have long-term consequences which influence the students' futures (Damgaard & Nielsen, 2018). This complicated situation may cause some students to defer the completion of academic tasks, to make unwise or wrong decisions, miss key deadlines or lose confidence (Castleman &

Meyer, 2020). Furthermore, some studies indicate that adolescents are particularly likely to be impacted by self-control problems. (Bettinger & Slonim, 2007). Pichardo, Justicia, de la Fuente, Martínez-Vicente, and Berbén (2014) state that self-control has a significant influence on students' academic performance. The empirical study conducted by (Damgaard & Nielsen, 2018) found that students who are impatient are those most likely to drop out of school.

In an online environment, the students' commitment can be affected by the complexity of the LMS or by behavioural factors. Patterson (2018) indicated that behavioural factors affect the individuals' ability to follow personal plans, and that interventions such as reminders may significantly increase students' commitment to adhering to their plan and improving their academic outcomes.

There is a lack of research focus on behavioural and cognitive factors, and on the digital environment in the higher education sector of SA. Most of the previous studies focus on social, economic, and organizational structures (Alkhazim, 2003; Krieger, 2007; Smith & Abouammoh, 2013) Therefore, an understanding of the cognitive, behavioural (Castleman & Meyer, 2020) and environmental (Mirsch, Lehrer, & Jung, 2017) challenges is essential when designing interventions to reduce the detrimental impact of such challenges. As mentioned above, behavioural interventions are a crucial and economical tool that can bring about the necessary reforms to education systems. This research explores and assesses some of the educational barriers or challenges that influence Saudi students in universities. This will provide an in-depth understanding of the Saudi university environment, enabling the design of successful e-nudging interventions that reduce the detrimental impact of such barriers because they secure the student's attention and have the potential to prevent unwise decision-making. This literature review gives a better understanding of the challenges or barriers (i.e., behavioural, cognitive and environmental) that influence students' academic outcomes, and how digital nudging can be an effective solution (see section 2.6).

Many universities worldwide have applied various strategies to sustain students' interest and improve their learning outcomes. For example, some have established support services to assist students who lack the academic skills required to achieve success at university. The support services include advisory centers, skills workshops, monitoring of student performance and issuing early warnings when required. Several researches have demonstrated the effectiveness of such education services in terms of student learning (Gordanier, Hauk, & Sankaran, 2019). On the other hand, Brock (2010, p. 119) states that, unfortunately, 32% of first-year students did not attend a new-students orientation program, and half did not meet with or recall seeing an academic adviser during their first four weeks of college. Also, some support services are unable to offer adequate support due to lack of funding. In addition, these support services tend to pay attention mostly to students who show low academic performance or to those students who directly ask them for help. Moreover, many advisor are overworked and unable to cater for a huge number of students daily and address all needs (Castleman & Meyer, 2020). Moreover, they cannot provide low-cost support for new students for the whole study journey, particularly in regard to education-related decision-making. Ultimately, the timing of the support being offered is important (Gordanier et al., 2019). In SA, for instance, the first academic warning is given to students who complete a semester with a low-grade point average (GPA). This warning is more likely to be effective when students finish the mid-term exams. Hence, early intervention plays a key role in helping students to improve their academic outcomes. This study proposes an early and low-cost support model for universities, using digital nudging theory in a digital environment (i.e., learning management systems) to assist students to make better education-related decisions.

2.4 Decision Barriers to Educational Attainment

Arguably, human decisions are not always rational and flawless. In addition, many important education-related decisions are difficult, complex, and sometimes unique, and unfortunately are not accompanied by the wisdom offered by practice and experience. For example, choosing a college is often a once-in-a-lifetime occurrence (Damgaard & Nielsen, 2018; Thaler & Sunstein, 2008). Many studies in psychology and behavioural economics have shown that people are affected by various psychological factors when they make a decision. Factors include a status quo bias, heuristics such as anchoring, availability, loss aversion, framing (Hausman & Welch, 2010; Mirsch et al., 2017) optimism and overconfidence (Hausman & Welch, 2010). In addition, individuals might choose badly due to social pressure (Hausman & Welch, 2010), and could be influenced by the choice of environment (Hausman & Welch, 2010; Mirsch et al., 2017).

Tertiary students are expected to become fully responsible for their studies and decisions; they need to independently check assessment guidelines, lecturers' announcements, and due dates for assessment tasks and other activities. Unfortunately, students can struggle to develop important academic abilities or skills such as self-control, self-directed learning, the navigation of unfamiliar university systems and cultures (Brooker et al., 2017) and willpower (Patterson, 2018), the lack of which can negatively affect student outcomes.

As previously mentioned, several factors (i.e., cognitive biases, behavioural economics and environment) are identified by sociology-based theories that have the potential to affect students' decisions (Brooker et al., 2017; Clark, 2005). The following sub-sections describe in detail some of the factors that influence student outcomes.

2.4.1 Behavioural-Economic barriers

In recent years, behavioural economics has featured in the nudge research field (Oliver, 2013). Indeed, behavioural economics is nothing more than a study and description of how humans make their decisions (Oliver, 2018). Furthermore, behavioural economic insights have attracted a lot of attention and have informed intervention design in education (Andor, Fels, Renz, & Rzepka, 2018; Damgaard & Nielsen, 2018; Hortal, 2020; Levitt, List, Neckermann, & Sadoff, 2016). This study focuses on two types of behavioral issues that affect students' decisions: bounded rationality (Harrison, 2016; Hortal, 2020; Patterson, 2018; Sulphey & Alkahtani, 2018) and lack of self-regulation (Damgaard & Nielsen, 2018; Lübcke, Seyfeli, Wannemacher, & Rhein, 2020; Schunk & Zimmerman, 2012; Sherr, Akkaraju, & Atamturktur, 2019).

- **Bounded rationality**

  Bounded rationality is the notion that when faced with choices, people will make decisions according to their financial situation, prior experiences and the social environment, not necessarily according to reason or preference. For example, people who are financially disadvantaged are more likely to value immediate gains rather than future or endpoint benefits (Harrison, 2016). Bounded rationality can occur as a result of inadequate information, thinking processes and limited time to make a decision (Caraban, Karapanos, Gonçalves, & Campos, 2019; Damgaard & Nielsen, 2018; Mirsch et al., 2017). Thaler and Sunstein (2008) stated that irrational decisions generally occur under four conditions. The first is when an individual would rather have immediate gratification, and deal with the subsequent cost in the future. The second condition is when no direct or immediate feedback is given. Finally, there are conditions that are unfamiliar to person, or which occur rarely. Unfortunately, the decision-making process in higher education occurs when students are young and lacking experience (Damgaard & Nielsen, 2018; Harrison, 2016). In this case, these students are more likely to making non-optimal or unwise decisions (Damgaard & Nielsen, 2018). Undoubtedly, several education decisions are complicated, difficult and uncommon or rare, because the university environment is new to students and numerous courses are on offer in local and international universities (Damgaard & Nielsen, 2018; Harrison, 2016). Moreover, some situations may be unfamiliar and may rarely occur, so students cannot make decisions based on past experience. For example, choosing a college is usually a once-in-a-lifetime occurrence (Damgaard & Nielsen, 2018; Thaler & Sunstein, 2008). Also, students might not understand some academic rules and practices such as unit codes and issues such as timetable conflicts when they attempt to enrol in a course. If students do not choose an appropriate course, this could affect their grade point average (GPA) or increase the length of time required to complete their studies.

- **Self-regulation**

  Another behavioral barrier is the lack of self-regulation that affects students' academic performance. Self-regulation refers to students' self-generated thoughts, behaviours, feelings, and actions taken to help them achieve their learning goals (Cohen, 2012; Schunk & Zimmerman, 2012; Sherr et al., 2019). Self-regulation is a significant issue for students in higher education as they encounter an enormous amount of material, subjects, and assignments within a short period of time (Cohen, 2012). Self-regulation involves a set of processes that assist students to learn and succeed (Sherr et al., 2019). For example, students in higher education need to understand and remember material presented during class lectures. Also, students experience great pressure when required to complete assessment tasks and adhere to submission deadlines. To succeed academically at university, students need to remain motivated and make consistent and sustained efforts. Thus, some students may need a soft nudge to improve their results and help them make better decisions.

2.4.2 Cognitive Biases

Cognitive biases are important factors in the decision-making process. These biases occur due to the human brain's tendency to employ different techniques like heuristics to simplify the complex choice situations and information processing in order to made decisions quickly (Acciarini, Brunetta, & Boccardelli, 2020). In the education context, two important cognitive biases that influence students' decisions are attentional limitation and overconfidence, described below.

- **Limited attention**

  The limited attention issue sometime causes students to forget to do academic tasks or assignments (Patterson, 2018). When students face a complex choice, they are more likely to make a poor decision because their lack of attention means that they (intentionally or unintentionally) have missed all or some of the information given to them, or have ignored it. Several researchers have found that students have inadequate information about their university's policies in regard to administration, course withdrawal, and changing majors, despite the availability of this information. The students tend to focus more on salient information or options when making decisions. For example, the cost of attending university is more salient than the benefits of continued studying (Damgaard & Nielsen, 2018). Löfgren and Nordblom (2020, p. 2) state that "one important reason most people are subject to limited attention and not fully rational is that optimization is cognitively demanding, and the outcome of a decision is often subject to some uncertainty. Hence, making a well-informed, utility-maximizing choice often requires a cognitive effort”. In addition, the attention problem is related to reading difficulty and poor academic achievement.

- **Over-confidence**

  Optimism and over-confidence bias leads students to believe that they are more capable and more successful than their peers (Damgaard & Nielsen, 2018). Unrealistic optimism influences students’ decisions which in turn impacts on their academic performance. If students have one or more of these cognitive biases, they are more likely to benefit from nudges. Hence, such students are more likely to benefit from nudges when they have limited attention.

2.4.3 Environmental Barriers

The environment and the presentation of information strongly influence a person’s choices and decisions. In a digital environment, people are more likely to make irrational decisions. On-screen, they make a fast and automated decision or choice as a result of the enormous amount of information available on the Internet. This makes it difficult for them to process all relevant details in order to make the best decision (Mirsch et al., 2017). In an online environment, many students find it hard to use the LMS (Bradford et al., 2007). For instance, instructors are commonly asked questions about grades, as many students do not realise that their grades are available on the LMS (Smith et al., 2018). Also, there is dissatisfaction with the learning environment and problems associated with motivation and academic performance. These reasons explain why some students abandon higher education (Hovdhaugen & Aamodt, 2009). Therefore, some universities are now utilising electronic LMS such as Blackboard and Angel/LMS to improve the learning environment and make learning more convenient by adopting efficient and appropriate technology (Landry, Griffeth, & Hartman, 2006; Talebian, Mohammadi, & Rezvanfar, 2014). Nevertheless, many students still find these systems difficult to use, especially those students who have inadequate academic and computational experiences (Bradford et al., 2007; Thuseethan, Achchuthan, & Kuhanesan, 2014). Thuseethan et al. (2014) found that many students struggle with the functionality, design and technical issues associated with Blackboard, although they like to use it and they are computer-literate. Some students may find specific aspects complex, from login to assignment submission. Bradford et al. (2007) pointed out several Blackboard limitations, two being that it is harder to learn than expected, and the system has shortcomings. In their paper, Sandnes, Jian, Hagen, and Talberg (2007) focused on the Human–Computer Interface (HCI) guidelines of the learning system called Fronter which is popular in Norway. Although the assignment submission feature is the most important element, the submission process is still difficult. Also, the navigation is difficult and unclear. For example, the system has a different format for hyperlinks although a standard format would be more convenient (i.e., colored blue and underlined). In this case, the developer did not adhere to common HCI guidelines.

Therefore, to improve usability, it is important to update the current system, and adhere to HCI standards (Thuseethan et al., 2014) and navigation processes. Nakamura, de Oliveira, and Conte (2017) conducted a systematic mapping study on usability and User Experience (UX) for LMSs. They concluded that more research is required to evaluate LMSs, although many studies have already been conducted in this area. Most LMSs are in the initial stages and need to improve or require more comprehensive empirical research. Therefore, it is important to conduct a thorough evaluation of LMS interface functionality, HCI, usability and navigation. This will help to address some of the environmental barriers in education and assist with the design of effective digital nudging systems. Subsequently, this will ensure that these environmental barriers do not affect and reduce the nudge's influence on students. An inefficient digital environment will make it difficult, if not impossible, to design an effective nudge.

To sum up, these barriers and limitations (cognitive and behavioural factors and learning system complexity) impede the learning process and can have a detrimental effect on students' academic performance (Brooker et al., 2017; Clark, 2005). They factors are predictable (Bradbury, McGimpsey, & Santori, 2013; Thaler & Sunstein, 2008), so decision-making can be framed in specific ways to nudge students to make better choices.

2.5 Nudge Theory

A nudge is defined as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid”. (Thaler & Sunstein, 2008, p. 6). The term ‘nudge’ and its concept were introduced by Richard Thaler and Cass Sunstein in 2008 in their book titled “Nudge: Improving Decisions about Health, Wealth, and Happiness” (Thaler & Sunstein, 2008) .The authors argued that individuals should be free to choose what they like, and they should be able to opt out of any undesirable situation. For instance, by means of framing, customers in a cafeteria can be nudged to eat healthy food. The way the food is presented (i.e., placing healthy food at the front and junk food at the back), will act as a nudge for the customer. This is done without restricting the choices or eliminating the junk food because customers can choose junk food if they prefer. However, the framing of the products is nudging customers towards making the right decisions that will promote better health. Indeed, the nudge is a behavioral economics strategy that attempts to influence behavior by changing the environment.

2.5.1 Nudge Types

The dual process theory is a concept that emerged in modern psychology and neuro-science, and was introduced by Thaler and Sunstein in their book titled “Nudge: Improving Decisions about Health, Wealth, and Happiness” (Thaler & Sunstein, 2008). Also, psychologist Daniel Kahneman made this theory central to his book titled “Thinking, Fast and Slow” (Daniel, 2017).

Dual process theory asserts that the human brain uses two ways of processing information: one is automatic thinking called “System 1” and the other is reflective thinking called “System 2”.

“System 1” thinking is uncontrolled, effortless, fast, instinctive, and usually not associated with experiences that can be described as conscious thinking. For example, a driver may slow down when reaching a dark tunnel as a habitual or automatic response. “System 2” thinking is controlled, effortful, slow, and associated with the thoughtful and conscious processing of information. It needs concentration and effort. An example of this type of thinking is when a prospective buyer compares the features and prices of two television sets (Hansen & Jespersen, 2013; Weijers, de Koning, & Paas, 2020). Table 2.1 summarizes the key characteristics of each system.

Table 2.1: Two cognitive modes of thinking adopted from (Hansen & Jespersen, 2013).

Automatic thinking “System 1”	Reflective thinking “System 2”
uncontrolled	controlled
effortless	effortful
associative	deductive
fast	slow
unconscious	self-aware
skilled controlled	rule-following

This research adopts the Hansen and Jespersen (2013) framework to discuss different categories of nudges and determine the categories best suited to educational contexts. There are four nudge categories. The framework distinguishes between Type 1 and Type 2 nudges, and transparent and non-transparent nudges. Each type of nudge is explained below.

2.5.1.1 Type 1 and Type 2 nudges

As mentioned above, Type 1 nudges aim to influence behavior that is facilitated by automatic thinking, and without involving reflective thinking. For example, a smaller plate in a cafeteria can reduce customers’ calorie intake. The customer is nudged by “change of default” to put less food on his plate, resulting in the consumption of fewer calories without thinking about it. However, Type 2 nudges aim to trigger reflective thinking that subsequently shapes behavior. In fact, both types of nudges aim to influence automatic mode, although Type 1 nudges endeavor to influence behaviors that do not involve deliberation and choice, while Type 2 nudges attempt to change deliberate actions and choices (Hansen & Jespersen, 2013; Thaler & Sunstein, 2008; Weijers et al., 2020).

2.5.1.2 Transparent and non-transparent nudges

Hansen and Jespersen (2013, p. 17) define a transparent nudge as "a nudge provided in such a way that the intention behind it, as well as the means by which behavioral change is pursued, could reasonably be expected to be transparent to the agent being nudged as a result of the intervention". According to this definition, an example of a transparent nudge is the labelling of healthy food with a green label. This type of nudging and the intended behavioral change are clear and immediately apparent to most people (Weijers et al., 2020). In contrast, the non-transparent nudge is not easily distinguished by the ordinary person. An example is the changing of a classroom's seating arrangement to reduce bullying (Van den Berg, Segers, & Cillessen, 2012).

Many researchers claim that transparency is an important requirement for design nudging in order to maintain the individual's autonomy and to forestall any ethical complaints (Grüne-Yanoff & Hertwig, 2016; Hortal, 2020). However, no research has been conducted to examine the effect of nudge transparency in education. There is a need to conduct more research to investigate the extent to which different levels of transparency influence the effectiveness of a nudge (Weijers et al., 2020).

Type 1 and Type 2 nudges (both transparent and non-transparent) give rise to four categories of nudges:

- **Transparent Type 1 nudges**
  A transparent Type 1 nudge influences behavioral change without engaging the reflective system, but clearly informs the targeted person of its purpose. This nudge attempts to engage automatic thinking without triggering reflective thinking (Hansen & Jespersen, 2013; Weijers et al., 2020). An example is using red color to draw attention to an important action as mentioned in (Hansen & Jespersen, 2013). In education, an example of this type of nudge is making enrolment for exams as opt-out instead of opt-in. The purpose of this default nudge is transparent and obvious to all students. Weijers et al. (2020) stated that the current literature on nudging in education offers few examples of this type of nudging. This category is located in the bottom left-hand corner of Figure 2.3.

- **Non-transparent Type 1 nudges**

  This type of nudge manipulates behavior without engaging the reflective system and in a way that makes it unlikely to be recognized. An example is the rearranging of the food display in a cafeteria to get individuals to choose healthy food like a salad rather than an unhealthy food that is sweet (Hansen & Jespersen, 2013). This category is located in the bottom right-hand corner of Figure 2.3.

- **Transparent Type 2 nudges**

  This type of nudge changes behavior by engaging the reflective system. The nudge intervention makes it easy for the person to reconstruct the intentions and change his choice. For example, the use of green footprints is intended to nudge people to take the stairs, or showing calorie values on food menus may induce people to reflect on the consequences of healthy vs. unhealthy food choices (Hansen & Jespersen, 2013). This category appears in the top left-hand corner of the matrix in Figure 2.3.

  Weijers et al. (2020) stated that this nudge category is very appropriate for most educational contexts because it is transparent and triggers reflective thinking.

- **Non-transparent Type 2 nudges**

  This category is shown in the top-right corner of Figure 2.3. This nudge engages reflective thinking, but does so in a way that its goal is not necessarily clear. For example, this nudge uses behavior norms or activates a preference to nudge individuals to make particular choices (e.g., placing gums and sweets next to the cashier, causing customers to be more likely to buy them) (Hansen & Jespersen, 2013). Weijers et al. (2020) stated that this nudge category is useful for education because it has the potential to help students achieve sustainable behavioral goals.

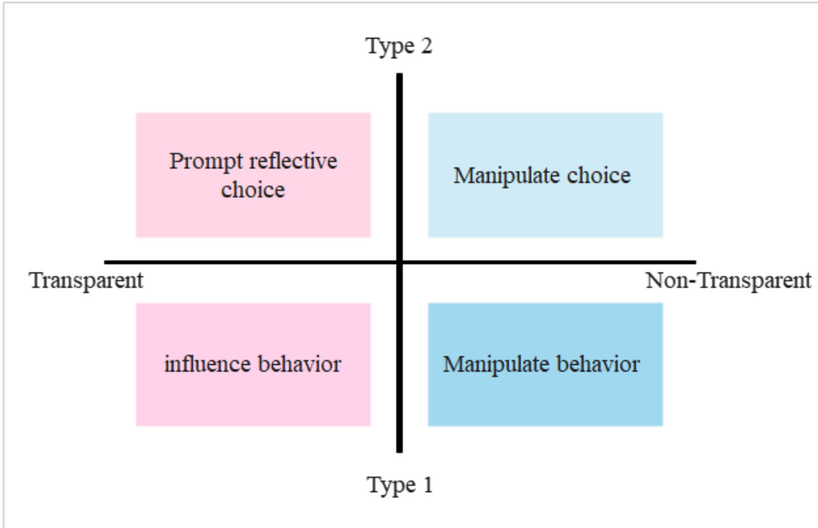


Figure 2.3: Four categories of nudges (developed by the researcher) adopted from (Hansen & Jespersen, 2013).

2.5.2 Nudge's Promises in Education

Generally, nudges have the capacity to dramatically improve individual decisions at minimal cost. The design of an effective nudge can help people achieve their goals. Moreover, the nudge does not limit people's options, and they still have the freedom to choose what they like.

The effectiveness of nudging interventions has been demonstrated in many fields in countries such as the United States (Carroll, Samek, & Zepeda, 2018; Dimant, van Kleef, & Shalvi, 2020; Grebitus, Roscoe, Van Loo, & Kula, 2020; Wilson, Just, Swigert, & Wansink, 2016), United Kingdom (Bourdeaux, Davies, Thomas, Bewley, & Gould, 2014; Giubilini et al., 2019; Momsen & Stoerk, 2014) Spain (García & Vila, 2020; van Bavel, Rodríguez-Priego, Vila, & Briggs, 2019) and Switzerland (Buchs, Gilles, Antonietti, & Butera, 2016; Miesler, Scherrer, Seiler, & Bearth, 2017; Schulz, Thiemann, & Thöni, 2018). Furthermore, there are similarities between education and the areas where nudging has been applied successfully (Weijers et al., 2020). Damgaard and Nielsen (2018) demonstrated in their review that the nudge is a promising prospect for education. The review documented several nudge studies in education, and showed that nudging has been successful in improving student outcomes and behaviours. Significant, positive results were reported by some studies on the application of nudges in the education sector (see sub-section 2.5.5).

As mentioned above, many students arrive at university campuses unprepared for the level of academic work in terms of both quantity and difficulty (Brock, 2010). Students are likely to agree that they want to have the necessary skills and behaviors such as self-regulation and the ability to pay greater attention in order to succeed in their studies. However, students face problems related to behaviours and cognitive processes that prevent them from achieving these goals. For example, they lack willpower, they procrastinate, or they overestimate their own capabilities.

In terms of money and time, the implementation of a nudge is relatively inexpensive. The removal or mitigation of behavioral barriers could unlock skill development and give a long-term, lifetime reward. Even a small improvement of education outcomes could be cost effective (Oreopoulos, 2020).

To conclude, the nudge can be an effective tool to motivate and support students. Nudges can influence more than the psychological barriers to learning (Mirsch et al., 2017). Nudge provides cheap and timely solutions for all students during a semester, and the university can alleviate the pressure placed on students by nudging students to make better choices and decisions (Thaler & Sunstein, 2008).

2.5.3 Nudge Challenges in Education

The adoption of nudge theory in education is challenging despite the promising results. Each education environment has its own characteristics, so the type of nudging that is successful in other fields is not necessarily transferable to the education sector. For example, education involves long-term goals; hence, any intervention must be aligned with long-term behavioral change. Therefore, one of the main challenges is to design a nudge that has a long-term influence (Marchiori, Adriaanse, & De Ridder, 2017). Raymaekers, Brans, and Fobé (2018) mentioned that many nudge interventions have not had long-term impacts. It is still unclear what the influences of nudge are in the long term, as most of the nudging research has focused on short-term or immediate behavioral change (Marchiori et al., 2017; Raymaekers et al., 2018). Hence, more research is need in order to obtain a better understanding of the effects of nudging in the long term.

It is important to ensure that nudges applied within the educational context do not conflict with educational principles such as knowledge transfer. Additionally, it is important to ensure that nudges do not have negative effects in other important areas such as freedom of choice, and do not add pressure. Also, they should not reduce the students' responsibility for their own learning by making them reliant on nudging, particularly since most are adults (Weijers et al., 2020).

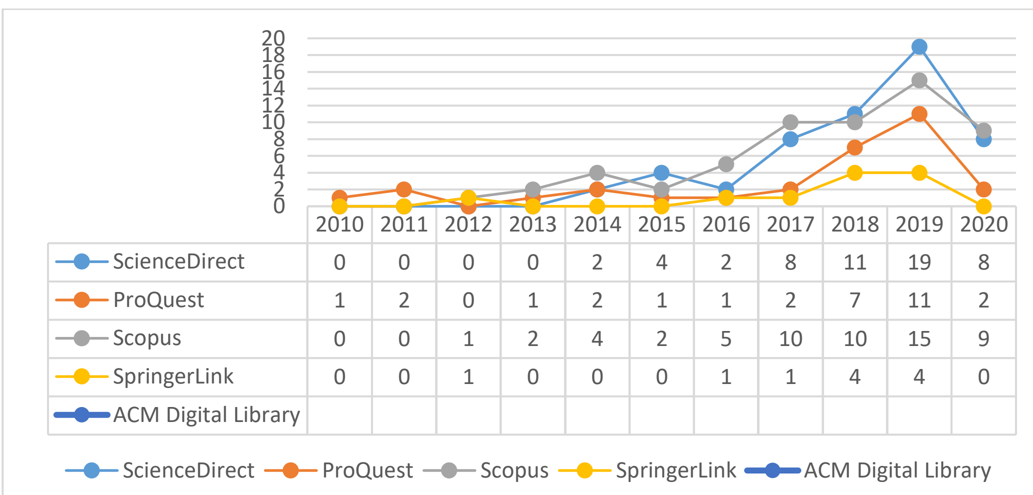
The aim of this research is to overcome or mitigate these challenges, and to assist stakeholders and decision-makers to implement digital nudging successfully in SA's higher education by proposing e-nudging model to improve students' learning outcomes and reduce the drop-out rate. Also, the research investigates the behavioral, cognitive and environmental factors that can influence students' educational decisions, and that can be affected by a digital nudge.

2.5.4 Nudge's Systematic Review for Nudge Applications

Nudge theory is widely applied in different areas such as financial (Blanchett, 2017; Chirico, Inman, Loeffler, MacDonald, & Sieg, 2019; García & Vila, 2020; Jones, Loibl, & Tennyson, 2015; Karlan, McConnell, Mullainathan, & Zinman, 2016), health (Bourdeaux et al., 2014; Giubilini et al., 2019; Lakerveld et al., 2018; Lewis et al., 2019; Miesler et al., 2017; Wagstaff, van Doorslaer, & Burger, 2019), security (Kankane, DiRusso, & Buckley, 2018; Nicholson, Vlachokyriakos, Coventry, Briggs, & Olivier, 2018; van Bavel et al., 2019; Wisniewski, Knijnenburg, & Lipford, 2017; Zhang & Xu, 2016), donation (Damgaard & Gravert, 2018; Grieco, Lacetera, Macis, & Di Martino, 2018; Schulz et al., 2018; Zarghamee et al., 2017), and consumption (Chabe-Ferret, Le Coent, Reynaud, Subervie, & Lepercq, 2019; Gillingham & Tsvetanov, 2018; Holladay, LaRiviere, Novgorodsky, & Price, 2019; Kurz, 2018; Myers & Souza, 2020; Venema, Kroese, De Vet, & De Ridder, 2019). However, little research has been conducted on the application of nudge theory in the education sector (Weijers et al., 2020)

In the education domain, a systematic review on nudging conducted by Szaszi, Palinkas, Palfi, Szollosi, and Aczel (2018, p. 359) found that only 4% of the identified studies were focused on nudges in the education field, whereas 42% were focused on promoting health. Furthermore, Hummel and Maedche (2019) analysed 96 nudging studies and none of them were concerned with the education field.

In this research, the initial systematic review of nudging domains was conducted at the beginning of 2020 using a specific search strategy. Four academic databases - Science Direct, ProQuest, Scopus and Springer Link – were searched for papers on nudging applications that were published between January 2010 and May 2020. The key terms used for the search were: “nudge”, “digital nudge”, “digital nudging”, “e-nudge”, “nudge and education”, “nudging student”. Only titles were searched and any that contained one or more of the key terms were downloaded. Figure 2.4 shows the increase in the number of studies on nudge over the ten years after filtering process.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ScienceDirect	0	0	0	0	2	4	2	8	11	19	8
ProQuest	1	2	0	1	2	1	1	2	7	11	2
Scopus	0	0	1	2	4	2	5	10	10	15	9
SpringerLink	0	0	1	0	0	0	1	1	4	4	0
ACM Digital Library											

Figure 2.4: Number of studies included in the literature review and year of publication (prepared by the researcher).

Initially, 855 studies were found (N=855). The researcher considered only English-language studies examining nudge intervention techniques in education or any research fields. The inclusion criteria are shown in Table 2.2.

Table 2.2: Inclusion criteria for the literature search (prepared by the researcher).

Inclusion Criteria
1. Full text 2. Study manuscript written in English 3. Published between January 2010 and May 2020 4. Academics articles from scholarly journals, dissertations & theses, books, chapters of book chapters, and conference papers & proceedings **5.** Studies applied nudge interventions in education or any domains such healthcare, consumption, security… etc.

The articles were screened according to the established criteria listed in Table 2.2. The screening was conducted in two stages. First, the initial screening of the titles and abstracts of the candidate studies. Then, the studies that passed the first screening were examined based on the full text. After that, duplicate studies were removed. The final numbers of target articles were N= 153. The full process is illustrated in Figure 2.5.

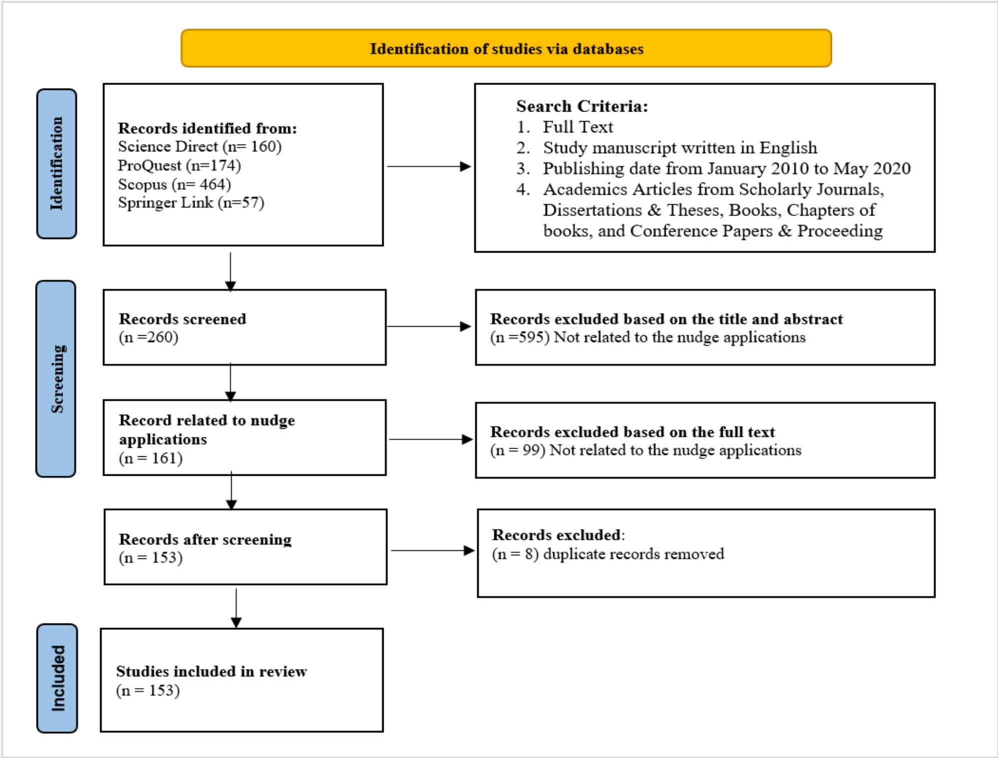


Figure 2.5: Information flow of the screening process for systematic review nudging applications (prepared by the researcher) adopted from PRISMA Flow Diagram (Page MJ et al., 2021).

The articles screened according to the domain of studies are shown in Table 2.3.

Table 2.3: The article domains and total in each domain (prepared by the researcher).

Nudge Research fields	No. of Articles
Education	13
Health care	11
Economic	4
Retirement (Saving money)	6
Donation	8
Security	10
Consumption (energy, food, water)	18
Pro-environmental	9
Healthy lifestyle (food, diet, hygiene)	35
Other fields (games, traffic, travel…etc.)	39
Total	**153**

This research found 40 % of the studies in the database contained at least one significant successful nudges intervention, 29.9 % of the studies showed a moderate effectiveness of the nudge interventions, whereas the 30.1% found that nudge interventions produced no significant changes in behaviour.

The literature review showed that the empirical basis of the nudge researches are increasing dramatically. This review does not include an exhaustive list of relevant studies, as only those studies published between 2010 and May 2020 were included. Additionally, according to this research time restrictions and the limitation of the accessing academic databases, the review may also miss empirical findings from the nudge literature. However, this review gives a good indication of the research trend over the last decade, and hopefully will increase research interest in this emerging field. The next subsection presents findings from studies conducted on the use of nudge in education.

2.5.5 Application of Nudges in Education

This section presents an overview of the use of nudging in education. This research focused on the higher education domain and four digital nudging interventions (i.e., feedback, reminder, social comparison, and reduced distance) used to steer students' behavior in Saudi universities. These four nudge interventions can deal with educational barriers that are discussed in section 2.4. However, the discussion is organized according to the types of nudge interventions. Then we discuss the behavioural issues targeted by interventions. The section concludes with the results found regarding the effects of interventions on student outcomes. Table 2.4 summarizes the literature review on four nudges interventions in higher education.

- **Feedback**

  The nudge feedback is a type of informational nudge (Damgaard & Nielsen, 2018). The feedback aims to provide information to individuals about their behavior and keeps them engaged in order to help them remain aware of their decisions. Several researchers (Bandiera, Larcinese, & Rasul, 2015; Brade, Himmler, & Jäckle, 2018; Feild, 2015; Fischer & Wagner, 2018; Gordanier et al., 2019; Smith et al., 2018) have tested the effect of feedback on students' academic outcomes. Gordanier et al. (2019) investigated the effectiveness of early intervention on college students' academic performance. They informed students about their current performance and offered them support services such as course-specific tutorials and workshops on study skills and time management. The study results indicate that these interventions can significantly affect students' academic performance. Fischer and Wagner (2018) examined the effectiveness of timing and different forms of feedback in secondary schools. Relatively few students showed improvement in their performance. Brade et al. (2018) tested the effect of positive and negative feedback on first-year students at university. They found that students' performance improved only when the feedback was positive. Another study utilized e-mail to send the feedback about grades to students in higher education. The target behavior is bounded rationality. The results showed the nudge feedback improved homework performance by 4% (Smith et al., 2018, p. 2). Graham, Toon, Wynn-Williams, and Beatson (2017) examined the feedback nudge on university student engagement. The results revealed a significant improvement in student engagement. Another interesting study investigated the effectiveness of visualizing feedback to higher education students, and provided guidance on how they might improve their performance by starting tasks promptly and meeting submission deadlines. This intervention was intended to encourage students' self-regulation. The findings revealed that nudges encouraged students to modify their behaviors and achieve better performance (Feild, 2015). Furthermore, in higher education, Bandiera et al. (2015, p. 2) tested effectiveness of feedback on students' performance. The study found that feedback had a positive impact as the standard deviation of test scores increased by 13%. The authors claim that students are not given enough information on how their effort translates into test scores, so feedback might be a cost-effective solution that can increase students' performance.

- **Reminders**

  A reminder can be defined as a person or thing that helps one remember something. Several studies have been conducted to determine the influence that reminders have on students. Castleman and Meyer (2020) found that text reminder messages sent to first-year university students strongly influenced the course credits accumulated during the first semester. However, these effects did not persist into the second semester. Kizilcec, Schneider, Cohen, and McFarland (2014) tested the effects of reminders sent to MOOC students to contribute to an online discussion forum. The study found short-term effects as, after the intervention, the number of contributions increased. Moreover, Patterson (2018) tested two reminder interventions on MOOC students to improve their memory. The first reminder intervention was sent after the student had spent half an hour on distracting websites, reminding them to study. The other reminder was sent to remind students to focus on studying when they logged into the course website. The results found no effects on any of the outcome variables. Chen and Okediji (2014) reminded university students about their academic standing in courses. When a student obtained a score below an announced cut-off score on the midterm exam, a reminder was sent reminding the student about the risk of failing the course. The intervention had a significant impact on students' performance on the final exam. The reminder nudge was also tested on high school students and parents (Castleman & Page, 2014; York, Loeb, & Doss, 2019). The results showed that the reminder is an effective nudge tool that helps students to improve and not engage in undesirable behaviors.

- **Social comparison**

  Social comparison information is a special type of informational nudge. This type of nudge provides information that compares a person with others in order to encourage that person to adhere to social norms. Azmat, Bagues, Cabrales, and Iriberri (2019) found decreases in educational performance after comparisons of college students. The authors claim that it is important to focus on the role of prior beliefs when designing a nudge. Pugatch and Wilson (2018, p. 1) conducted a study to improve the tutorial attendance of college student by using social comparison, framing, and financial incentives. The findings showed a 7% increase in tutorial attendance. Martinez (2014, p. 1) used two interventions -framing and social comparison- on MOOC students. The first experimental group received emails to inform them of the percentage of the class than were doing better than they were. The other group was informed of the percentage of the class doing worse. The interventions increased students' efforts and they took more quizzes, doing on average, 8.43 % better than students who did not receive the nudge. Davis et al. (2017) showed a significant increase in the course completion rate for MOOC students. Maxim, Winkler, Buhl-Wiggers, and Hardt (2019) utilized social comparison on leaded learner (i.e., combine online and traditional classroom-based teaching). They found that nudges via email are effective. Also, male students were more influenced by nudges than were the female students. However, with time, the effects of these nudges became weaker. Conversely, multiple studies have demonstrated that social comparison feedback has negative effects on course completion rate (Rogers & Feller, 2016) of MOOC students. The author stated that no short-term effects were indicated and, in the long term, the effects were slightly negative.

- **Reduced distance**

The reduced distance intervention is a new type of nudge that provides information related to the future (Caraban et al., 2019). This nudging type has not yet been tested in the education field, although it is important as it relates to long-term, future outcomes. When the outcomes are distant in time (i.e., future), this prevents individuals from engaging in productive activities. This kind of nudge could increase the motivation of individuals who struggle with self-regulation and irrational decisions, as it reduces the psychological distance between actions and outcomes (Caraban et al., 2019; Sulphey & Alkahtani, 2018; Thaler & Sunstein, 2008).

Table 2.4: Prior literature on nudging in education presented based on year publication (prepared by the researcher).

Reference	Target population	Type of nudge	Findings
Castleman and Meyer (2020)	university first-year students	Reminder	Students strongly influenced their earned course credits in the first semester. However, these effects did not persist into the second semester
Gordanier et al. (2019)	college students	Feedback	the nudge may significantly affect students' academic performance
Maxim et al. (2019)	leaded learner	social comparison	Social comparison nudges are effective. Also, male students are more influenced than female
(Azmat et al., 2019)	college students	social comparison	The nudge has negative effects on student performance.
York et al. (2019)	parents of preschoolers	Reminder	The frequency of literary activities at home increased.
Smith et al. (2018).	university Students	Feedback	Homework performance improved by 4% points.
Brade et al. (2018)	university first-year students	Feedback	Students' performance improved only when the feedback was positive

Pugatch and Wilson (2018)	college Students	social comparison and frame	There is increase of 7% in tutorial attendance.
Patterson (2018)	students in MOOCs	Reminder	No effects on student behaviors
Fischer and Wagner (2018)	Secondary schools students	Feedback	Few students showed improvement in their performance.
Graham et al. (2017)	university students	Feedback	There is on a significant improvement in student engagement.
Davis et al. (2017)	students in MOOCs	social comparison	significant increase in the course completion rate
(Rogers & Feller, 2016)	students in MOOCs	social comparison	The nudge has negative effects on course completion rate.
(Feild, 2015)	High education students	Feedback	nudges encouraged students to modify their behaviors and achieve better performance
Bandiera et al. (2015)	university students	Feedback	The study found the feedback has positive impact on students' performance. by 13%
Chen and Okediji (2014)	university students	Reminder	The intervention significantly impact on students' performance on the final exam.
Kizilcec et al. (2014)	students in MOOCs	Reminder	Number of students contribute to an online discussion forum increased.
Castleman and Page (2014)	High school students	Reminder	The low-income, college-intending students number increased
Martinez (2014)	students in MOOCs	social comparison and frame	The interventions increase students' effort and they retake more quizzes, on average, 8.43 %

2.6 Digital Nudging

Digital nudging is a concept that emerged in 2016. It transferred the nudge theory to the digital environment. Digital nudging "is the use of user-interface design elements to guide people's behavior in digital choice environments" (Weinmann, Schneider, & Vom Brocke, 2016, p. 1). Weinmann el at. (2016) posit that the concept of digital nudging is based on insights from behavioral economics. It relates to the elements of a user interface design that can steer user behavior toward specific decision-making in a digital environment. In addition, there are several advantages of digital nudging: the implementation is easier, faster and cheaper; moreover, the Internet allows designers to tailor nudges for particular users, which makes them more effective (Mirsch et al., 2017). In addition, digital nudging can be easily generated and modified for a digital environment. Hence, the effectiveness of the nudging can be tested quickly by means of an online experiment (Schneider, Weinmann, & vom Brocke, 2018).

However, other types of research were conducted on issues related to digital nudging, such as security (Peer et al., 2020), social security administration (Gregor & Lee-Archer, 2016), reduced digital consumption (Okeke, Sobolev, Dell, & Estrin, 2018). In spite of the recency of digital nudging, some studies (Almuhimedi et al., 2015; Demarque, Charalambides, Hilton, & Waroquier, 2015) used nudging in user interfaces before 2016. In the education field, nearly all nudge interventions were delivered to students via an institutional agent such as a post office or emails, rather than utilizing LMS or digital instructional tool (Brown, Schiltz, Derry, & Holman, 2019). Also, this literature review found only a few studies that applied nudging in a digital environment. Dimitrova, Mitrovic, Piotrkowicz, Lau, and Weerasinghe (2017) applied personalized nudges to recruit participants (i.e., postgraduate students) by sending invitations to people in several mailing lists encouraging them to engage with video content by rating and adding comments in an active video watching system (AVW).

Several studies found evidence of learning, but nudging did not make differences to experiences, motivation for learning, or participants' levels of engagement. Andor et al. (2018, p. 6) tested nudging as a prompt which was embedded in the course interface as a pop-up rather than an external website to reduce the drop-out rate from MOOCs. The nudging prompt increased the course completion rate by 19%. This study was not applied to high school or university students. Brown et al. (2019) developed an E-Coach system which is a web-based student support system for university students. The authors claimed that personalized interventions show promising results in encouraging students to improve their performance. The students with lower grade responded positively to multiple nudges. Table 2.5 summarizes the studies on digital nudges in higher education.

Table 2.5: Prior literature on digital nudging in education (prepared by the researcher).

Reference	Target population	Type of nudge	Findings
Brown et al. (2019)	university students	Feedback	Promising results in terms of encouraging students to improve their performance
Andor et al. (2018)	students in MOOCs	Feedback and reminder	19% increase in course completion rate
Piotrkowicz, Lau, and Weerasinghe (2017)	postgraduate students	Feedback	Evidence of learning, but no significant differences on. previous experience, motivation for learning, or engagement levels

2.7 Review of Current Nudging Frameworks and Models

There are six nudge models in the literature. The key features of each nudge model are summarized at the end of the discussion of each model. The models are discussed in chronological order from the oldest to the newest model. There is one nudge model and five digital nudge models.

2.7.1 The Nudge Development Process

One particular model for a nudging design was proposed by (Ly, Mazar, Zhao, & Soman, 2013). The authors proposed a general approach to nudge development. They provided a sequential structure that makes the process more accessible as shown in Figure 2.6. The model focuses on the decision- making process by analysing the context and the task (how does an individual make a decision, and under what typical circumstances is this done?), then identifying the key heuristics and the influences on the decision. A summary of key factors for this model is shown in Table 2.6.

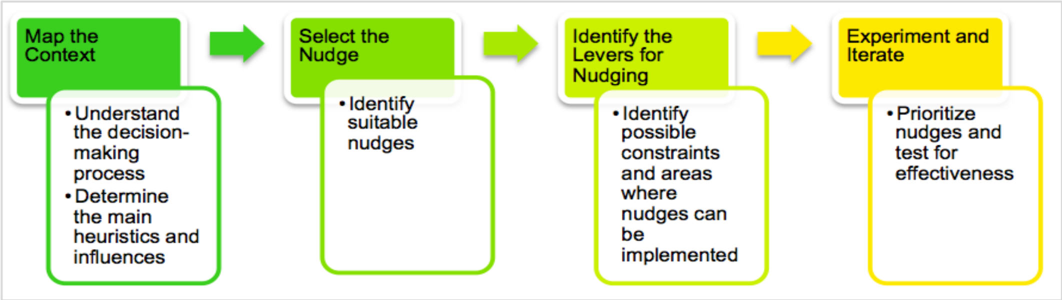


Figure 2.6: The nudge development process (Ly et al., 2013).

Table 2.6: Nudge development process (Ly et al., 2013) and factors generated for the initial model (prepared by the researcher).

The model Factors	**Factors generated for the initial e-nudging model for higher education in SA**
Map the context	
• Understand the decision-making process	Understand the decision-making process
• Determine the main heuristics and influences (behavior, cognitive, environment)	Determine the barriers and influences (behavior, cognitive, environment)
Select the nudge	
• Identify suitable nudges	Select nudge method
Identify the Levers for nudging	
• Identify possible constraints	Identify constraints
• areas where nudges can be implemented	Implement e-nudge
Experiment and Iterate	**Test Stage**
• Prioritize nudges and test for effectiveness	Test nudge impact

2.7.2 Digital Nudging Process

This model was proposed by Weinmann et al. (2016). They designed the first model for the digital nudging process, which comprise five phases for online decision environments as illustrated in Figure 2.7. The model was adopted from (Ly et al., 2013) nudge development process and (Datta & Mullainathan, 2014) behavior design process.

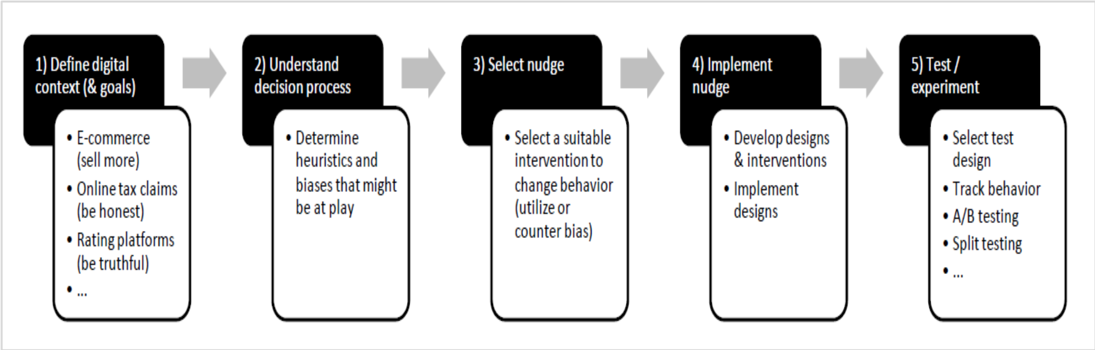


Figure 2.7: Digital nudging process model (Weinmann et al., 2016).

The five phases are depicted below (Weinmann et al., 2016):

- ***Define digital context and goals***: The user behavior is influenced by the context. Therefore, the context and goals should be identified as a first step.
- ***Understand the decision process***: Heuristics and biases may influence user decisions. Thus, understanding the decision process is essential in order to select suitable nudges.
- ***Select nudge***: The type of nudge depends on the heuristics used in the decision process. Moreover, the user interface design may influence user decisions, and includes the presentation of defaults or anchors (e.g., when the user gives a product rating by using the respective number of stars).
- ***Implement nudge***: It is less expensive to implement nudges in digital environments than in offline environments. It is easy to modify the design according to the user, and multiple different designs can be tested with less effort. Users' decisions can be tracked and, and an analysis can be made of users' personalities, demographics, and even emotional states to understand their decisions and influences. Also, the impact of nudge in a digital environment can be easily assessed.
- ***Test/Experiment***: Digital nudging can be tested quickly, easily and in real time. The split testing and A/B testing (or split testing) are a common method of testing the effectiveness of a digital nudge.

A summary of key factors for this model is shown in Table 2.7.

Table 2.7: Digital nudge process (Weinmann et al., 2016) and factors generated for the initial model (prepared by the researcher).

The model Factors	Factors generated for the initial e-nudging model for higher education in SA
Define digital context and goals	Identify e-nudge goal
Understand the decision process	Understand the decision process
• Determine the heuristics and biases that might be at play influences (behavior, cognitive)	Determine the barriers and influences (behavior, cognitive)
Select nudge	
• Select a suitable intervention to change behavior (utilize or counter bias)	Select nudge method
Implement nudge	**Implementation stage**
• Develop designs& interventions	Design e-nudge prototype
• Implement designs	Implementing e-nudge
Test/Experiment	**Test stage**
• Select test design	
• Track behavior	Test e-nudge impact
• A/B testing	
• Split testing	

2.7.3 Digital Nudging Process Model (DINU)

The second model proposed by Meske and Potthoff (2017), consists of a cyclical three-phase process for the design of digital nudges, known as "digital nudging process model" (DINU) (see Figure 2.8). The three phases are: analysis, design, and evaluation which includes a feedback loop.

- **Analyzing:** This is the first step which collects and analyzes requirements; here, the designer should determine the behavioral characteristics of the targeted audience. It is important to analyze the user in detail to find the reasons for undesirable behavior and determine the goals for digital nudging.
- **Designing:** In this phase, the focus is on finding the right elements and situations to design the digital nudge based on the pre-defined goals, reasons, and user (i.e.,

nudge) characteristics. To design a successful digital nudge, the authors identified most of the factors contained in the nudging literature and found those that can improve the element selection.

- **Evaluating:** This is the last step in the model. The designed digital nudge is evaluated after implementation to determine whether the desired behavior is achieved, or whether the digital nudge needs to be modified.

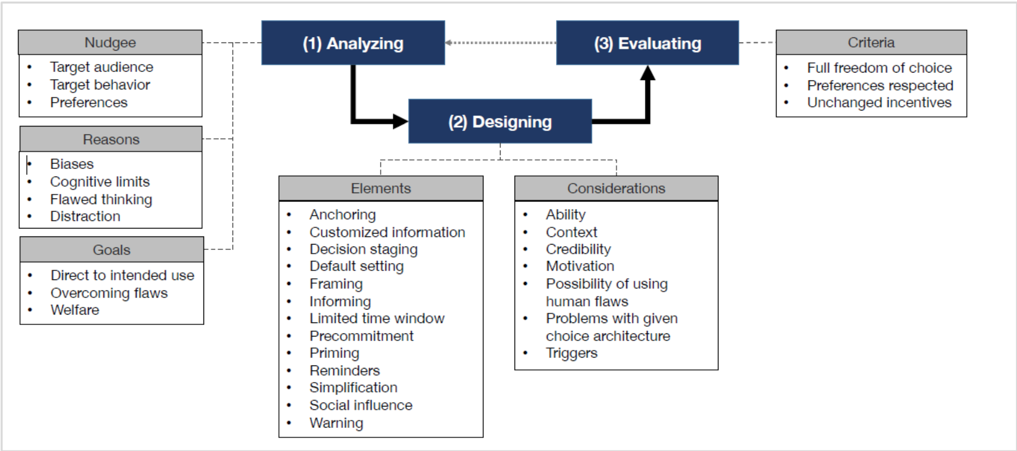


Figure 2.8: Digital nudging process model (DINU) (Meske & Potthoff, 2017).

The key factors for this model are shown in Table 2.8.

Table 2.8: Digital nudge process model (DINU) (Meske & Potthoff, 2017) and factors generated for the initial model (prepared by the researcher).

The model Factors	Factors generated for the initial e-nudging model for higher education in SA
Analyzing	**Analysis stage**
• Define nudge goal	Define nudge goal
• Target audience	Understand decision process
• Target behavior	
• Define reasons (behavior, cognitive)	Determine Barriers and influences (behavior, cognitive)
Designing	**Design stage**
• design the digital nudge	Design e-nudging prototype
Evaluating	**Test Stage**
• Assess digital nudge	Test e-nudge impact

2.7.4 Designing Digital Nudges

Schneider et al. (2018) developed a cyclical, four-phase model (define the goals, understand the users, design the nudge, and test the nudge) with a feedback loop to design digital nudges The design is adopted from the (Ly et al., 2013) nudge development process and (Datta & Mullainathan, 2014) behavior design process. The model is showed in Figure 2.9. These authors also designed the previous model (digital nudging process) described in sub-section 2.7.2. The 2018 model included a new factor: ethics. It is important to consider the ethical implications when people are being nudged to make a particular choice. The effectiveness of digital nudging can be tested by conducting online experiments, such as A/B testing (or split testing). Moreover, the researchers mentioned that it is important for designers to ensure the design is consistent and usable by following the design guidelines established for the respective platforms. A summary of key factors for this model is shown in Table 2.9.

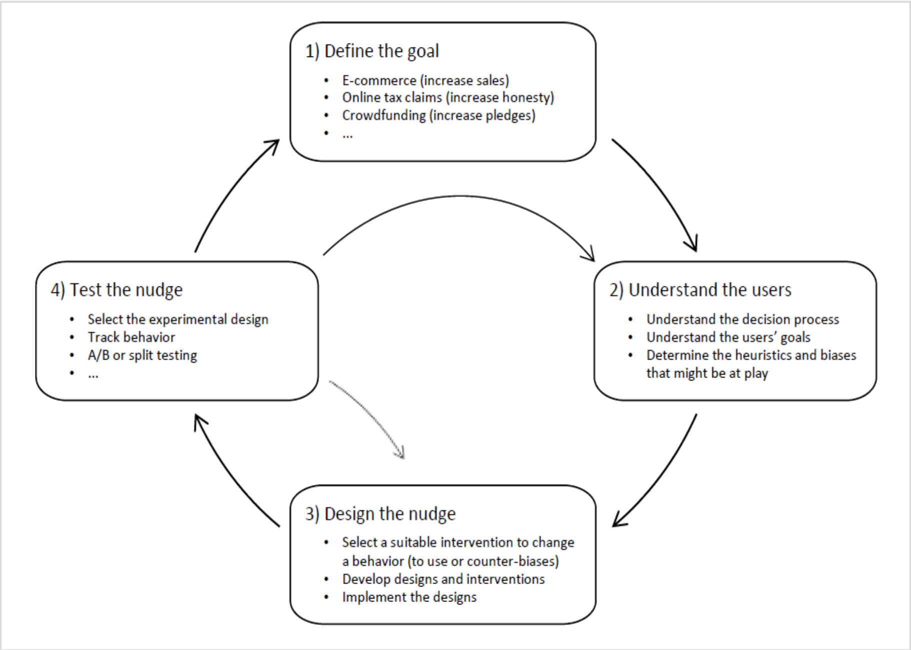


Figure 2.9: Cycle of digital nudge design (Schneider et al., 2018).

Table 2.9: Summary of the digital nudge design cycle (Schneider et al., 2018) and factors generated for the initial model (prepared by the researcher).

The model Factors	Factors generated for the initial e-nudging model for higher education in SA
Define the goals	Identify e-nudge goal
Ethics	Ethics
Understand the user	
• Understand the decision process	Understand the decision process
• Understand the user's goals	
• Determine the heuristics and biases that might be at play influences (behavior, cognitive)	Determine challenges and influences (behavior, cognitive)
Design nudge	**Design stage**
• Select a suitable intervention to change behavior (utilize or counter bias)	Select nudge method
• Develop design and interventions	Design e-nudging prototype
• Implement design	Implementing e-nudge
Test the nudge	**Test stage**
• Select experimental design	
• Track behavior	Test e-nudge impact
• A/B testing or Split testing	
• test usability	test usability

2.7.5 Functional Digital Nudges

This model modified the Schneider et al. (2018) model by considering timing as a critical factor for the success of digital nudges (Purohit & Holzer, 2019) as depicted in Figure 2.10.

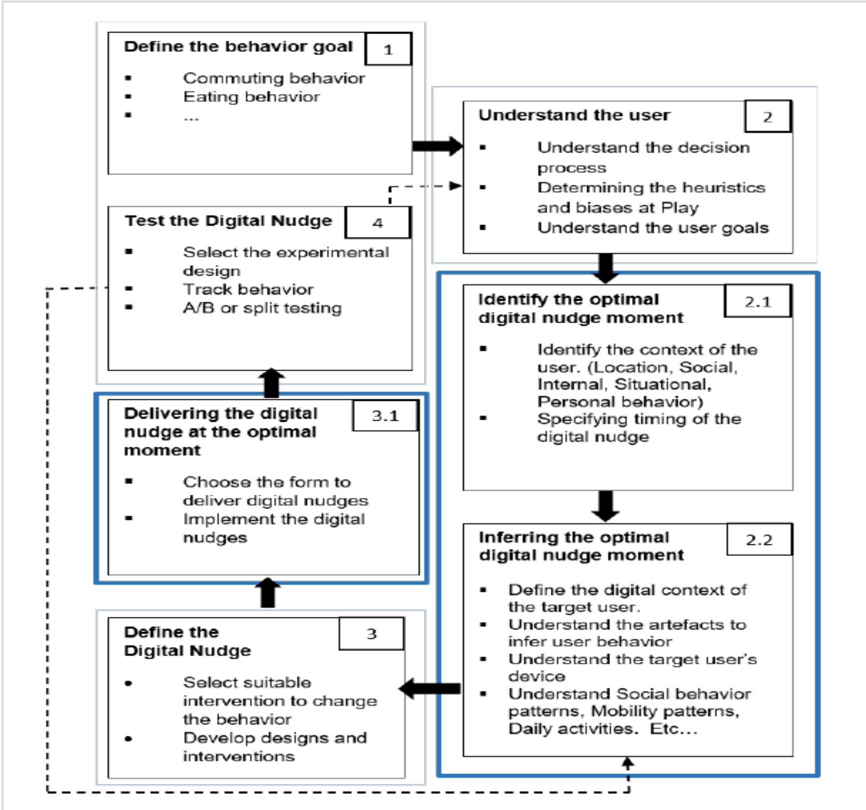


Figure 2.10: Functional digital nudges model (Purohit & Holzer, 2019).

The authors added three new factors:

- **Identifying the optimal digital nudge moment:** the timing is crucial to digital nudging achieving the intended goal(s). There are five categories as dimensions of nudge moments: location, social, internal, situational, and personal behavior. The nudge moment can contain one or more of these dimensions. The timing of the nudge can be set to before, during or after in each nudge intervention moment
- **Inferring the optimal digital nudge moment:** The designer must understand the digital context of the target user, including the hardware and software. For example, location context can be utilized from GPS in the user's smartphone, to determine the nudge moment.
- **Delivering the digital nudge at the optimal moment:** It is crucial to identify a suitable digital form for the delivery of a digital nudge, such as sound and vibration

notifications. The delivery style is not limited to personal devices, but can include other objects such as lights, public displays etc.

A summary of key factors for this model is shown in Table 2.10.

Table 2.10: Functional digital nudges model (Purohit & Holzer, 2019) and factors generated for the initial model (prepared by the researcher).

The model design stages	Factors generated for the initial e-nudging model for higher education in SA
Define the goals	Identify e-nudge goal
Ethics	Ethics
Understand the user	
• Understand the decision process	Understand the decision process
• Understand the user's goals	
• Determine the heuristics and biases that might be at play influences (behavior, cognitive)	Determine the barriers and influences (behavior, cognitive)
Identify the optimal digital nudge moment	Identifying the optimal digital nudge moment
Infer the optimal digital nudge moment	Test the optimal digital nudge moment
Define the digital nudge	**Design stage**
• Select a suitable intervention to change behavior (utilize or counter bias)	Select nudge method
• Develop design and interventions	Design e-nudging prototype
• Implement design	Implementing e-nudge
Deliver the digital nudge at the optimal moment.	**Test Delivering the digital nudge at the optimal moment.**
Test the nudge	**Test stage**
• Select experimental design	
• Track behavior	Test e-nudge impact
• A/B testing or Split testing	
• test usability	test usability

2.7.6 Designing a Smart Nudge

The last model is the smart nudge proposed by Karlsen and Andersen (2019). The design comprises an eight-step cycle with a feedback loop as shown in Figure 2.11. A summary of key factors for this model is given in Table 2.11.

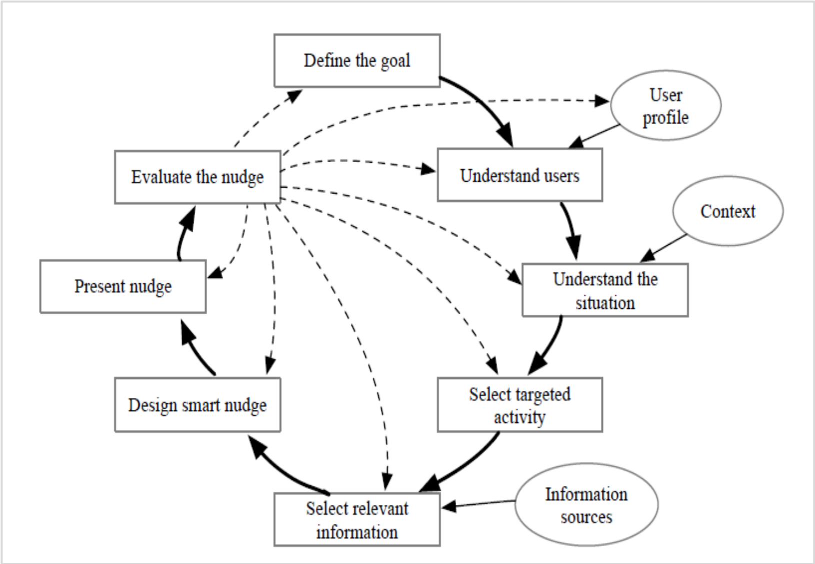


Figure 2.11: Designing a smart nudge (Karlsen & Andersen, 2019).

The three phases are:

- **Define the goal:** The goal of the nudge is determined in this step.
- **Understand the users:** This step includes two points: understanding users' psychological traits that influence their behaviors and decisions, and understanding the specific user in order to design a personalized nudge (i.e., a smart nudge)
- **Understand the situation:** It is important to understand the decision-making context such as time of day and location. The situation influences the choice made by the specific user.
- **Select the targeted activity**: The nudge goal includes a set of relevant activities that are offered to the user. In this step, the user chooses one of the activities.

- **Select relevant information**: All the nudge information is collected and used to inform the user about the targeted activity and softly push the user to respond positively to the nudge.
- **Design the nudge**: The nudge intervention provides practical information to assist the user to choose the suggested activity.
- **Present the nudge**: The nudge is presented to the user in suitable form at the time when a decision is to be made.
- **Evaluate the nudge**. The effectiveness of nudge is evaluated according to how the user receives it and how it influences his behavior and decision.

Table 2.11: Designing a smart nudge (Karlsen & Andersen, 2019) and factors generated for the initial model (prepared by the researcher).

The model Factors	Factors generated for the initial e-nudging model for higher education in SA
Define the goal	Identify e-nudge goal
Understand the user	
• Understand user psychological effects	Understand the decision process
• Understand the specific user	
Understand the situation	
Select the targeted activity	
Select relevant information	
Design the nudge	Design e-nudging prototype
Present the nudge	Implementing e-nudge
Evaluate the nudge	Test e-nudge impact

2.8 Research Gap

The research is constructed from the intersection of three fields (nudging, education, HCI & usability) as depicted in Figure 2.12. The stream of studies related to each of these fields are examined below. The research is divided into education (focusing on students' issues in higher education) as the first research stream. The second research stream is HCI and usability direction (focusing on interactive design) and the individual's characteristics (focusing on behavioural, cognitive, and environmental biases). Finally, digital nudging constitutes the third research stream.

Until recently, to the best of the researcher's knowledge, no study has been conducted on developing and assessing a digital nudging model for the education field and for SA higher education. There are only six nudging models, discussed in section 2.7. A clearer theoretical model is needed to address the challenges associated with students' educational decisions in a digital environment. Although several types of studies have already been conducted on this topic (see sub-section 2.5.5 and section 2.6), some nudge researches in the education domain found inconsistent results, and in some cases the nudge has negative effects, Damgaard and Nielsen (2018, p. 2) conclude that "few interventions produce positive effects for everyone and some nudges even have negative effects.". Hence, there is a need to design a digital nudge model for higher education to guide designer in developing and implementing effective nudging interventions that improve students' decisions.

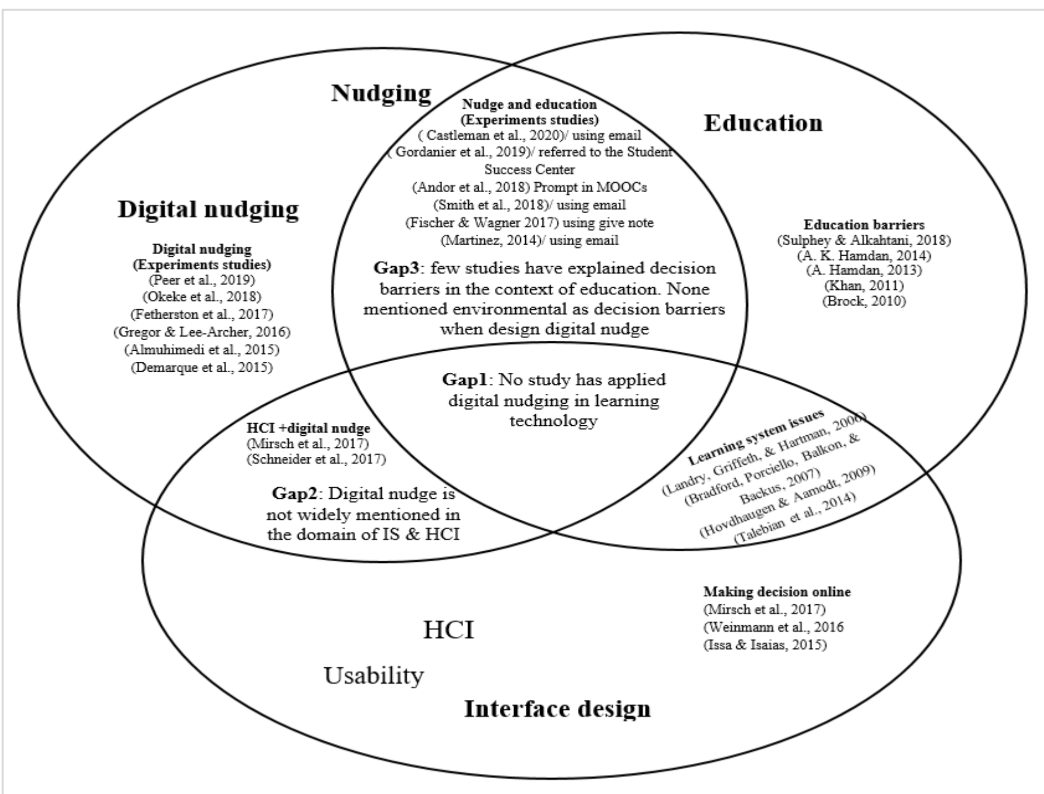


Figure 2.12: Overview of research streams and intersecting fields (prepared by the researcher).

Because the concept of digital nudging involves user interfaces, this requires establishing a relationship between digital nudging and the field of Information Systems (IS) and Human Computer Interaction (HCI) in particular. Knowledge of behavioral design is essential. In addition, understanding how digital nudging affects the environment can help the designer to steer the user towards the best, most desirable choice (Weinmann et al., 2016). Mirsch et al. (2017); Weinmann et al. (2016) argue that nudging is not widely mentioned in the domain of IS and HCI; hence, the first intersection area is identified for this study.

To date, five digital nudging models have been proposed (Karlsen & Andersen, 2019; Meske & Potthoff, 2017; Purohit & Holzer, 2019; Schneider et al., 2018; Weinmann et al., 2016). All the models have similar process cycles (identify goals, analysis or understand user, design nudging, evaluate or test nudging). Purohit and Holzer (2019) argue that the time when nudging occurs is important. They proposed three steps: identifying, inferring, then delivering the digital nudge at the optimal moment. However, after comparing the models, some of the processing steps and factors were found to be missing in some models, and none of these models considers the HCI and usability principles when designing digital nudging. According to Issa and Isaias (2015), the aim of HCI is to design a user interface (UI) that meets users' needs and requirements. UI design should maximize the usability and user experience (UX). The usability refers to the ease of use and efficiency. UX refers to the internal state of the user that includes, for example, feeling, motivation, and expectations when interacting with the technology. As mentioned above, there is no general way to design choices due to the changes in the environment and the ways in which humans interact with technologies (Mirsch et al., 2017; Weinmann et al., 2016). These changes have prompted HCI researchers to develop approaches to improve the interaction between user and technologies. Digital nudging is an emergent concept that can potentially inspire HCI research (Mirsch et al., 2017).

Furthermore, none of the previously proposed models has an evaluation step after each phase; all the models assess the effectiveness of the digital nudging at the end of the entire process in the testing phase. Evaluation is a critical step when developing new technology. The designer needs to plan each evaluation step during the development cycle and before releasing the technology to the user in order to ensure that the new technology meets the user's requirements (Issa & Isaias, 2015).

Also, ethics must be taken into account when designing a nudge. The concept of nudging originates from economics and aims at maintaining individual freedom of choice, without limiting or forbidding any choice. It is unethical to nudge people towards decisions that could harm them or compromise their welfare (Hortal, 2020). Sunstein (2015) stated that if nudges are designed to ensure freedom of choice, individuals can choose what they like and not be constrained to follow nudges. Also, it is important to not use individuals' behavioral issues such as inertia or inattention against them (Sunstein, 2016). Nudging must be non-irresistible and transparent. Individuals should be aware of any kind of intervention that is intended to restructure the choice environment in order to direct their behavior (Hortal, 2020).

Furthermore, no current digital nudging model has appropriately identified the environmental factors that affect the user's behavior. Although the environment is mentioned as a possible influencing factor, no details are given. Digital choices are included in the user interface (environment). The ways in which a system is organized and presented in the digital environment is more likely to influence the user's decisions (Issa & Isaias, 2015; Weinmann et al., 2016). This is central to the design of nudges. (Dimitrova et al., 2017). Nevertheless, no research to date has focused on a design that takes into account the features of the environment, while some studies focus only on the application of nudges and their impact on individual behaviours (Sulphey & Alkahtani, 2018).

Moreover, in education, the behavior and cognitive process that occurs between the nudge and final goal merits attention. In the Damgaard and Nielsen (2018) review, more than half of the nudges studies in education do not focus on improving behavior - only on improving end goals such as academic performance and grades. Weijers et al. (2020, p. 7) argued that "a key aspect of nudging in education, namely the necessary focus on investigating cognitive processes and subsequent behavior, is required to successfully implement nudging in education". Therefore, it is important to understand the behavioral effects of the interface design elements on the user’s decisions, and to ensure that digital nudging is properly conducted and does not occur at random.

Additionally, this study aims to provide academic knowledge about important behavioral, cognitive and environmental factors in the education field, facilitating the design of successful digital nudging in learning systems since, as yet, no study has explored and assessed education barriers or challenges in Saudi Arabian universities. Therefore, it is important to understand the behavioral, cognitive, and environmental influences on the user’s decision, and to ensure that digital nudging is properly conducted and does not occur at random.

This study proposes a conceptual model called “e-nudging model” (see section 2.9) that includes all these factors in order to address the research gap, no research to date has conducted on the use of digital nudging for students in Saudi Arabian universities. The initial model will be examined and assessed by several lecturers in Saudi universities by using the mixed-methods research approach. Details are given in sub-section 3.4.3.3).

To conclude, Table 2.12, shows the absence of the aspect indicated in the corresponding column and a (✓) indicates the presence of the specific aspect and (×**)** indicates the absence of the specific aspect.

Table 2.12: Factors discussed in e-nudging model for higher education in SA(prepared by the researcher).

Authors	Planning							Analysis		Design					Implementation	Testing			
	Identify e-nudge goals	Identifying constraints	Understand decision process	Determine Barriers and influences			Mapping decision process with barriers identified	Select nudge method	Identifying the optimal digital nudge moment	HCI	Navigation	Usability	Design e-nudging prototype	Ethics	Implement nudging	Test e-nudge impact	Test delivering methods of the digital nudge and	Test the optimal moment	Test usability
				Behavioral	Cognitive	Environment													
Karlsen and Andersen (2019)	√	×	√	√	√	×	×	×	×	×	×	×	√	×		√	×	×	×
(Purohit & Holzer, 2019)	√	×	√	√	√	×	×	√	√	×	×	×	√	√	√	√	√	√	×
(Schneider et al., 2018)	√	×	√	√	√	×	×	√	×	×	×	×	√	√	√	√	×	×	√
(Meske & Potthoff, 2017)	√	×	√	√	√	×	×	√	×	×	×	×	√	×	√	√	×	×	×
(Weinmann et al., 2016)	√	×	√	√	√	×	×	√	×	×	×	×	√	×	√	√	×	×	×
(Ly et al., 2013)	×	√	√	√	√	√	√	√	√	×	×	×	√	×	√	√	×	×	×

2.9 Proposed Initial Model

The initial proposed e-nudge model for SA higher education is informed by the current nudge models discussed in section 2.7. The proposed model also takes into account other features of an interactive design: HCI, navigation, and usability as the digital nudge is an element of the user interface. Moreover, the initial model considers the environment barriers as factors that affect students' decision in the digital learning system. Also, the initial model has evaluation after each stage.

The development of the e-nudging model for a digital environment comprises three phases. All three phases include a feedback loop to improve the design. The reason for having these three main phases is to simplify the main aspects of the digital nudge design. The main points are analysed, nudge then test behaviour. The first phase called "*analysing user behaviour*" which involves two stages: planning and analysis. The second phase called "*nudge user behaviour*" which also involves two stages: design and implementation. The last phase is "*assessing nudge impact*" includes the testing stage. All three phases comprise a feedback loop to enhance the development process. Nudging is not widely mentioned in the IS and HCI domains; hence, the e-nudging model architecture, which is illustrated in Figure 2.13, is inspired by the system development life cycle (the number of stages and flow or loop). Thus, designers can easily update the current system to adopt and implement the e-nudging model by applying the following processes.

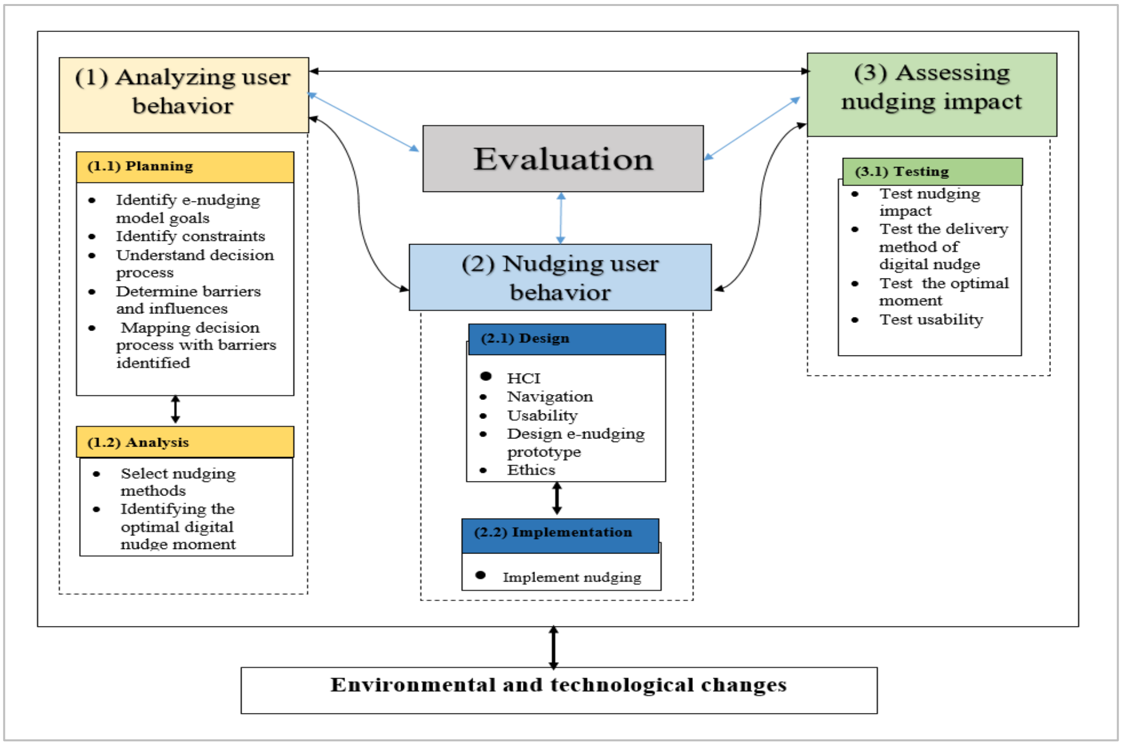


Figure 2.13: Initial e-nudge model for this research (prepared by the researcher).

2.9.1 Planning Stage

The planning stage guides the designer team through the other stages. The stage defines the goal, timeline, cost, and resources. The decision for implementing the digital nudge is made in this stage. The stage contains five factors: “identify e-nudging goals”, “identify e-nudge constraints”, “understand decision process” “determine barriers and influences”, and “mapping decision process with barriers identified”.

- **Identify e-nudging goals**: in this step, the digital nudge goal is determined. For example, the goal could b to increase students’ attention to improve their academic achievements.
- **Identify e-nudge constraints:** the time constraint and available resources required to develop the digital nudge are determined in this step. Also, it is important to consider other constraints such government policy and organizational constraints in order to avoid any possible conflict with digital nudging goals.
- **Understand decision process:** In order to design appropriate digital nudges, it is crucial to have an understanding of students’ decision-making process, since the heuristics and biases can influence students’ decisions (Bertheim, 2018).
- **Determine barriers and influences:** It is important to match the nudge goal with the defined barrier. For example, if the undesired behavior is limited attention, then the digital nudging goal is to increase students’ attention so as to improve their academic performance. In this research, three types of educational barriers were considered: behavioral, cognitive and environmental.
- **Mapping decision process with barriers identified:** This is the last factor in the planning stage, and relates to the critical actions involved in students’ decisions in order for the digital nudge to be effective. Also, this step provides pros and cons of taking alternative decisions, so that the student makes the right decision. This assists the designer to develop an effective digital nudge intervention to nudge students towards making the right decision.

2.9.2 Analysis Stage

The purpose of this stage is to analyse and examine what is required in order to achieve the identified digital nudging goal. This analysis stage contains two factors: “select nudge method” and “Identifying the optimal digital nudge moment”, explained below.

- **Select nudge method**: the nudging methods or interventions can be selected in this step after determining the barriers that influence student choices. Finally, choosing and prioritizing the best nudging method that meets the system requirements and can influence student’s decision effectively is the final step in this phase, and becomes the input for the design stage.
- **Identifying the optimal digital nudge moment:** the timing of the nudge is an essential consideration in an e-nudging model (Purohit & Holzer, 2019). For example, reminders given at different times during the semester are a useful nudging for students who suffer from limited attention. Purohit and Holzer (2019) state that the nudging time can be set to occur before, during or after the semester. This step becomes easier after conducting the mapping decision process.

2.9.3 Design Stage

This stage is the core of the development process when designing a digital nudge in the digital environment. During the design stage, it is essential to ensure the user interface is consistent and usable by follow commonly accepted design guidelines (Issa & Isaias, 2015; Schneider et al., 2018). The design should meet students’ requirements. Thus, the HCI, usability and navigation are key factors in the initial e-nudging model for higher education. This stage contains five factors:

- **Human computer interaction (HCI):** this is an essential element of a system design, and must meet users’ needs and requirements (Issa & Isaias, 2015). When designing the digital nudge, subtle changes are made to the ‘choice architecture’ to steer people's behaviors correctly in predictable ways (Caraban et al., 2019; Konstantinou, Caraban, & Karapanos, 2019). Moreover, the digital nudge occurs via the user interface (Weinmann et al., 2016), so it is an element of the user interface. Thus, the HCI is an imporant factor in the e-nudge model in order to meet students' requirements and improve their education-related decisions.

- **Navigation:** this is an important aspect to be considered to improve UX factors such as feeling, motivation, and expectations when users are interacting with the system. (Issa & Isaias, 2015). The navigation assists students to find materials and grades easily on the LMS (Kung, Mat Yamin, & Wan Ishak, 2012). As mentioned previously, user interfaces are likely to influence students' decisions in an online environment. Therefore, when designing a nudging prototype, it is important to consider the design elements and the way that the nudging appears on the interface. For instance, the nudging feedback could be designed using different forms such as notification, vibration or text.
- **Usability:** this refers to users being able to use the system effectively in order to complete a task with ease and satisfaction (Thuseethan et al., 2014). Usability means that a system is effective, efficient, safe to use, easy to use and evaluate, enjoyable, and satisfying (Isaa and Isaias, 2015). In the education context, the usability enhances students' learning experiences (Thuseethan et al., 2014). As mentioned above in sub-section 2.4.3, many students face functional, design and technical issues when using Blackboard, although they like to use it. Therefore, a digital nudge that is integrated into a system that is difficult to navigate will be useless in terms of influencing student behaviour or decision-making.
- **e-Nudging prototype:** the prototype for the digital nudge is designed in this step to assess how the nudging will appear among other elements on the students' interface in the LMS. Various designs can be proposed and evaluated to determine which one will best achieve the e-nudging goals. It is important to consider the other elements in the interface and the way that the nudging appears on the learning system (Mirsch et al., 2017).
- **Ethics**: this must be taken into account when designing a nudge. The concept of nudging originates from economics and is intended to safeguard liberty without limiting or precluding any choice. It is unethical to nudge people towards decisions that could harm them or compromise their welfare (Hortal, 2020; Sunstein, 2015).

In the final step, the nudging prototype nudging is evaluated according to two criteria: efficiency and full freedom of choice. This step improves the nudging design by reworking and testing it until the nudging prototype meets the requirements and ethics before the implementation stage.

2.9.4 Implementation Stage

In this stage, the best and most efficient nudging method derived from the design stage, is implemented. This stage has one factor:

- **Implementing the e-nudging:** the digital nudge prototype that met requirement in the design stage will be implemented and any changes required in the learning system interface will be made as well.

2.9.5 Test Stage

This stage measures the effectiveness of the digital nudging on student decisions. The test stage is crucial. It assesses the digital nudge based on context, goals and target groups (Schneider et al., 2018). This stage contains four factors:

- **Test nudging impact**: this step measures the effectiveness of the digital nudging and determines whether the nudging goal has been achieved, or the digital nudge needs to be modified. Digital nudges can be tested by conducting online experiments using A/B testing and split testing (Schneider et al., 2018).
- **Test delivery method of the nudging:** this step focuses on the design of the nudge delivery (i.e., notification, sound, vibration or message).
- **Test the optimal moment:** The timing of the nudge can be set to occur before, during or after in each nudge intervention moment. It is important to test the timing of the nudge to ensure the nudge is occurred in the correct time for decision is be made.
- **Test usability:** it is important to test the usability of the whole system after the final nudging implementation.

2.9.6 Evaluation Stage

This stage aims to evaluate the outcomes of each of the e-nudging model stages. In fact, none of the proposed models described in section 2.7 has an evaluation step after each stage; all the models assess the effectiveness of the digital nudging only in the test phase, after the entire development process has been completed.

2.9.7 Environmental and Technological Changes

The changing nature of the environment and technology need to be considered so that an e-nudging system meets the students' requirements. It is important for a digital nudge to be flexible enough to adapt to rapid changes caused by technology and the environment (Jaffe, Newell, & Stavins, 2003).

2.10 The Impact of COVID-19 Influences on Education

The Covid-19 pandemic is a health crisis that has challenged education systems worldwide. In order to control the spread of the disease and save lives, many countries have ordered education institutions to close and to switch to teaching virtual classes online (Daniel, 2020). This decision is a massive shock to parents, teachers and children's social lives and learning. This movement is done with a lot of trial and error and uncertainty situation for everyone. (Burgess & Sievertsen, 2020).

Students are facing uncertain environments characterized by financial hardship in many cases, and health problems that are both physical and psychological. Moreover, the lack of adequate equipment (i.e., laptop, Internet, and home environment) hampers students' ability to undertake their studies online. Students have been affected in terms of their academic performance, educational plans, and expectations about future work (Aucejo, French, Araya, & Zafar, 2020). Aucejo et al. (2020) found that approximately 50% of college students reported a decrease in study hours and in their academic performance. Aristovnik, Keržič, Ravšelj, Tomaževič, and Umek (2020) found that teaching staff and universities' public relations personnel provided the most important support for the students during the pandemic. In contrast, the students were prevented from performing well because of the lack of computer skills and the subsequent higher workload. Concerns about future careers and study issues were reported by students during lockdown. Students feel bored, anxious, and frustrated. Moreover, daily routines have had to change: masks need to be worn, social distancing has to be observed, and hygiene protocols need to be strictly followed. Copeland et al. (2021) found that the covid-9 pandemic has had detrimental impacts on college students' behavioral and emotional functioning, particularly in terms of externalization and attention problems. In SA, Tanveer, Bhaumik, Hassan, and Haq (2020) found more than 67% of participants felt that they were affected by the closure of the education sector (school, colleges and universities). Also, many participants faced difficulties related to their courses and autonomous learning. Due to social distancing restrictions, students are unable to engage in collaborative work and discussions with their classmates, making it difficult for them to fully understand the course content. The stress and pressure on students have increased significantly. Many fear losing their Internet connection required for the submission of tasks, with a subsequent loss of marks or credits.

As a matter of urgency, educational institutions must cater for vulnerable student groups (Aristovnik et al., 2020), identify the issues and challenges facing students, and be prepared to make tough decisions in the coming months. The universities need to ensure that standard of student learning outcomes and quality of education are not compromised. Post-pandemic, the higher educational institutions must be prepared for a tough road, because their decisions will shape and lead students into the future (Rashid & Yadav, 2020). SA has used digital technology during the pandemic. In education, SA continues to develop the electronic learning infrastructure of institutions and indicated promising directions for widespread adoption in the future. The Saudi Vision 2030, released in 2017, has paved the way for digital transformation and the pandemic has been a catalyst for this transition (Hassounah, Raheel, & Alhefzi, 2020).

2.11 Chapter 2 Summary

This chapter provides a comprehensive review of the literature on nudging in higher education. The chapter starts by discussing the scope of the literature review. Then it gives the background of higher education in SA and why digital nudging is important for SA higher education. Then the educational barriers in education (behavioural, cognitive, and environmental) are discussed in detail. The chapter presents an overview of nudge theory, a detailed discussion on digital nudge, and the current usage of nudge interventions in higher education. The research gaps are identified in this chapter. Six current nudge models are examined. A summary of the key aspects of each model is presented. An examination of the current nudge models shows that it is impossible to generalize any of these models to the Saudi tertiary sector as each is inadequate for this purpose. Hence, there is a need to design e-nudging model to meet the needs of the SA higher education. The initial model is developed based on the current literature review and will be enhanced and modified according to the findings of the mixed-methods approach to design e-nudging model that best suits the higher education in SA context. The next chapter explains the methodology adopted for this thesis.

Chapter 3. Research Methodology

3.1 Introduction

The previous chapter presented a comprehensive review of the literature on education barriers and nudging theory and its applications, within the context of higher education sector in SA. It explained how the students will benefit from the proposed e-nudging model to improve their academic achievement especially in the SA and generally in the Gulf Cooperation Council (GCC) countries. The research type is explored, and the mixed-methods approach has been deemed the most appropriate for this research.

This chapter explains the research significance, and states the research questions and objectives. Also, it discusses and justifies the choice of research methodology for study. In this chapter, the important areas of the research onion are described and the concepts in each area are clarified. This chapter starts with an explanation of the research significance in section 3.2 followed by the research questions and objectives in section 3.3. After that, the research design is described in section 3.4, while section 3.4.1 considers the research philosophy. Then, research approach is described in sub-section 3.4.2. The methodological choice is explained in sub-section 3.4.3, followed by strategy in sub-section 3.4.4. The fifth layer of the research onion (time horizon) is presented in sub-section 3.4.5, while the last layer comprising techniques and procedure is described in sub-section 3.4.6. Section 3.5 summarizes the elements of the research onion that are applied in this study. The target population, data analysis methods and tools are presented in section 3.6 and section 3.7.Then, research reliability and validity are explained in section 3.8. The ethical approval is presented in section 3.9. Then section 3.10 concerns the possible research risk. Finally, the research phases and chapter summary are given in section 3.11 and section 3.12 respectively.

3.2 Research Significance

It is important to clarify how the research contributes to the current knowledge or helps to solve a problem. This is known as the research significance, which is theoretical and practical. Theoretical significance relates to the new knowledge or new understanding that the research will contribute, and the future research opportunities that it presents. Practical significance relates to the application of the findings to real-life situations. The purpose of this research is to design an e-nudging model for the higher education sector in SA using a mixed-methods research approach. This approach can be defined as a procedure for collecting, analysing, and integrating the findings from both quantitative and qualitative data within a single study (Doyle, Brady, & Byrne, 2009; Johnson, Onwuegbuzie, & Turner, 2007; Morse, 2016). The nudge is a new concept, especially in the context of SA education. The significant advantage of using a sequential mixed-methods approach is that it provides a comprehensive picture of a phenomenon due to the qualitative data being built on the quantitative results. This allows qualitative data to provide a rich explanation of statistical quantitative results by exploring in depth the research participants' views (Ivankova, Creswell, & Stick, 2006). In addition, this method helps the research to be completed more expeditiously and efficiently than multiple methods, with coherent and accurate research results (Morse, 2016). At the end, the results of this research show how the different aspects of digital nudge can be integrated and guide further research on this topic.

3.2.1 Theoretical Significance

This study will contribute a new theoretical perspective to the growing literature on the relationship between HCI and digital nudging. The concept of digital nudging is likely to add a new aspect to UI and user experience (UX) design. A clear understanding of the behavioral and cognitive effects on the human decision-making process will assist UI designers to improve their design and determine whether or not the digital environment nudges the users as intended. Also, this study aims to contribute more knowledge about important behavioral, cognitive and environmental factors in the education field, facilitating the design of successful digital nudging in LMS. In the context of education in the SA, currently in the best knowledge of researcher no study has been conducted on the initiation and assessment of digital nudging in Saudi Arabian universities.

This research proposes an e-nudging model for higher education in the SA to improve students' outcomes and reduce the drop-out rate. It is anticipated that the study's findings will encourage the stakeholders such as academics, scholars, and governments to undertake research on digital nudging which has great potential to benefit both research and society. In addition, this study provides a significant opportunity for Saudi PhD and Master students to benefit from the support offered by digital nudging in the SA education system as well as in other developing nations, especially the Gulf Cooperation Council (GCC) countries.

3.2.2 Practical Significance

It is anticipated that this study will make a contribution in terms of practical application. Until recently, to the best of the researcher's knowledge, no study has been conducted on the initiation and assessment of the effectiveness of digital nudging in Saudi Arabian universities. This study aims to assess the proposed e-nudging model, the relevant factors and how they influence the effectiveness of digital nudging in a LMS to improve students' outcomes. Given the Saudi Arabian government's vision for the development of the higher education sector (Alharbi, 2016), the nudge is consider the fourth strategic technologies influences higher education industry in 2020 Gartner (2020). The research findings will assist stakeholders such as universities, education departments and governments to make more informed decisions about applying digital nudging successfully in the education system and reap the benefits of this emerging concept. The main outcome of this study will be an e-nudging model that is appropriate for higher education in SA.

The e-nudging model will provide the foundation for stakeholders to effectively establish and implement the e-nudging techniques in the Saudi education system. Moreover, The proposed e-nudging model will improve understanding of the concept of digital nudging and its application in the learning and teaching field, particularly as it offers a significant opportunity for students to improve their academic achievement and reduce the dropout rate. Ultimately, the availability of this new e-nudging model may benefit students and academic staff in SA and the Gulf Cooperation Council (GCC) countries as they share many common characteristics such as culture, religion, social, language, and economic and financial system.

3.3 Research Objectives and Research Question Design

The formulation of good research questions is an important step in the research process. Also, it helps to determine the research objective in the specific area the research will address (Creswell, 2014; Johnson & Christensen, 2014). In addition, the research questions are crucial because they inform the choice of methodology and research design (Lipowski, 2008). Formulating clear and articulate research questions will enable the researcher l to find the answers in a focused, clear manner (Collis & Hussey, 2009; Doody & Bailey, 2016).

3.3.1 Primary Research Question and Objective

This research explores and expands the concept of digital nudging adoption in the education field in SA. Also, the research seeks to determine of the relevant factors that influence e-nudging implementation in higher education settings in SA. This leads to the primary research objective is:

- *To identify the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia*.

The primary research question:

- *What are the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia?*

3.3.2 Secondary Research Questions and Objectives

In this research, it is required to understand the different aspects that impact e-nudging design from different stakeholders' perspectives, in order to develop appropriate model for higher education in SA universities. It is important to assess the effectiveness of those factors. Indeed, select the most relevant factors to design effective e-nudging model is one of the most challenging tasks in the research.

There are several issues that influence students' education-related decisions that need to be taken into consideration in order to successfully develop e-nudging model into higher education in SA. It is crucial to understand the impact of these educational barriers (i.e., cognitive, behavioural and environmental) on students' decision making to design successfully e-nudging interventions that improve students' decision making which lead to improve their academic achievements. Therefore, the secondary research objectives are:

1. *To assess the perceptions of university expert academics towards the e-nudging model for Saudi Arabia higher education.*
2. *To evaluate if the e-nudging model will meet the requirements of students.*

The secondary research questions are:

- *What are the perceptions of university expert academics regarding the e-nudging model for Saudi Arabia higher education?*
- *How can an e-nudging model meet the requirements of students?*

Table 3.1 illustrates the relationships between research questions, objectives, methods, and analysis techniques that are applied in this research.

Table 3.1: The relationships between research questions, objectives, method and analyses (prepared by the researcher).

Research Objective	Research Question	Research Method	Analysis
To identify the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia	Q1: What are the specific factors that must be considered when designing an e-nudging model for higher education in Saudi Arabia?	**Literature review** **Mixed methods**	Exploratory factor analysis (EFA) of quantitative data from survey Thematic analysis of qualitative data from the interview
To assess the perceptions of university expert academics towards the e-nudging model for Saudi Arabia higher education	Q2: What are the perceptions of university expert academics regarding the e-nudging model for Saudi Arabia higher education?	**Mixed methods**	Thematic analysis of qualitative data from the interview
To evaluate if the e-nudging model will meet the requirements of students	Q3: How can an e-nudging model meet the requirements of students?	**Mixed methods**	Exploratory factor analysis (EFA) of quantitative data from survey

3.4 Research Design

One way to develop a better-organised methodology is to use the *Research Onion* model created by Saunders, Lewis, and Thornhill (2016). The research onion is comprised of six main layers as illustrated in Figure 3.1

There are different elements in each layer that lead to the development of the final research design. The researcher follows the research onion framework from the outer layer to the inner layer (Saunders, Lewis, & Thornhill, 2016). Each layer will be explained in the subsections below.

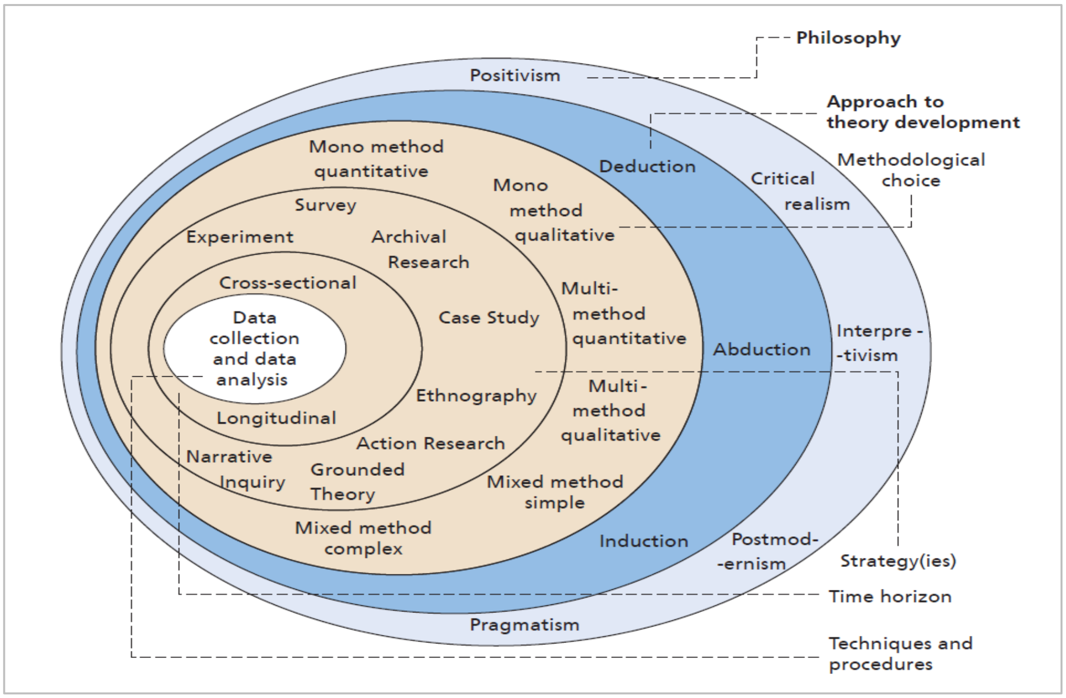


Figure 3.1: Research Onion (Saunders et al., 2016, p. 130).

3.4.1 Research Philosophy

Research philosophy is the first layer of the research onion. Research philosophy refers to the set of beliefs and assumptions about the development of knowledge in a particular filed (Bryman, 2016; Saunders et al., 2016). Saunders et al. (2016) states that the labels ‘philosophies’ and ‘paradigms’ are sometimes used interchangeably in management research. In this step, the researcher adopts a certain philosophy for a particular study to reflect beliefs and assumptions about his opinion and the way in which he understands the reality. In fact, the type of knowledge being investigated in the research determines the choice of research philosophy (May, 2011). The philosophy helps to justify the methodology adopted for the research. The choice of methodology should be guided by the nature of the phenomenon being investigated.

According to Saunders et al. (2016), understanding the research assumptions helps the researcher to distinguish between individual research philosophies. There are three types of research assumptions: ontology refers to how a researcher understands existence, epistemology refers to the valid information required for the research and how a researcher can get knowledge and obtain it, and axiology refers to role of values and ethics on the research process (Saunders et al., 2016). These assumptions shape the philosophy underlying the research. The most significant philosophies explained in the research onion are positivism, critical realism, interpretivism, postmodernism and pragmatism see Figure 3.1. Each philosophy will be discussed separately below and the chosen one will be identified.

3.4.1.1 Positivism

This philosophy relates to knowledge obtained through experience and proof. Positivism supposes that reality (i.e., knowledge) is independent and the researcher's role is limited to data collection, and the outcomes are interpreted in an objective manner. Thus, the positivist approach is scientific and uses empirical evidence such as data and statistics to reveal objective truths. In these types of studies, the results and findings are usually quantifiable and observable, and not influenced by human interpretation or bias (Saunders et al., 2016; Wilson, 2010). The researchers who adopt the positivist paradigm depend on facts and consider the world as stable, real, external and objective (Wilson, 2010). Also, their studies can be replicated by other researchers. Crowther and Lancaster (2008) mentioned that positivist research usually adopts a deductive research approach, explained in sub-section 3.4.2.

3.4.1.2 Critical Realism

Critical realism research philosophy assumes that the social reality is independent from the human mind (i.e., researcher). Realism is similar to positivism in its procedure. However, the difference is that the realism assumes that scientific methods are imperfect. Moreover, the reality is structured and layered (Saunders et al., 2016; Taylor, 2020). In this philosophy, reality is external and independent, but not directly observable. Critical realism concentrates on explaining what can be seen and experienced, in terms of the fundamental structures of reality that form the observable events (Melnikovas, 2018; Saunders et al., 2016). Although several research methods are compatible with critical realism philosophy, the final choices should depend on the nature of the research and the outcomes (Easton, 2010).

Critical realism philosophy states that two factors should be considered in order to understand the reality. The first comprises the feelings, emotions and events that individuals experience. The second is the mental processing that occurs at some point after their experience (Saunders et al., 2016). Actually, critical realist researchers should understand that the research might be influenced by their socio-cultural background and experiences or bias, and they strive to be more objective when conducting the research (Saunders et al., 2016; Taylor, 2020) .

3.4.1.3 Interpretivism

Interpretivism philosophy assumes that the reality is complex, and it has many explanations. According to this philosophy, the reality can have diverse interpretations as different individuals with different cultural backgrounds and under different circumstances create different experiences and different meanings. Interpretivism philosophy emerged as a critique of positivism but from a subjectivist perspective. This philosophy aims to generate new, abundant understandings and interpretations of social context (Iovino & Tsitsianis, 2020; Sahay, 2016; Saunders et al., 2016). Saunders et al. (2016) highlighted that people and their social worlds cannot be tested in the same manner as physical phenomena; thus, social sciences research should be conducted differently from natural sciences research. Furthermore, Bryman (2016) argue that this difference should be respected. According to interpretivist approach, it is critical that the researcher appreciate that there are differences between individuals. In addition, interpretivism researches focus on meaning and might adopt several methods in order to present different perspectives on the issue (Sahay, 2016; Saunders et al., 2016).

3.4.1.4 Postmodernism

This philosophy assumes that reality is created by using languages and the power of relationships and perceptions. The reality is created by researchers and other social actors. In postmodernism research, there is no absolute truth, and different researchers will come to different conclusions about the same subject, and all of them are important. The researchers who follow this philosophy conduct an in-depth investigation of phenomena. Also, the power relationship between the researcher and the study subject helps to create the knowledge (Saunders et al., 2016). Postmodernism emerged as a means of understanding the nature of modern society and culture and present it as knowledge (Bryman, 2016).

3.4.1.5 Pragmatism

The pragmatism research philosophy is a contrast of the positivism and interpretivism philosophies. The research starts with the research problem and is intended to contribute practical results that shape future practice. Pragmatism sees the practical results as important. Moreover, the pragmatist researcher adopts the research method (e.g., qualitative, quantitative or a combination of both) that best suits the research aims and needs (Iovino & Tsitsianis, 2020; Sahay, 2016). The values held by the researcher drive the research. Saunders et al. (2016, p. 144) state that pragmatics “recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities”

Table 3.2 shows a summary of those five philosophies adopted from Saunders et al. (2016, p. 136). The next subsection will justify the choice of philosophy for this research.

Table 3.2: Summary of five research philosophies adopted from Saunders et al. (2016, p. 136).

Philosophy Type	Philosophical assumption			Typical Methods
	Ontological assumption	**Epistemological assumption**	**Axiological assumption**	
Positivism	Real, External, Independent Objective	Scientific method Researcher is independent and neutral regarding what is researched	value-free and unbiased research	Deductive, highly structured, large samples, uses quantitative data
Critical realism	Layered (the empirical, the actual and the real) Objective structures, external, independent	Knowledge historically situated and transient	Value-laden research Researchers strive to be as objective as possible	Retroductive Range of methods are compatible, but it implies choice dependent on the nature of the research
Interpretivism	Reality is complex and subjective Multiple meanings	Researcher is a part of what is researched	Value-laden research the essence of research is subjectivity	Inductive, small sample size, qualitative methods range of data interpretations,
Postmodernism	Socially constructed through power relations Complex Multiple meaning	Dominant ideologies decide what consider as truth and knowledge	Value-constituted research	Deconstructive Range of data types, typically qualitative analysis
Pragmatism	Complex External and multiple reality Objective or subjective	Focus on problems, practices and relevance Knowledge is something solve problem and improve practice	Value-driven research	Follows research problem and research question Range of methods: mixed, multiple, qualitative, quantitative research Emphasis on practical solutions

3.4.1.6 The Chosen Philosophy

Because digital nudging is an emerging concept, an in-depth analysis is required in order to have a better understanding of this topic. It is essential to determine the factors that should be included in the design of effective e-nudging model for the tertiary education sector in SA.

Pragmatism philosophy is selected as the appropriate paradigm for this research for several reasons. Firstly, the main aim of the research is to explore the usage of digital nudging in education and then create a conceptual model. Moreover, the researcher can utilize multiple research methods that are appropriate for the research objectives and answer the research questions.

Unfortunately, the single-paradigm philosophies have some limitations. For example, the positivists' research assumes that everything is observable and can be measured. It tends to be inflexible, and the objectives and finding should not be influenced by human interpretation or bias. On the other hand, interpretivism philosophy is subjective and more suitable for qualitative research. As indicated in Table 3.2, pragmatism philosophy lies somewhere between objectivism and subjectivism. The research problem and research question(s) are important. Furthermore, a range of methods can be utilized, making the pragmatist approach is suitable for value-driven research. Hence, it is suitable for this research and informs the research design. The selected philosophy is highlighted in red in Figure 3.2.

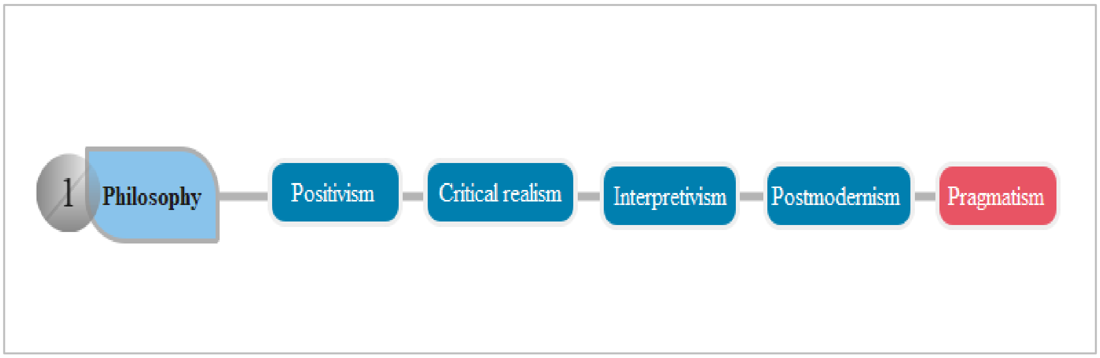


Figure 3.2: Selected philosophy (prepared by the researcher).

3.4.2 Research Approach

The second layer of the research onion is *Research Approach*. After the research philosophy has been determined, the next step is to identify the appropriate research approach. As illustrated in Figure 3.1, there are three types of research approaches: induction, deduction, and abduction. Each approach will be explained below and then the chosen one will be identified.

3.4.2.1 Deductive Approach

The deductive approach begins with developing a hypothesis (or hypotheses) based on existing theory which is generated from the literature review, then a strategy is designed to test this hypothesis (Saunders et al., 2016). This approach proceeds from general to more specific levels. The researcher examines previous studies and existing theories, then tests the hypothesis derived from these theories (Mitchell & Education, 2018).

This approach offers many advantages. First, it makes it possible to explain the relationship between concepts and variables. Second, the researcher can measure the concepts using the quantitative method. Third, the research outcomes can be generalized to a certain extent. Further, it is possible for the researcher to complete the research within a short time and, finally, there is minimal risk associated with this approach as the inductive approach leads to conclusions deduced from propositions (Snieder & Larner, 2009).

The deductive approach explores a known theory and tests whether the theory holds in certain circumstances. This approach closely follows the path of logic (Snieder & Larner, 2009). To simplify, a hypothesis is deduced from theory, then the hypothesis is formulated that suggests a relationship between two specific variables. After that, the hypothesis is tested and the outcomes are analysed to determine whether or not the hypothesis can be accepted.

3.4.2.2 Inductive Approach

The inductive approach is the opposite of the deductive approach. This approach starts with observation, and a new theory is formed based on what has been observed (Saunders et al., 2016). It moves from the specific to the general. With the inductive approach, a general conclusion is drawn from the observation of a specific phenomenon. Thus, the researcher starts with research questions with the purpose of creating a new theory (Mitchell, 2018). The inductive approach utilizes data to develop theory (Saunders et al., 2016).

Mitchell (2018, p. 104) stated that "inductive reasoning, we begin with specific observations and measures, begin to detect patterns and regularities, formulate some tentative hypotheses that we can explore, and finally end up developing some general conclusions or theories".

This approach does not involve the formulation of a hypothesis. Also, there is scarcity of sources in the literature. This type of research is risky because there is the possibility that even after long-term observation of a phenomenon, no theory will emerge (Snieder & Larner, 2009).

3.4.2.3 Abductive Approach

The abductive approach is designed to address the shortcomings of the deductive and inductive approaches. In this approach, the researcher starts with surprising facts and the research process is committed to finding explanations (Bryman, 2016). These surprising facts may emerge when the researcher faces an empirical phenomenon that cannot be explained by existing theories. Here, the researcher seeks the best explanation for these facts. Saunders et al. (2016, p. 145) described this approach as "collecting data to explore a phenomenon, identify themes and explain patterns, to generate a new or modify an existing theory which researcher subsequently test through additional data collection". Although this approach sets out to overcome the shortcomings of previous traditional approaches, the practice is challenging.

Table 3.3 below presents the major differences between deductive, inductive and abductive research approaches in terms of logic, generalizability, use of data and theory adopted from (Mitchell, 2018, p. 105; Saunders et al., 2016, p. 145). The next subsection will justify the approach chosen for this research.

Table 3.3: Summary of three research approaches add the sources please adopted from (Mitchell, 2018, p. 105; Saunders et al., 2016, p. 145).

	Deduction	Induction	Abduction
Logic	when the premises are true, the conclusion should be true as well,	known premises are utilized to produce untested conclusions	Known premises are utilized to produce testable conclusions
Generalizability	Generalised from the general to the specific	Generalised from the specific to the general	Generalised from the interactions between the specific and the general
Use of data	Data collection is utilized to assess propositions or hypotheses related to an existing theory	Data collection is utilized to discover a phenomenon, identify themes and patterns and create a conceptual framework	Data collection is utilized to discover a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth
Theory	Test or evaluate theory	Build or generate theory	Develop and elaborate a theory iteratively

3.4.2.4 The Chosen Approach

In this research, the initial e-nudging model was derived from the literature review which yielded four new factors: HCI, usability, navigation, environmental barriers. The initial e-nudging model comprised five main stages: planning, analysis, design, implementation, testing and evaluation stages. Each stage contained several factors, all of which had to be evaluated.

The initial e-nudging model was assessed by means of an online survey. The model was modified according to the feedback from the survey participants, and then evaluated again by interviewees. Interview data was used to refine the model for final presentation. The phases and factors were developed and established sequentially. Therefore, the abduction approach was selected for this research as there was no testing of a hypothesis. Because an in-depth analysis is required, a sequential explanatory research design is applied, and the most suitable approach is abduction. The selected approach is highlighted in red in Figure 3.3.

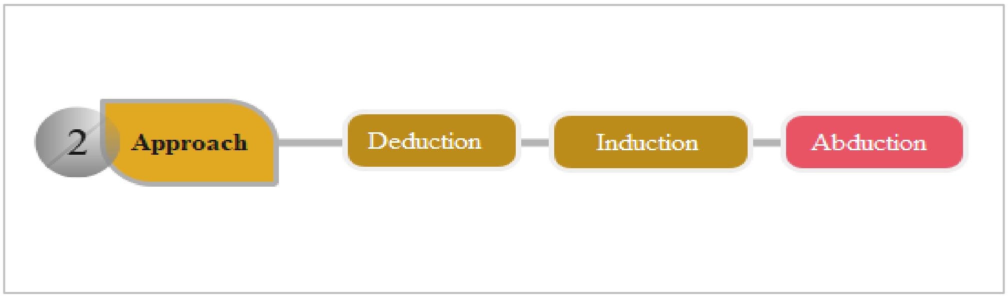


Figure 3.3: Selected approach (prepared by the researcher).

3.4.3 Methodological Choice

The next important layer of the research onion framework is the *research methodology*. The methodological choices include the selection and use of qualitative, quantitative, or mixed-methods research design. The main difference between the qualitative and quantitative research approaches is the data type. The qualitative use non-numeric data that takes the form of descriptions such as pictures, words, video clips and other relevant materials, while quantitative data is presented numerically (Sahay, 2016; Saunders et al., 2016). The mixed-methods approach applies both qualitative and quantitative data-collection techniques and analytical processes (Mitchell, 2018). The next subsection explains each methodology separately, then methodology chosen for this research is identified.

3.4.3.1 The Quantitative Research Method

Quantitative research systematically examines phenomena by collecting quantifiable data and analysing it using mathematical techniques. The results are usually presented numerically. It is important for the researcher to use the right data collection instruments such as questionnaires. Moreover, quantitative researchers assume reality to be objective (Sukamolson, 2007). Generally, quantitative research examines and measures social phenomena. It can be conducted on a large number of participants, and then the findings can be generalized to the entire population (May, 2011; Sukamolson, 2007).

With the quantitative method, the data can be collected and analyzed quite quickly. The findings are independent and objective. This method is useful when the study requires a large sample size. On the other hand, the researcher might miss a phenomenon because the focus is on testing a specific hypothesis rather than developing or generating a new theory or hypothesis (Johnson & Onwuegbuzie, 2004).

There are two types of quantitative research methods: mono-method and multiple methods. With the mono-method, the researcher applies a single data-collection technique such as a questionnaire and a subsequent quantitative analysis. When the researcher uses more than one quantitative data collection technique with a corresponding analytical procedure, this is known as a multiple methods technique (Sahay, 2016; Saunders et al., 2016).

3.4.3.2 The Qualitative Research Method

The qualitative approach is based on the constructivist paradigm. Qualitative research collects data from observations and interpretations of people’s perceptions of different contexts. Qualitative research is typically utilized for examining and exploring a social or human problem. With this method, the researcher creates a complex, holistic picture from the participant’s perspective and the researcher’s view of reality. Qualitative data is richer and subjective (Khan, 2014).

With the qualitative method, the data is rich as the gathered information is based on different people’s opinions and experiences. The method is useful for an in-depth investigation using a small number of cases. Moreover, it is an appropriate method used to describe or investigate a complex phenomenon. The method is flexible and receptive to any change that might occur throughout research process. However, the research findings cannot be generalized to other people. Qualitative research requires more time for data collection compared with the quantitative method. Additionally, the data analysis process is time consuming and the researcher's personal biases can easily influence the research outcomes (Johnson & Onwuegbuzie, 2004).

Like the quantitative research method, there are two types of qualitative research methods as explained by Saunders et al. (2016). The first type is a single qualitative data collection technique known as the mono-method, and includes semi-structured interviews and subsequent qualitative data analysis. The qualitative multiple method is applied when more than one strategy is used for data collection and analysis.

3.4.3.3 Mixed Research Method

The mixed-methods approach is used to collect both quantitative and qualitative data for a single research. Johnson and Onwuegbuzie (2004, p. 17) define the method as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study". This method benefits from the strengths and minimizes the weaknesses of quantitative and qualitative approaches when they are used on their own. Mitchell and Education (2018) argue that mixed methods investigate, predict, explore, describe, and understand the phenomenon.

According to Saunders et al. (2016), there are three types of mixed-methods research (see Figure 3.4). These are explained below.

- **Concurrent mixed-methods research:** the data collection and analyses for both qualitative and quantitative are done in a single phase.
- **Sequential mixed-methods research**: the data collection and analyses are done in two phases:
    - **Sequential exploratory research design:** the qualitative data collection and analyses are done in the first phase, followed by quantitative data collection and analysis in the second phase.
    - **Sequential explanatory research design:** the quantitative data collection and analyses in the first phase are followed by qualitative data collection and analysis in the second phase.
- **Sequential multi-phase:** Data collection and analyses are done in more than two phases, in sequence. For instance, qualitative is followed by quantitative and then qualitative.

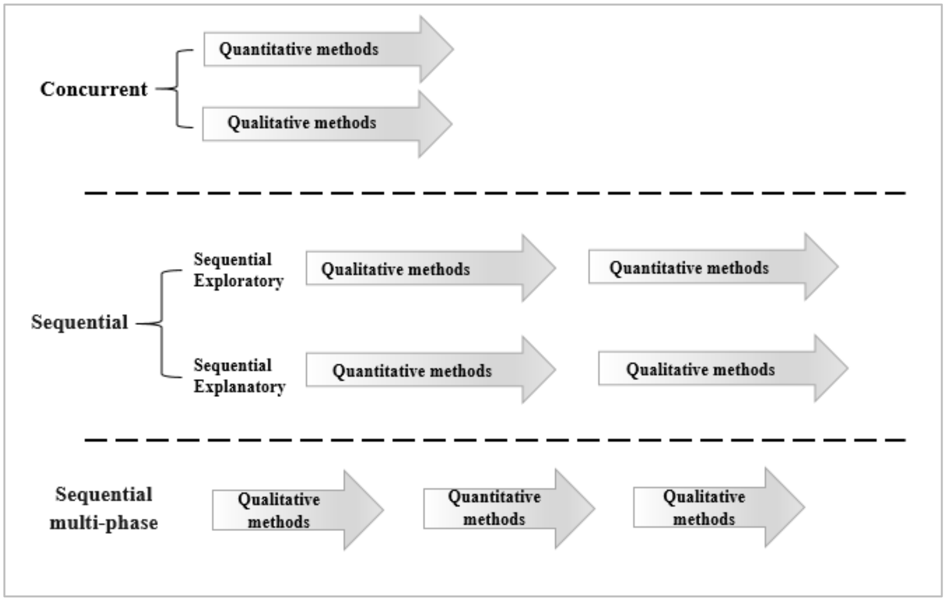


Figure 3.4: Mixed methods research designs (prepared by the researcher and adapted from (Saunders et al., 2016, p. 170).

The mixed-methods approach provides robust research findings. This method utilizes words, pictures, and narrative to improve the meaning of numeric and statistical results. The generalizability of results is greater when this method is utilized. However, the mixed-methods approach imposes an extra workload on the researcher, which is the main disadvantage of this method (Johnson & Onwuegbuzie, 2004).

3.4.3.4 The Chosen Research Methodology

The most suitable methodology for this research is the mixed-methods approach, particularly given the sequential explanatory research design. In this research, the quantitative data was collected and analysed in the first phase, the qualitative data collection and analysis was done in the second phase. The mixed-methods approach is appropriate for answering a research question and uses more than approach in order to answer research questions that cannot be addressed comprehensively by using a singular method (Doyle et al., 2009; Venkatesh, Brown, & Bala, 2013). The main goal for using mixed method is gain the benefit from both method strengths and minimize the weakness, in traditional single method (Mitchell, 2018). The generalization of results can be increased by employing this method. In Figure 3.5, the selected methodology is highlighted in red.

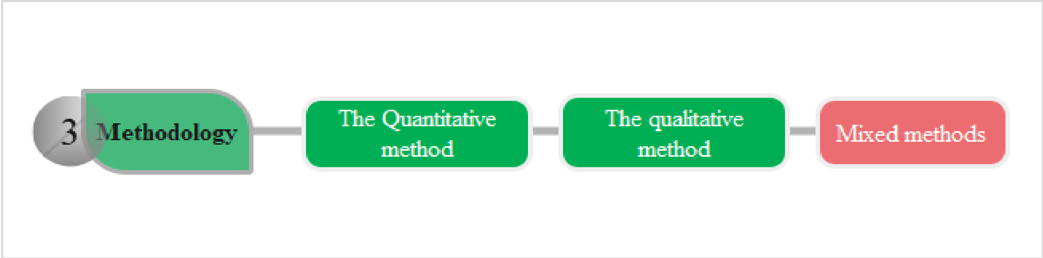


Figure 3.5: Selected methodology (prepared by the researcher).

The significant advantage of using a sequential mixed-methods approach is that it provides a comprehensive picture of a phenomenon due to the qualitative data being built on the quantitative results. This allows qualitative data to provide a rich explanation of statistical quantitative results by exploring in depth the research participants' views (Ivankova et al., 2006).

This research aims to find information regarding how a digital nudging design can be used in a digital learning environment as a means of improving students' academic achievements. In this research, the mixed-methods approach was adopted in order to collect and analyse the participants' opinions about the new learning model proposed for Saudi Arabian universities. First, the quantitative data was collected to assess model's factors and identify any new factors that should be included in the e-nudging model. In the next phase, the qualitative method was applied to obtain expert academics' opinions about the modified e-nudging model, to obtain a better understanding of these constructed factors, and to confirm the factors that should be considered when developing an e-nudging model for SA.

3.4.4 Research Strategies

The next layer of the research onion is *Research Strategies*. Generally, strategy is a plan of action established in order to achieve a goal (Sahay, 2016). Saunders et al. (2016) defined a research strategy as a plan of actions that a researcher takes so as to answer the research question(s). Strategies can include:

- **Experiment**: a laboratory-based research strategy for natural science studies. The purpose of an experiment is to study the cause-effect relationship between two or more variables. The researcher manipulates the independent variable(s) to study the changes occur in the dependent variable (Saunders et al., 2016).
- **Survey:** is a popular strategy for data collection. It can be utilized for exploratory and descriptive research. The researcher can use questionnaires to collect standardized data from large sample size quickly and economically. The survey is a valid means of collecting data and people trust it. The survey is easy to explain and made understandable to participants (Axinn & Pearce, 2006; Saunders et al., 2016).
- **Archival and Documentary Research:** this strategy is applied to collect data from historical records and documents. The researcher seeks and extracts evidence from archival records. These documentary archives are repositories for textual, visual and audio representations (Saunders et al., 2016).
- **Case Study:** this strategy is applied to obtain concrete, contextual, in-depth knowledge about a specific real-world subject. It allows the researcher to explore the key features and understand the implications of a single phenomenon in a natural setting (Collis & Hussey, 2009; Saunders et al., 2016).
- **Ethnography:** is used to study culture or social science (Saunders et al., 2016). In this strategy, the researcher observes and interacts with the research participants in a real-life environment (Collis & Hussey, 2009). This research provides in-depth knowledge of how those participants see and interact in reality.
- **Action Research:** is utilized to solve a real-life organizational problem via collaboration between researcher and participants. The purpose of this strategy is to encourage organizational learning and improve practical learning by identifying problems, planning action, taking action and evaluating action (Saunders et al., 2016).
- **Grounded Theory:** is conducted to develop a theatrical explanation of a social science phenomenon (Saunders et al., 2016). It is used with the inductive method and qualitative data to develop a theory (Collis & Hussey, 2009).

3.4.4.1 The Chosen Strategy

The survey is the appropriate strategy for this research. According to Saunders et al. (2016) the survey strategy includes both quantitative and qualitative data.. The quantitative data was collected first via an online survey in order to obtain students', academics' and IT staff's opinions regarding the initial model, to assess the model factors and identify any new factors that may influence the e-nudging model. In the next phase, the qualitative method was applied using semi-structured interviews to obtain expert academics' opinions about the refined e-nudging model, and to obtain a deeper understanding of these constructed factors. Figure 3.6 highlights the chosen strategy in red.

Figure 3.6: Selected strategy (prepared by the researcher).

3.4.5 The Time Horizon

The fifth layer of the research onion framework is the *time horizon* as shown in Figure 3.1. It is important determine how the data collection will be done: whether it will be conducted once during a specific period, or several times during several periods over the course of the research. In terms of temporality, the research study can be either longitudinal or cross-sectional.

- **Longitudinal study:** this is undertaken to investigate a phenomenon or a population over a period of time (Caruana, Roman, Hernández-Sánchez, & Solli, 2015; Collis & Hussey, 2009). This type of study helps the researcher to track changes in a phenomenon over time. This method gives a comprehensive picture of a phenomenon and a better understanding of the degree and direction of change over time. However, the researcher should carefully consider the cost and time.

Generally, this type of study incurs greater temporal and financial costs (Caruana et al., 2015).

- **Cross-sectional study**: this is used to study a phenomenon at one point in time. With this method, the researcher can compare different groups at a specific time (Collis & Hussey, 2009). The cross-sectional study often utilizes the survey strategy. The purpose of the study is to describe a phenomenon, and research findings can be generalized to the population as a whole. The cross-sectional study gives the researcher better control over the data collection and measurement processes. The cross-sectional study is affordable and does not take as long as the longitudinal study (Levin, 2006).

3.4.5.1 The Chosen Time Horizon

Based on the chosen methodology (i.e., mixed method) and strategy (i.e., survey), the appropriate time horizon for this research is the cross-sectional study. The data collection for both phases (i.e., quantitative and qualitative) was conducted at one time and for a specific period. Moreover, as this four-year doctoral thesis had a deadline, time was a constraint and therefore the cross-sectional study was adopted. Furthermore, the cross-sectional study is affordable as it is much less inexpensive, and it takes less time. The cross-sectional study gives the researcher good control over data collection and analysis. It is a descriptive study, and the outcomes can be generalized to the entire population. Figure 3.7 depicts the chosen time horizon in red.

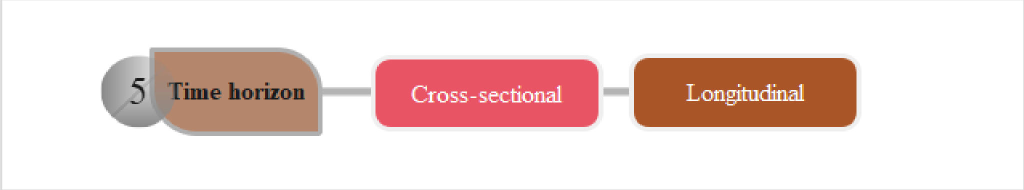


Figure 3.7: Selected time horizon (prepared by the researcher).

3.4.6 Techniques and Procedures

The last layer of the research onion is *techniques and procedures* as shown in Figure 3.1. Techniques and procedures refer to what is used to obtain and analyse data. This includes, for example, questionnaires, observation, and interviews, as well as both quantitative (statistical) and qualitative (non-statistical) analysis techniques (Saunders et al., 2016).

The aim of all data collection techniques is to capture quality evidence that allows the designing of a convincing and acceptable answer to research questions (Kabir, 2016). There are many types of data collection techniques. The most popular techniques are described below.

- **Interview:** this is a qualitative data collection technique. The interview involves asking questions and taking answers from participants. The researcher can interview one person or a group of people. The interview can be conducted face-to-face, via telephone or electronic devices such as computers (Kabir, 2016). There are three types: structured, semi-structured, and unstructured (Kabir, 2016; Saunders et al., 2016). It is essential that any type of interview be consist with the research objectives, questions and adopted research strategy (Saunders et al., 2016). The interviews help the researcher to obtain rich and in-depth information from interviewees, and provides a broad picture of a specific event or phenomenon based on the interviewees' perceptions of and opinions about the event (Kabir, 2016).
- **Focus Group:** this is used to collect qualitative data. It involves small groups of between four and 12 persons brought together to discuss topics associated with the study agenda (Saunders et al., 2016). This technique provides in-depth details about a phenomenon. The researcher should have the skills (moderating, facilitating, observing and analysis) to launch and conduct the meeting successfully. This technique is useful for exploring complex issues and cultural and health issues. Focus groups take a great deal of time, and it might be difficult and time consuming to analyze the data (Kabir, 2016).
- **Observation:** observations are made to examine and evaluate a specific, ongoing behavior in natural settings. This technique is a qualitative data collection technique that involves the systematic viewing, recording, description, analysis and interpretation of people's behavior (Kabir, 2016; Saunders et al., 2016). There are many types of observation such as structure observation, observation of

participants (Saunders et al., 2016), direct and indirect observation, and controlled and uncontrolled observation (Kabir, 2016).

- **Survey:** is one of the most popular quantitative data collection techniques, used to collect people's thoughts, opinions and feelings about a phenomenon or issue. The researcher can design a survey to be specific or more global (Kabir, 2016). According to Kabir (2016), the prime purpose of a survey is to enable the researcher to generalize the findings from the sample to the population. This method is useful for collecting a large amount of data, and is relatively cheap and easy to administer (Kabir, 2016). It can be conducted face-to-face, by telephone or mail, or online (Kabir, 2016; Saunders et al., 2016). Various types of questions can be used in the survey design. These are: closed questions, open-ended and scaled questions, and multiple-choice questions. Additionally, when developing the survey, the researcher should take into account: question sequence, layout, language, length and cover letter (Kabir, 2016).

3.4.6.1 The chosen data collection techniques

As mentioned in sub-section 3.4.3.4, the chosen methodology for this research is the mixed method. This method consists of two phases (i.e., quantitative, and qualitative). Each phase includes data collecting, analysing, and interpreting findings. This methodology provides a better understanding of a research problem or issue. In the quantitative phase, the online survey was selected as data collection technique. The survey was utilized to assess the initial e-nudging factors and gather opinions about the proposed e-nudging model. The survey can collect large amounts of data that help to generalize the outcomes. In the second phase, the semi-structured interview mode was chosen to collect qualitative data to obtain rich data from interviewees. In Figure 3.8, the selected techniques and procedures are highlighted in red.

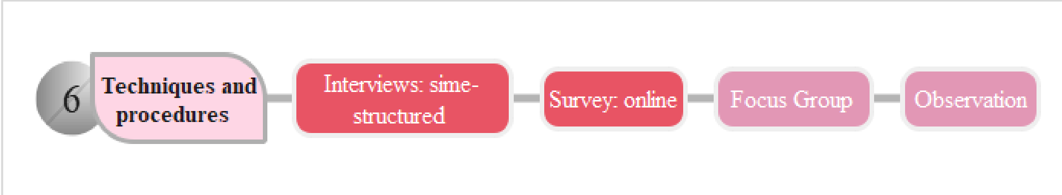


Figure 3.8: Selected technique and procedures (prepared by the researcher).

In this research, all the data will serve to answer the research questions. Further information is provided below.

3.4.6.1.1 Online survey

The quantitative data was collected by online surveys designed using the Qualtrics platform. The online survey was developed from current literature review and the researcher developed new questions to meet the research needs. As mentioned in sub-section 4.2.1, two online surveys were designed: one for the academics and IT staff and the other for students. Each survey comprised four sections. The questions were translated using a qualified third-party translator. The surveys were available in both Arabic and English languages since the Saudi community speak Arabic and have English as their second language. The hyperlinks to the surveys were randomly to participants in the selected Saudi Arabian universities. The surveys' target population were academics, IT staff, and students at Saudi universities. The academics and IT survey contained between four and six statements that were developed to assess the significance of each factor in the initial model. The students' survey was developed to determine whether the e-nudging model will meet their requirements. The sample size for this research was 373 academics and IT staff and 384 students as explained in sub-section 4.2.3. In fact, the researcher has managed to collect more than the sample size. The valid completed response was 375 for academics and IT staff, and 408 for students.

The survey items were presented on a five-point Likert scale, to allow respondents to express the extent to which they agreed or disagreed with each statement. This uneven number gives participants the option of remaining neutral by choosing the middle number (Saunders et al., 2016). Moreover, the five-point scale is a popular measurement and an efficient means of capturing a significant amount of the true variance in the participants' opinions, and decreasing the frustration level of participants (Passmore, Dobbie, Parchman, & Tysinger, 2002). The data analysis was conducted using IBM SPSS Statistics (version 26), and Excel 2016 software. The survey design, target population, analysis method and tools are described in more detail in section 4.2. The survey outcomes were used to improve the initial e-nudging model and develop the interview questions.

3.4.6.1.2. Semi-structured interviews

The qualitative data was collected through semi-structured interviews. The aim of interviewing academics who are experts in education was to gather their opinions on the enhanced e-nudging model in order to validate and confirm those factors that should be retained in the final e-nudging model. More details about the interview design, target population, analysis method and tools are given in section 5.2.

The semi-structured interview design was based on the data obtained from the online surveys. The interview questions were divided into two sections. The first section contained questions related to the factors that should be retained in the final e-nudging model. Questions in the second section sought the interviewees' opinions about the enhanced e-nudging model.

In this research, the number of interviewees were 25 experts academics who work in Saudi universities and are interested in education developments or nudging theory as explained in sub-section 5.2.3.

In the data analysis step, the coding or categorization of qualitative data can be done either manually or with the NVivo (Version 1.0) software. After that, themes and patterns are identified, and the results are used for further explanation to achieve the research objectives (Maxwell, 2012; Ritchie, Lewis, Nicholls, & Ormston, 2013).

3.5 Summary of the Research Onion Steps Applied in this Research

The research onion includes six layers to design effective organize research methodology. The following points summarized the applied steps in this research. These choices illustrated in Figure 3.9.

- **Philosophy: Pragmatism**

  As discussed in sub-section 3.4.1, with pragmatism philosophy researcher can utilise multiple research methods in order to achieve research objectives and answer research questions in appropriate way.

- **Approach: Abduction**

  As mentioned in sub-section 3.4.2, data collection in this research is conducted to discover and identify factors and stages, locate these in a conceptual model and assess this by sequential data collection process. Therefore, the suitable approach for this research is abduction.

- **Methodology: Mixed method**

  As indicated in sub-section 3.4.3, this method combined both quantitative and qualitative approaches in single research, and it can provide comprehensive picture and better understanding for research problem that might not achieved when only one research method is utilized.

- **Strategy: Survey**

  As discussed in sub-section 3.4.4, the survey is an appropriate strategy for this research. The survey includes both quantitative and qualitative data.

- **Time Horizon: Cross-sectional**

  As mentioned in sub-section 3.4.5, it provides a good control to researcher. Another reason, with methodology (i.e., mixed method) and strategy (i.e., survey) is often applied in cross-sectional studies.

- **Techniques: Interview and online survey**

  As indicated in sub-section 3.4.6, this research is adopted mixed method which consist of two phases (i.e., quantitative, and qualitative). These two techniques have complemented each other, provide a better understanding and in-depth knowledge about this research topic.

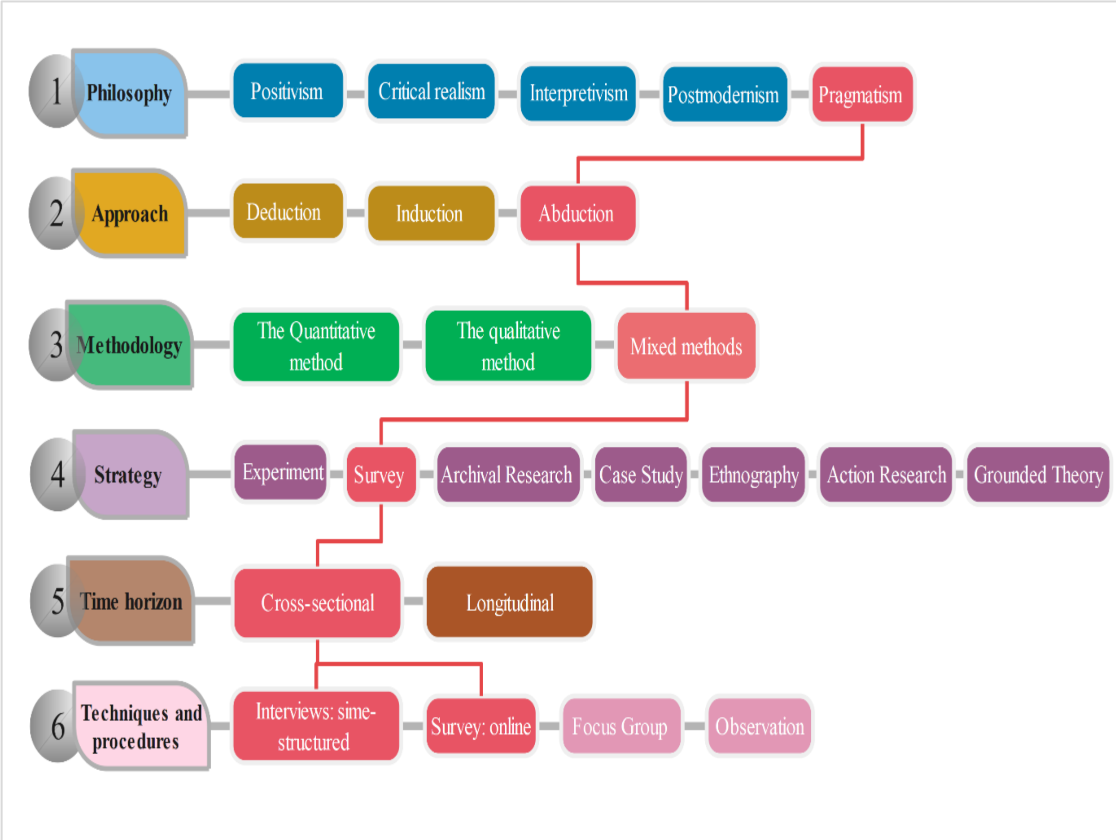


Figure 3.9: The refined 'research onion' of this research (prepared by the researcher).

3.6 Research Target Population

The participants recruited for this research were academics, IT staff and students from public and private universities in SA. The public universities cater for a large number of students. The private university differs from the public in terms of size, culture, and environment. It is important to have enough diversity in the selected sample so as to explore the influence of certain characteristics (Ritchie et al., 2013). All selected universities offer courses in several areas such as business, science, and engineering and computer science and information system programs. Moreover, they use learning management systems such as Blackboard and Moodle as platforms. It was important to ensure that the participants have a knowledge and understanding of the concept of nudging in the context of higher education. Therefore, the letter inviting these universities to participate stated the objectives of the study and gave a brief explanation of the nudging concept. Because the researcher had been working for one of the selected universities, it was easier for her to contact and access the participants (i.e., academics, IT staff and students). In this research, the random sample method was applied in order to obtain the best result by avoiding selection bias (Teddlie & Yu, 2007). In order to conduct the study, the researcher required the approval of the Ethics Committee at Curtin University. The numbers of students and academics in each of the selected universities were gathered from the statistics centre of the Ministry of Education in SA[1].

3.7 Data Analysis Methods and Tools

The quantitative data collected from the online surveys was analysed using Microsoft Excel 2016, SPSS software version 26 and NVivo 1.0. Two statistical data analysis tools, Factor Analysis and Descriptive Statistics, were used to filter and identify factors related to each stage of the e-nudging model

The qualitative data collected from interviews was analysed using thematic analysis. NVivo software helps to identify word frequency and the opinions of participants. Moreover, different nodes are generated and presented by NVivo.

The first two sub-sections below explain the analysis methods applied to the survey data. The third sub-section explains the analysis method used for the interview data.

3.7.1 Descriptive Statistics

Descriptive statistics are utilized to estimate population characteristics and discover hidden patterns. They assist the researcher to simplify large amounts of data in a manageable and simple form by reducing a large data set.

More information can be obtained from the Ministry of Education website: http://www.moe.gov.sa/en/Pages/default.aspx

The measurement characteristics or features of individuals are called variables. The data presentation is helpful to discover patterns and relationships between the variables and is considered as an effective and convenient method for displaying the research results. Data can be presented succinctly in figures and tables (Nick, 2007).

The description of one variable at a time is called univariate data, and when describing two or more variables, this is called bivariate or multivariate data. There are three types of descriptive statistics: distribution, central tendency, and variability. The distribution relates to the frequency of each value. It often provides a list summarizing the frequency of every value of a variable and the number of individuals who have each value. The central tendency relates to the averages of the values. One of the most common ways to measure data average is by using the mean value (Kaliyadan & Kulkarni, 2019; Nick, 2007; Wildemuth, 2016). The variability provides the sense of who the response values are spread out. It can be calculated by range, standard deviation, and variance. Each type give different side of spread (Nick, 2007; Wildemuth, 2016).

3.7.2 Exploratory Factor Analyses

Exploratory Factor Analysis (EFA) is a statistical technique used as a reduction methodology. It is used to reduce the relatively large amount of data to a more manageable number of variables. The EFA approach enables the researcher to explore the main factors to generate a model from a relatively large set of variables (Osborne, Costello, & Kellow, 2014; Williams, Onsman, & Brown, 2010). Thus, EFA is used in this research to reveal the factors that need to be retained in the e-nudging model. EFA is a linear analysis process that has a five-step protocol developed by Williams et al. (2010) and Zeynivandnezhad, Rashed, and Kanooni (2019). The following subsections describe each step of the protocol.

3.7.2.1 Test Data Suitability for Factor Analysis

The first step is to test data suitability for factor analysis. This test measures three features: sample size, factorability of the correlation matrix, and sufficiency of the sample.

- **Sample size:** The literature on factor analysis offers many opinions regarding the appropriate sample size. The majority recommend at least 200 as a sample size that is adequate for obtaining high quality results (Comrey & Lee, 2013; Hair, Black, Babin, & Anderson, 2014; Jung & Lee, 2011; Williams et al., 2010). Tabachnick and Fidell (2007) Yong and Pearce (2013) suggest at least 300 samples are required for factor analysis (see sub-section 4.3.2).
- **Factorability of the correlation matrix:** a correlation matrix indicates the relationships among individual variables. It is important to ensure there is sufficient correlation to provide a satisfactory factor analysis solution (Hair et al., 2014; Williams et al., 2010). The minimum relationship value between variables is 0.3 to produce an adequate solution (Pallant, 2011; Tabachnick & Fidell, 2007; Williams et al., 2010) (see sub-section 4.3.2).
- **Kaiser-Meyer-Olkin (KMO) and Bartlett's test**: The adequacy of the sample is measured by utilizing Bartlett's test of sphericity (Bartlett, 1954) and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1974). Bartlett's test of sphericity is used to assess the strength of correlation among variables (Pallant, 2011). To determine whether factor analysis can proceed, Bartlett's test of sphericity should be significant (sig = .05 or less) (Pallant, 2011; Williams et al., 2010). According to Pallant (2011), KMO index values between 0 and 1. The minimum suggested value for KMO test is 0.6 for a good factor analysis result. Kaiser (1974) provided general rules for interpreting the KMO measures, shown in the following Table 3.4.

Table 3.4: The KMO measures interpretation adopted from (Kaiser, 1974).

KMO	Interpretation
0.90 and above	Marvellous
0.80 to 0.89	Meritorious
0.70 to 0.79	Middling
0.60 to 0.69	Mediocre
0.50 to 0.59	Miserable
Under 0.5	Unacceptable

3.7.2.2 Method Selected for Factor Extraction

The factor extraction process is used to determine the smallest number of factors that should be retained. This decision is arrived at by applying one of the factor extraction methods to determine the smallest number of factors that present the best interrelationship between variables (Pallant, 2011). There are numerous methods for factor extraction such as Maximum Likelihood, Principal Component Analysis (PCA), image factoring; principal factors; Alpha factors and unweighted least squares. A summary of extraction methods is provided by Tabachnick and Fidell (2007, p. 633). The most common methods used for factor extraction are Maximum Likelihood (ML) and Principal Component Analysis (PCA). The Maximum Likelihood has a significant test for factors and it is useful for confirmatory factor analysis (Tabachnick & Fidell, 2007; Yong & Pearce, 2013).

Principal Components Analysis (PCA) is a reduction technique used to extract maximum variance from the data set. The PCA extracts as many components (i.e., latent factors) as possible with a minimal loss of information. The variables are correlated to each other and highly independent of other variables that are combined into other components. It is commonly used in EFA. Therefore, PCA is the default method in many statistical programs such as SPSS (Hair et al., 2014; Pallant, 2011; Williams et al., 2010). Overall, regardless of which extraction technique is applied, the differences in results are small when the sample size is large and there are numerous variables (Tabachnick & Fidell, 2007). Thus, PCA is applied in this research as an appropriate extraction technique. To the best of this researcher's knowledge, to date, no study has been conducted on digital nudging for students in Saudi Arabian universities. Therefore, the enhanced e-nudging model, which will be generated after factor reduction, will be examined more closely during the qualitative phase of the mixed-methods approach.

3.7.2.3 Determining Number of Factor Extraction

Generally, the researcher can decide the number of factors that best describe the relationship between the variables after reduction. In fact, it is important to strike a balance between finding a suitable and simple solution and with as few factors as possible (Pallant, 2011). According to Tabachnick and Fidell (2007) and Hair et al. (2014), experiments should be conducted using different numbers of factors until a satisfying result and easy-to-interpret result is found. There are many techniques that can be assist the researcher to decide the number of factors to retain: Kaiser's criterion (eigenvalue > 1 rule), cumulative percentage of variance and Eigenvalue > 1 Rule, the scree test and parallel analysis (Pallant, 2011; Williams et al., 2010). Some of factor extraction techniques are explained below:

- **Kaiser's criterion** is a commonly used technique according to the literature. The eigenvalue accounts for the total variance of the observed variables explained by that particular factor (Pallant, 2011). The rule is to retain all factors with an eigenvalue greater than 1.0 (Hadi, Abdullah, & Sentosa, 2016; Pallant, 2011; Yong & Pearce, 2013).
- **Cumulative percentage of variance** is a cumulative proportion of total variance extracted by sequential factors. It indicates how much the factor contributed to the total variance. There is no fixed amount for cumulative percentage. Hair et al. (2014) suggested that an acceptable variance explained is 60% or less in some instances and this is considered a satisfactory result. Also, Williams et al. (2010) stated that the explained cumulative proportion of variance is usually 50-60%.
- **Scree test** is another technique that assists the researcher to decide how many factors should be retained. It is a graph that contains eigenvalues on the y-axis and the number of factors on the x-axis. Each eigenvalue of the factors from largest to smallest is plotted in a downward curve. The curve flattens out and becomes horizontal. All factors above the elbow or break in the graph are retained (Pallant, 2011; Williams et al., 2010). Williams et al. (2010) mentioned that additional manipulation of data and extraction should be conducted if the scree plot is chaotic and hard to interpret.
- **Parallel analysis** is a process of comparing the actual eigenvalues with those obtained from a randomly-generated simulative data set. The simulative data set is generated from an actual data set. The rule is to retain all eigenvalues that exceed the random ordered eigenvalues. This technique is often not mentioned in the literature as this type of analysis is not available in statistical programs such as

SPSS. This technique is effective for defining the number of factors and obtaining accurate results (Çokluk & Koçak, 2016; Pallant, 2011; Williams et al., 2010).

- **A priori criterion:** the number of factors is defined before starting the factor analysis. When the required number of factors is extracted, the researcher terminates the computer process. This technique is effective when examining a hypothesis about the number of extracted factors or when replicating a previous study (Hair et al., 2014).

Moreover, selecting the number of factors is associated with identifying the best structure for factors to facilitate ease of interpretation (Hair et al., 2014; Tabachnick & Fidell, 2007). In addition, the researcher can decide which technique or criterion to apply to determine the number of factors. Hair et al. (2014); Williams et al. (2010) suggest using multiple techniques for factor extraction. The final structure of factors will be determined in the interpretation step. Therefore, the results obtained for different numbers of factors are examined before deciding the final factors structure (Hair et al., 2014).

In this research, the Kaiser's criterion and scree tests were utilized to identify the appropriate and accurate number of factors that should be retained in an e-nudge model to improve student academic achievement in higher education in SA. First, Kaiser's criterion was used to generate the initial number of factors. Next, the scree test was applied to identify factors before the inflection point or "elbow". These techniques are utilized to ensure that appropriate factors are retained to generate a more robust e-nudging model.

3.7.2.4 Select Rotation Method for Factor Analysis

The rotation method is an important step after the number of factors has been determined. Rotation helps the researcher to clarify and simplify the structure of factors so that they are easy to interpret (Hair et al., 2014; Osborne, 2015; Pallant, 2011). When factors are extracted without rotation, they are ordered according to their extracted variance. Almost every variable is loaded significantly on the first factor that has the largest amount of variance. The residual amount of variance is distributed to subsequent factors and, with each one, the factor has a smaller percentage of variance. The rotation method is used to redistribute the variance from the first factor to the last in order to obtain a clearer, simpler and more meaningful pattern for factor result (Hair et al., 2014). The rotation method generates a rotated loading matrix which includes the number of variables that load on each factor (Tabachnick & Fidell, 2007). Yong and Pearce (2013) state that the factor loading indicates how much a variable has contributed to a factor; hence, a high factor loading means this variable is well-aligned with the factor. There are two main type of rotation methods, oblique and orthogonal. The oblique rotation method assumes that factors are correlated in the analysis. However, with the orthogonal method, it is assumed that factors are uncorrelated (Hair et al., 2014; Osborne, 2015; Pallant, 2011).

In orthogonal rotation, the factors are rotated 90° from each other. It is widely used with three rotation techniques, Quartimax, Varimax and Equimax, although each has slightly different statistical goals (Tabachnick & Fidell, 2007). This method is appropriate when the goal is data reduction (Hair et al., 2014). The most common orthogonal rotation technique is Varimax. This technique is used to minimize the number of variables for each factor in order to obtain high loading and reduce the number of variables with small loadings. The Quartimax technique works like Varimax but is applied to variables. It minimizes the number of factors required to explain each variable. It is not as popular as Varimax because researchers tend to focus on factors more so than on variables. The Equimax is a hybrid of Quartimax and Varimax (Tabachnick & Fidell, 2007; Yong & Pearce, 2013). Tabachnick and Fidell (2007) and Osborne (2015) stated that results obtained through the orthogonal rotation method are much easier to interpret than oblique, and the results are often similar.

With the oblique rotation method, factors with a greater or less than 90-degree angle are rotated. The common oblique rotation techniques are Direct Oblimin and Promax (Tabachnick & Fidell, 2007; Yong & Pearce, 2013). Oblique rotation is applied when the research goal is to obtain several theoretically meaningful factors (Hair et al., 2014). However, there is no specific guide for selecting rotation methods. Generally, researchers select the orthogonal method because it is much easier to interpret than oblique. In addition, orthogonal method with Varimax technique is a default option in most statistical programs (Hair et al., 2014; Osborne, 2015). The choice of a rotation method should be based on the needs of the research project (Hair et al., 2014). In conclusion, this research adopted the orthogonal method with the Varimax technique as the results will be easier to interpret, and it reduces a large set of variables to generate more meaningful factors to improve the initial e-nudging model.

3.7.2.5 Interpretation

The interpretation of rotation results is the final step in exploratory factor analysis after rotation. In this step, variables are examined to determine which are attributable to a factor and to create a meaningful name or theme for that factor. To simplify the interpretation process, the researcher can utilize four procedures described below.

- **Identify factor loading score**

  Factor loading shows the correlation between a variable and a factor. A higher loading indicates that the variable has strong correlation and is better representative of the factor (Hair et al., 2014; Yong & Pearce, 2013). Interpreting factors depends on the significance of factor loadings. As explained by Hair et al. (2014) and (Field, 2013), a significant factor loading is equal to or greater than 0.75 with a sample size of fifty. Factor loadings equal to or greater than 0.55 is significant for a sample of 100 participants. When the sample size 350 or greater, the significance factor loading is 0.3 or above. This guideline helps researchers to obtain some insight into the variables and factors structure. In addition, the number of variables that load on each factor is important in deciding which loadings are significant (Hair et al., 2014). Tabachnick and Fidell (2007) pointed out that it is risky to use only one or two variables to interpret a factor.

  In this research, the two sample sizes are 375 for academics and IT staff, and 408 for students. In all research experiments for extracting factors, the factor loading was significantly high. Therefore, the cut-off points for the interpretation all loadings were 0.6 or above. When the variable had more than one significant loading (i.e., cross-loading), the highest loading was selected and assigned to that factor.

- **Assess the Communalities of the Variables:**

  After the significance factor loading is established, the next step in interpreting factors is to examine each variable's communality. The communalities are the variable's variance that can be explained by all factors. It can be defined as a summation of the squared factor loadings of all factors for a variable. The community indicates how much this variable has in common with other variables in the retained factors (Hair et al., 2014; Pallant, 2011). In other words, the communality indicates the extent to which a particular variable can be explained (Hair et al., 2014; Yong & Pearce, 2013). The commonality value ranges from one to zero. A low value indicates that the variable does not fit well or is not related to other variables in this factor (Pallant, 2011; Tabachnick & Fidell, 2007). Watson (2017) suggested that a communality value of 0.40 or above indicates that the variable should be retained. Pallant (2011) stated that variables with a communality value less than 0.3 cannot provide sufficient explanation and should be excluded. Furthermore, Yong and Pearce (2013) mentioned that often all variables are excluded when the communality value is less than 0.2. Also, the number of retained factors influences the communality value, so it is often better to determine the number of factors that should be retained before interpreting the community value (Pallant, 2011). In this research, the variable communality was 0.4 or above; this provided sufficient explanation indicating that related factors should be retained in the e-nudging model.

- **Internal Consistency**

  One of the common methods that is used to measure reliability is internal consistency. It is applied to test whether variables in the survey items are measuring the same construct or concept. Many methods are available for measuring internal consistency (Hair et al., 2014; Pallant, 2011), the most popular being the coefficient alpha developed by (Cronbach, 1951). Cronbach's coefficient alpha indicates whether all variables are measuring the same component (i.e., factor). The value range is between 0 and1, where 0 indicates poor consistency and 1 indicates excellent consistency between variables (Pallant, 2011;

Spiliotopoulou, 2009). Gliem and Gliem (2003) mentioned the alpha (α) rule of thumb: $\alpha > 0.9$ Excellent, $\alpha > 0.8$ Good, $\alpha > 0.7$ Acceptable, $\alpha > 0.6$ Questionable, $\alpha > 0.5$ Poor and $\alpha < 0.5$ Unacceptable. Hair et al. (2014) pointed out that in exploratory research the coefficient alpha might be as low as 0.6. However, Pallant (2011) stated that the coefficient alpha value could be small when the number of variables is small (less than 10).

3.7.3 Qualitative Thematic Analysis

The qualitative data aims to provide in-depth knowledge and detailed description and interpretation of the research topic. Description and interpretation of participants' perspectives are considered as characteristic of all analyses of qualitative data. One qualitative analysis approach is thematic analysis. It is a set of techniques utilized to analyse textual data and explain themes (Vaismoradi, Jones, Turunen, & Snelgrove, 2016; Xu & Zammit, 2020). Thematic analysis (TA) is a flexible, accessible and popular qualitative data analysis method (Braun & Clarke, 2012; Xu & Zammit, 2020).

Thematic analysis is a systematic process involving coding, examining meaning and providing a realistic description of themes emerging from important or interesting data, and using these themes to address the research problem (Maguire & Delahunt, 2017; Vaismoradi et al., 2016). The theme (i.e. pattern) can be defined as an attribute or descriptor used for organising the repeated idea in order to assist the researcher to answer research questions (Vaismoradi et al., 2016). The purpose of thematic analysis is to answer particular research question by identifying the relevant themes in that data set (Braun & Clarke, 2012).

According to (Braun & Clarke, 2012; Maguire & Delahunt, 2017; Xu & Zammit, 2020), there is a six-phase framework that is very useful for conducting thematic analysis. This approach was proposed by Braun and Clarke (2006). This research adopted this framework for the qualitative research phase. The six phases are described in detail below.

3.7.3.1 Become Familiar with the Data

The first step in any qualitative analysis is reading and re-reading the transcript. It is important for the researcher be familiar the entire corpus of data. First, all transcripts are read, notes are taken and first impressions noted. After that, the transcripts are read more carefully line by line (Braun & Clarke, 2012; Maguire & Delahunt, 2017). Making notes and highlighting segments of interest, help the researcher to start thinking about the meaning of the data (Braun & Clarke, 2012)

3.7.3.2 Generate Initial Codes

The coding step is used to reduce large amounts of data to small chunks in a meaningful and systemic way. There are different methods for coding depending on the researcher's perspective and the research question (Braun & Clarke, 2012; Maguire & Delahunt, 2017).

In this research, the thematic method is chosen. This method involves coding each data segment that captures something interesting or potentially relevant to the research question (Maguire & Delahunt, 2017).

For initial coding, a close reading of every data item is required; each item is coded before moving to other items in the transcript. Every segment that is potentially relevant to the research question is coded, because this is the early stage of analysis and what might be relevant is not yet known. Moreover, if the researcher is unsure whether this segment of data might be relevant, it is better to code it as it is easier to remove codes than to go back to the transcript to recode data (Braun & Clarke, 2012; Maguire & Delahunt, 2017).

When the data has been extracted and given a code, it is important to write a clear code name and mark the text. Sometimes, a part of the data can have more than one code. The coding process can be conducted on a hard-copy of transcript or using qualitative data analytic software such as NVivo (version 1.0) or using computer software like Microsoft Excel to manage coding (Braun & Clarke, 2012; Maguire & Delahunt, 2017). The code process involves organizing datasets into meaningful groups (Xu & Zammit, 2020). The coding process ends when the data has been fully coded and the data pertaining to each generated code has been collected and organized appropriately (Braun & Clarke, 2012).

3.7.3.3 Search for Themes

As indicated above, a theme is a pattern that captures something interesting or relevant to the research question (Braun & Clarke, 2006). Searching for the themes includes reviewing the initial codes to identify how relevant codes could be organized and collated into themes (Braun & Clarke, 2012; Maguire & Delahunt, 2017; Xu & Zammit, 2020). To generate themes or sub-themes, the basic process involves clustering or collapsing codes that seem to have similar features that indicate a meaningful pattern in the data (Braun & Clarke, 2012)

Braun and Clarke (2006) suggest that a thematic map contains an organized list of themes and codes that can assist the researcher to think about the correlation between codes and between themes. This step is likely to yield themes that can be labelled "miscellaneous", as they do not fit into any other theme categories; this may produce new themes or result in some themes being deleted (Braun & Clarke, 2012; Xu & Zammit, 2020). It is important to analyse data to capture something related to the research question, and not everything in a dataset may be relevant (Braun & Clarke, 2012).

3.7.3.4 Review Themes

This step is mainly concerned with quality checking. Firstly, the data associated with each theme must be checked to ensure that it supports the theme and its coherence. In this step, some codes might be discarded or relocated under another theme. Then, the researcher checks whether the candidate themes accurately represent the meanings of the entire dataset (Braun & Clarke, 2012; Maguire & Delahunt, 2017; Xu & Zammit, 2020).

The purpose of this step is to create a list of coherent themes that capture the significant and relevant elements in the corpus of data that will help answer the research question. When the themes do not reflect this, further reviewing is necessary to capture sufficient data. This step involves generating new themes, or tweaking or deleting existing themes (Braun & Clarke, 2012).

3.7.3.5 Define and Name Themes

In this step, the essence of each theme is defined (Braun & Clarke, 2006). It states the uniqueness and specific thing about each theme, how themes are related to each other but do not overlap. If there are sub-themes, it indicates how they related to the main themes (Braun & Clarke, 2012; Maguire & Delahunt, 2017).

The next step is to give each theme a name. The theme's name should be informative, succinct, attractive and easy to understand (Braun & Clarke, 2012).

3.7.3.6 Writing up

In this step, the analysis results are written, the interview design is explained, and the target population is described. The data collection process is described and the thematic analysis process is described. The results often address each theme by explaining how the theme was generated and what it means. Also, this step provides evidence of data. In the end, an explanation is given of how the analysis outcome has answered the research question. The purpose of this step is to present a rich story about the data and make a compelling argument in relation to the research question (Braun & Clarke, 2012; Xu & Zammit, 2020).

3.8 Reliability and Validity

Reliability refers to whether, if the research were repeated, the same results would be obtained (Collis & Hussey, 2009). The research findings are considered to be reliable if the research has been repeated and produced the same results. In other words, reliability refers to the extent to which research results are consistent over time and are a precise representation of the population under study. The research instrument is considered to be reliable if the results of the research can be reproduced using a similar methodology (Golafshani, 2003). One of the common methods that is used to measure reliability of the responses to surveys is internal consistency. It is applied to test whether variables in the survey items are measuring the same construct or concept (Hair et al., 2014; Pallant, 2011). The coefficient alpha is a popular method for measuring internal consistency. The value range of alpha is between 0 to1 (see sub-section 3.7.2.5). In this research, internal consistency is determined by a Cronbach's alpha (α) > 0.6, which is the measurement criterion signalling an acceptable result.

Validity is the extent to which the research results truly measure what the research was intended to measure. Validity relates to how precisely a method measures what the research is intended to measure. In other words, does the instrument of the research allow the researcher to address the research objective (Golafshani, 2003)? Sometimes, the responses obtained by the instrument might be highly reliable, although the outcomes are less useful and have low validity. Thus, it is important to ensure the research instrument questions correspond to the explanation about the research that the researcher provides to the participants (Collis & Hussey, 2009). In this research, the online survey was designed based on the literature review and the researcher designed new questions according to the research needs. After that, the questions were reviewed by the PhD supervisors. Then, a pilot study was conducted to improve the surveys' validity. Before participants began answering the online survey questions a link to a short video was given to participants. The video explained the purposes of the research and how the digital nudge will help students to make better academic decisions. Also, a cover letter accompanied the survey questionnaire, giving a brief explanation of the research aims, purpose, instrument structures, ethics...etc.

The aim of the second phase (i.e., interviews) of the mixed-methods approach was to extend and triangulate the first-phase (i.e., surveys) outcomes in order to strengthen the validity of the findings. Thus, semi-structured interview questions were designed based on the data obtained from the surveys. Then, the interview questions were reviewed by the PhD supervisors. Finally, the pilot study was conducted to improve validity (Kelle, Kühberger, & Bernhard, 2019). Also, a cover letter was attached to the interview questions, giving a brief explanation of the research aims, purpose, instrument structures, ethics...etc. Table 3.5 presents the number of participants in each research phase.

Table 3.5: Validity numbers for this research (prepared by the researcher).

Validity number				
	Target population	**Pilot**	**sample size**	**Number of completed response rate**
Survey	Academics and IT staff	10	373	375
	Students	10	384	408
Interview	Experts who are interested in educational developments or nudging theory	1-2	20-25	25

The validity of the research instruments (surveys and interview questions) was discussed in this section. Sub-section 3.8.1 below explains the strategies used to ensure the validity and trustworthiness of the qualitative findings in order to validate and confirm the factors to be included in the final e-nudging model.

3.8.1 The Trustworthiness of Qualitative Findings

This section mainly discusses the criteria used in this research to establish the trustworthiness of the qualitative findings. The trustworthiness of qualitative research comprises quality, authenticity, and truthfulness of the research findings (Kyngäs, Kääriäinen, & Elo, 2020). In other words, it is the degree of confidence in data, interpretation, and methods used to ensure the quality of a research (Connelly, 2016; Curtin & Fossey, 2007).

Four primary and six secondary criteria were used to assess trustworthiness. The four primary criteria are credibility, authenticity, criticality, and integrity proposed by Whittemore, Chase, and Mandle (2001). The other six secondary criteria might be applied to every qualitative research, but provide benchmarks of validity (Cope, 2014; Kyngäs et al., 2020). In this research, the four primary criteria were applied in addition to two secondary criteria: transferability and confirmability. Each criterion is explained below.

3.81.1 Credibility

Credibility refers to confidence in the truth value of the research findings (i.e. data and interpretations) (Kyngäs et al., 2020; Polit & Beck, 2018). This criterion relates to the judgment that the readers make about the believability of the researcher's findings and reporting. There are many methods used to improve research credibility and internal validity, two of which are triangulation and member checking (Curtin & Fossey, 2007; Polit & Beck, 2018; Saunders et al., 2016).

In this research, triangulation methods were applied to improve the validity and credibility of the findings. Saunders et al. (2016, p. 207) stated that "Triangulation involves using more than one source of data and method of collection to confirm the validity/credibility/authenticity of research data, analysis and interpretation". The purpose of triangulation is confirmation and completeness (Curtin & Fossey, 2007). There are four types of triangulation method: data triangulation, method triangulation, investigator triangulation, and theory triangulation (Amin et al., 2020; Polit & Beck, 2018; Guion, Diehl, & McDonald, 2011). In this research, data triangulation and method triangulation are used.

- **Data triangulation:** includes different data sources for the purpose of validating the conclusion. There are three types: time, space, person data triangulation (Polit & Beck, 2018; Thurmond, 2001). The person triangulation was selected for this research. This method involves collecting data from different types of participants to improve validation by seeking multiple perspectives on the phenomenon (Kyngäs et al., 2020; Polit & Beck, 2018). In this research, the interviewees were selected from different Saudi universities and have a variety of characteristics: position (e.g., lecturer, assistant professor, associate professor, full professor) in a Saudi university, different academic fields (information systems, computer science, and management) different work experiences, and different levels (high, medium and low) of knowledge in regard to e-nudging techniques.
- **Method triangulation:** uses multiple methods of data collection to develop a comprehensive, coherent understanding of a phenomenon (Guion et al., 2011; Polit & Beck, 2018). The method triangulation is called mixed-methods (Thurmond, 2001). The method triangulation here refers to data collection methods (i.e., qualitative and quantitative methods) not the study design. In this research, the qualitative phase has extended and triangulated the quantitative phase

findings (i.e., surveys) in order to provide a coherent rich picture of the adoption e-nudge in LMS in Saudi higher education.

3.8.1.2 Authenticity

Authenticity refers to the extent to which researchers fairly and completely show a range of different realities (Polit & Beck, 2018; Connelly, 2016). To address this criterion, the researcher should select appropriate individuals for the research sample. In this research, the participants are expert academics who work in a Saudi university and are interested in nudge theory or educational development in general. These participants have had experiences in the higher education system in SA; some of them have had experiences with nudge, and some have been involved in other aspects of educational development. They can provide rich, coherent information about the key factors in e-nudge model to design successful and effective nudge interventions that can enhance students' performance through LMS. However, another strategy to achieve authenticity is to provide a rich and detailed description of a phenomenon. This improves authenticity and increases the readers' understanding, which is an important advantage for qualitative research (Connelly, 2016). Furthermore, the inclusion of an adequate number of quotations from participants that clearly illustrate the connection between the results and data is another strategy that can strengthen authenticity. In this research, the researcher made an effort to provide sufficient various, and relevant quotations from different participants, to demonstrate that these quotations were generated from the original data. It is important to ensure the accuracy of these quotations, and that identification codes are used to preserve the anonymity of the participants (Polit & Beck, 2018).

3.8.1.3 Criticality

According to Cope (2014) criticality is "the researcher's decision process and critical appraisal of the evidence and interpretations". This criterion can be met by reporting faithfully and providing a rich description of the data and its analysis, and by repeatedly reviewing the interview transcripts in order to achieve data saturation and obtain a better understanding of the phenomenon.

In regard to participants, the researcher decided to apply the data saturation strategy. In this research, the number of interviews is 25 experts academics and data saturation was checked by reviewing transcript after each interview.

In this research, the researcher reviewed the interview transcripts many times to check for new data and determine whether new codes were required (Braun & Clarke, 2021). As mentioned above, the data triangulation is utilized to strengthen validity and reach data saturation (Fusch, Fusch, & Ness, 2018; Fusch & Ness, 2015). In this research, after 23 interviews, the data saturation point was reached, but the researcher decided to conduct two more interviews to be sure. In total, 25 valid and complete responses were obtained.

3.8.1.4 Integrity

Integrity refers to “critical reflection to uphold valid interpretations of the data” as Cope (2014) stated. The integrity criterion can be achieved by criticality. The description of in-depth data analysis and repeated reviewing transcripts leads to data saturation which improves the integrity of the qualitative research (Roy, Zvonkovic, Goldberg, Sharp, & LaRossa, 2015). In this research, the researcher made an effort to obtain rich data by repeatedly reviewing transcripts and reaching data saturation0, providing accurate findings after reviewing all analytical processes and consulting with PhD supervisors.

3.8.1.5 Transferability

Transferability refers to the degree to which the research findings can be applicable to another context, group or domain (Kyngäs et al., 2020; Polit & Beck, 2018). It is synonymous with external validity. Saunders et al. (2016, p. 206) stated that “Transferability is providing a full description of the research questions, design, context, findings and interpretations, the researcher provides the reader with the opportunity to judge the transferability of the study to another setting in which the reader is interested to research”. A full description of the research is important for reader to follow and understand what the research has achieved. Additionally, full or rich descriptions improve research validity (Curtin & Fossey, 2007).

In this research, the researcher attempted to accurately and comprehensively report the research phases, design method, clarify the research process and procedure, findings and interpretations in order to ensure transferability and open up new research paths for other researchers or postgraduate students.

3.8.1.6 Confirmability

Confirmability relates to the connection between data and results. This criterion is concerned with the level of confidence that the findings are shaped by participants more than by potential researcher biases (Kyngäs et al., 2020). The findings should reflect the participants' narratives and words, not the researcher's biases (Polit & Beck, 2018). Several strategies can be used to ensure confirmability, one of which is the audit trail, although this strategy could harm the trustworthiness of the research (Kyngäs et al., 2020). In this research, the researcher kept detailed notes of all her decisions and analysis processes to support the connection between the data and findings. The researcher discussed all the analysis results and her decisions with PhD supervisors to confirm the final results. Moreover, these discussions prevented the researcher's perspective from influencing the results due to biases (Connelly, 2016).

3.9 Ethics Approval

According to university policy, researchers are required to submit the standard form "Application for recognition of ethics approval from another institution" to the Human Research Ethics Committee of Curtin University prior to commencing the data collection phase. The researcher must submit the application form to obtain approval for low-risk research projects. The researcher needs to have each data-collection method approved. Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2020-0060).

Prior to the data collection, all universities selected for this study received an official letter explaining the research objective and value of their participation in the study. Then, after seeking approval for a pilot study, the pilot survey approval was carried over to the main survey. In the survey all participants (i.e., academic, IT staff and students) received a brief description of the concept of nudging, the research aims, and an explanation of the data ethics and their consent to participate in the study. The survey questionnaire was written in both English and Arabic in case the participant preferred the Arabic language. Therefore, the questions were translated using a qualified third-party translator.

In the interview, the participants (i.e., expert academics) received an official letter to illustrate the research requirements, their roles, and their consent to participate in the study.

Furthermore, respondents were informed that participation was voluntary, and they had the right to withdraw at any time from the research without needing to give an explanation. The participants were assured that the data obtained would be anonymous and confidential. The collected data could be used by researcher, research supervisors, PhD committee or third-party organization. The consulting collected data would be available on the R Drive (based on Curtin Data Management policy) at Curtin University, and only the researcher and the PhD committee would have the authority to access it. The data would be used for the research purposes and would not be revealed to or shared with others. Table 3.6 shows how the consent forms were sought for this research.

Table 3.6: How informed consent was sought for this study (prepared by the researcher).

The data collection method	How informed consent was sought
Online survey	Consent form placed before survey questions
Online interview	Consent form placed before survey questions

3.10 Research risks

To guarantee the researcher’s access to SA university information, the researcher obtained an official letter from Curtin University stating that all data and information would be used for research purposes and would be retained only in the School of Management under Curtin University’s ethics standards and guidelines. In addition, an acceptable number of valid responses had to be collected during the online survey stage. Hence, a local company was employed to help the researcher with the online data collection if the number of responses was low. In this situation, the Saudi Arabian ethical approval would be applied.

3.11 Phases of the Research

This research aims to design and assess a new e-nudging model for the higher education sector of SA. The phases of this research are illustrated in Figure 3.10.

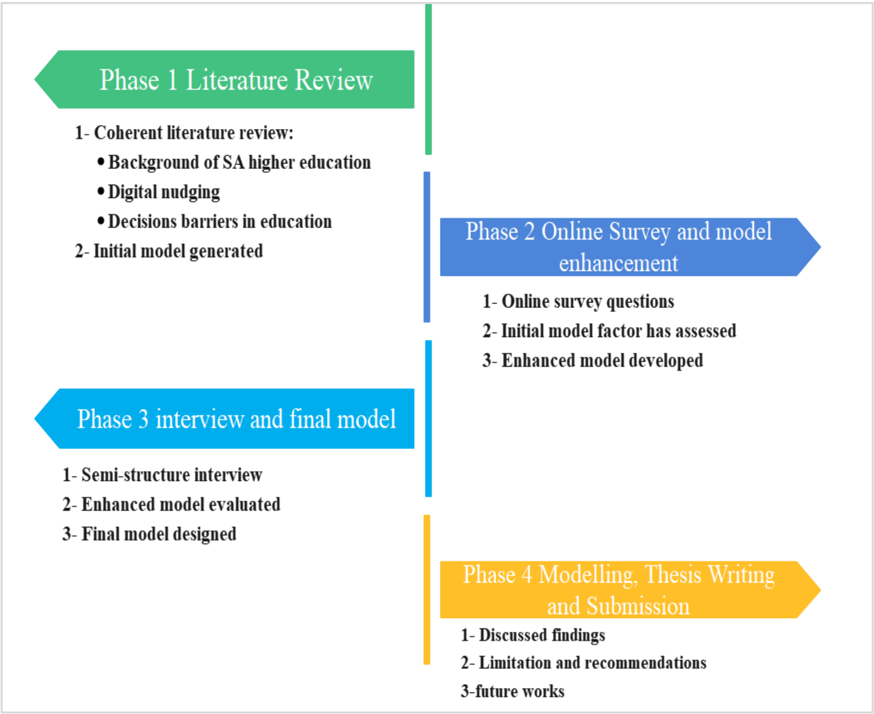


Figure 3.10: Research process flow chart (prepared by the researcher).

Phase 1 Literature Review: In this phase, a coherent literature review was presented in chapter 2 comprising studies relevant to the background of SA higher education, digital nudging and decision barriers in education to discuss the nudging theory in general, to identify the research gap, and to formulate succinct and manageable research questions. The factors that may possibly have an effect on the design of an e-nudging model for a learning management system were identified. After that, the initial research model was designed. Because human participants are involved in the research, ethics approval was obtained from the Human Research Ethics Committee of Curtin University prior to beginning the data collection.

Phase 2 Online Survey and model enhancement: Survey questions were formulated for two online surveys, and translated into Arabic by a qualified third-party translator. Then the survey questionnaires were developed using the Qualtrics platform, and a hyperlink of the online surveys was distributed to potential participants: academics and IT staff (first survey) and students (second survey) in Saudi universities via official email and social networks to assess the initial e-nudging model and determine the education barriers faced by students. Then the data was analysed using Microsoft Excel 2016, SPSS software version 26 and NVivo 1.0. The outcomes from this phase were used to improve the initial model. This refined model was evaluated by the interviewees (qualitative phase).

Phase 3 interview and final model: interviews were conducted, targeting experts who works in Saudi universities and who are interested in educational development. They were asked to assess factors in the e-nudging enhanced model and give their opinions about the model and its usefulness to tertiary students. The interview questions were developed using the Qualtrics platform, and a hyperlink to the online surveys was distributed to potential participants via email and social networks. The data collected in this phase was analysed using NVivo 1.0 qualitative data analysis software. The outcomes derived from this phase informed the design of the final e-nudging model for higher education in SA.

Phase 4 Modelling, Thesis Writing and Submission: this phase involved the thesis write-up and referencing, editing, proofreading, revisions, amendments, and submission. The final e-nudging model was developed. The thesis was sent to a professional editor for proofreading prior to the final submission.

3.12 Chapter 3 Summary

This chapter discusses the research questions and objectives, and explains the theoretical and practical significance of this research. The chapter explains all decision for research process that guided by adopting research opinion framework. The research onion was research philosophy. Pragmatism philosophy is chosen that aimed to find practical solution for a problem in the real world. Also, this philosophy allows research to conduct multiple research methods in order to achieve research objectives and answer research questions in suitable way. The research approach for this study is abductive, because an in-depth analysis is required, the mixed method (i.e., sequential explanatory research) is applied. This research method provides robust a proof for the research findings and in-depth analysis. With this method, the researcher can overcome the weaknesses in traditional single method. Guidelines for the each of the data collection phases are presented. The analysis methods that used in this research: descriptive statistics, exploratory factor analysis, and qualitative thematic analysis are discussed. Sampling size and the analysis tools for each of the phases is provided. The chapter concludes by discuss the ethics considerations and risk in this research.

Chapter 4 describes the quantitative phase which involved collecting data by means of an online survey. The results from the data analysis were used to refine the design of the initial e-nudging model.

Chapter 4. Quantitative Data Analysis

4.1 Introduction

Chapter 3 discussed the first phase of the research methodology approach which was adopted for this research. For this research, mixed-methods "Explanatory Sequential Design" approach was adopted. The approach consists of two phases: a quantitative phase, followed by a qualitative phase. The significant advantage of using the approach is that it provides a comprehensive picture of the phenomenon of e-nudging in higher education in SA, as the qualitative data complements the quantitative results (Ivankova et al., 2006).

This chapter presents the findings from the quantitative phase of the research which involved an online survey. The online survey was conducted in order to assess the factors included in the e-nudging model for higher education in SA, driven by the literature review (see Figure 2.13).

Furthermore, the online survey examined the current education barriers namely, behavioural, cognitive, and environmental factors that pose significant challenges to tertiary students and can influence their education-related decisions, in order to design an effective e-nudging intervention in LMS that meets students' requirements. The purpose of the online survey was to improve the initial model by testing the relevance of the factors which were derived from the literature review, and extracting new factors based on the results of the online survey.

In this chapter, details of the survey design are presented in section 4.2, followed by the survey analysis method in section 4.3 and section 4.4 provides the results for survey of academics and IT staff. Section 4.5 shows the results for the students' survey.

Finally, the chapter describes the main changes that will be made to the initial model. It explains why certain factors remained unchanged and why other factors were deleted based on the analysis of the survey data. Section 4.7 modifies and presents the new e-nudging model. The chapter concludes with a summary in section 4.8.

4.2 Survey Design

For this stage, the proposed research model was designed based on the literature review. This research study applied the explanatory sequential design approach which adopts a mixed-methods research design in order to achieve research objectives and answer the research questions. Then, Exploratory Factor Analysis (EFA) was used to reduce the number of factors required to enhance the e-nudging model.

The outcome of this stage is a new e-nudging model after confirming relevant factors and discarding factors based on the results of the survey analysis. To achieve this, two online surveys were designed, one for the academics and IT staff, and one for university students. The following subsections will explain the survey populations, the survey structure and contents, the development of the surveys, the channels used for data collection, and the survey timeline.

4.2.1 Structure of Surveys

It is important to structure the online survey to ensure that it is simple but addresses the research objectives and answers the research questions. A good survey design will increase the response rate and assist respondents to complete the questions easily and within a certain time. The online survey covered the following themes: factors for the e-nudge model, participants' perception, education barriers, and e-nudging techniques as shown in Table 4.1.

Table 4.1: Mapping table for online survey (prepared by the researcher).

Survey Themes	Academic	IT Staff	Student	Research Objective	Research Question
Factors for e-Nudging Model	√	√		RO1	RQ1
Planning Stage					
▪ Identify e-nudging model goals					
▪ Identify constraints					
▪ Understand decision process					
▪ Determine barriers and influences					

▪ Mapping decision process with barriers identified					
Analysis Stage					
▪ Select nudging methods					
▪ Identifying the optimal digital nudge moment					
Design Stage					
▪ Human Computer Interaction (HCI)					
▪ Navigation					
▪ Usability					
▪ Design e-nudging prototype					
▪ Ethics					
Testing Stage					
▪ Test nudging impact					
▪ Test the delivery method of digital nudge					
▪ Test the optimal moment					
▪ Test usability					
Perception of:	√	√	√	**RO3**	**RQ3**
▪ Implementation of an e-nudging in SA’s higher education					
▪ Students’ e-nudging interface					
Education barriers			√	**RO3**	**RQ3**
Behavioral barriers					
▪ Self-regulation					
▪ Bounded Rationality					
Cognitive barriers					
▪ Attention					
▪ Memory					
▪ Self-confidence					
Environmental barrier					
▪ LMS interface Complexity					
e-Nudging Techniques	√	√	√	**RO3**	**RQ3**
▪ Feedback					
▪ Reminder					
▪ Peer comparison					
▪ Reduced distance					

Figure 4.1 shows that each section pertains to specific themes based on the information the researcher is seeking from academics, IT staff and students. The questions in the first section of the survey questionnaire are multiple choice, and intended to collect participants' demographic information. The second section contained a five-point Likert scale with items relevant to the factors that will be considered by participants regarding the design of an e-nudging model for the SA higher education sector. The scale is anchored by 'strongly disagree', 'disagree', 'neutral', 'agree', and 'strongly agree', with values ranging from 1 to 5 respectively. The five-point scale is familiar to most if not all participants as it is a popular measurement and an efficient means of capturing a significant amount of the true variance in the participants' opinions and reducing participants' frustration level (Passmore et al., 2002). The third section also comprised a five-point Likert scale with items that determined participants' perceptions of implementing e-nudging. The fourth section examined perceived education barriers and again used the five-point Likert scale for responses. The last section contained five-point Likert scale to assess e-nudging techniques. In addition, the survey contained two open-ended questions to give respondents the opportunity to express their opinions and thoughts regarding the implementation of an e-nudging, and to suggest other factors that might facilitate or influence the of e-nudging model.

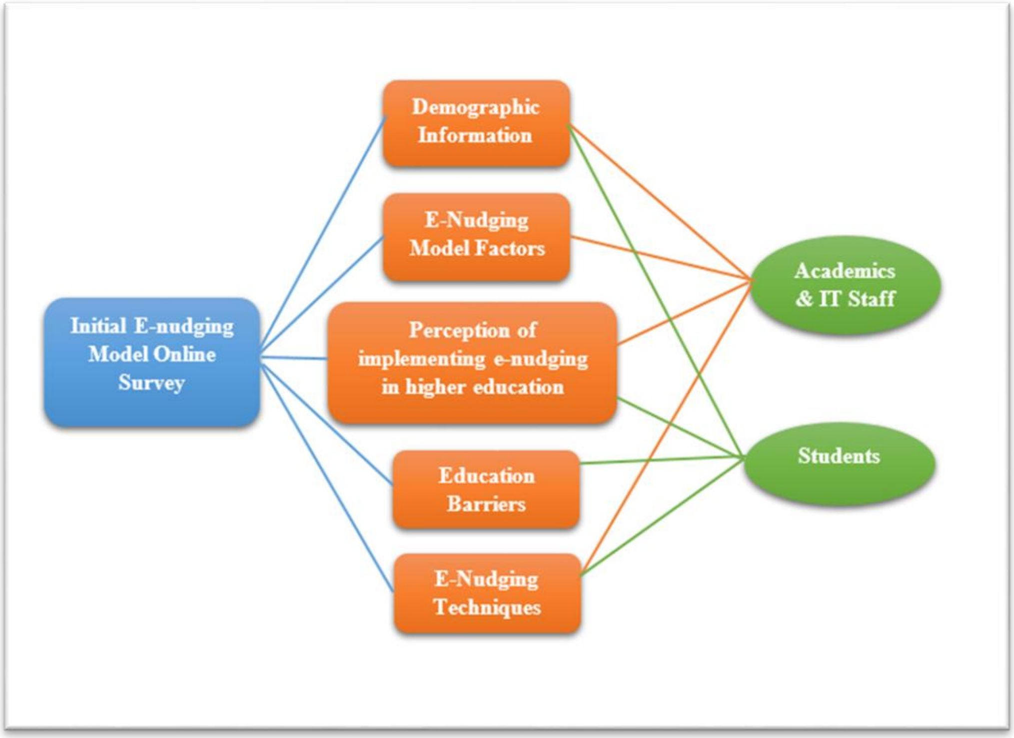


Figure 4.1: Structure of the online survey on the initial e-nudging model (prepared by the researcher).

In addition, from these five sections the researcher designed two separate online survey hyperlinks - one for the academics and IT staff that has four sections comprising demographic information, e-nudging factors, perception, and e-nudging techniques. As depicted in Figure 4.1, the online survey for academics and IT staff contained 30 questions and the estimated time required for completion was 20 minutes. The students' online survey contained 26 questions and had four sections comprising demographic items, perception, education barriers, and e-nudging techniques. The estimated time required to complete the survey was 20 minutes.

Finally, a letter was attached to inform participants about the aim of the research and to give a brief explanation of e-nudging concepts. A short video was designed and the link was included before participants began answering the online survey questions to explain the research aims and how the digital nudge will help students to make better academic decisions. To watch the video, participants were asked to click on the link: https://drive.google.com/file/d/1y4FQzIQZb-mKKrT-3jsWNtB3RfxgthEZ/view?usp=drivesdk. The questions were translated using a qualified third-party translator. The surveys were available in both Arabic and English languages since the Saudi community speak Arabic and have English as their second language.

4.2.2 Developing the Survey Questions

The online survey was developed based on the literature review, and the researcher designed new questions according to the research needs. As mentioned in sub-section 4.2.1, two online surveys were generated - one for the academics and IT staff and the other for students. Each survey comprised four sections. Three sections were similar, and one section was different as demonstrated in Figure 4.2. The academic and IT staff survey contained sections for: demographic information, e-nudging model factors, perception of implementing e-nudging in higher education, and e-nudging techniques. The students' survey included items related to: demographic information, education barriers, perception of implementing e-nudging in higher education, and e-nudging techniques. Each section is described in detail below.

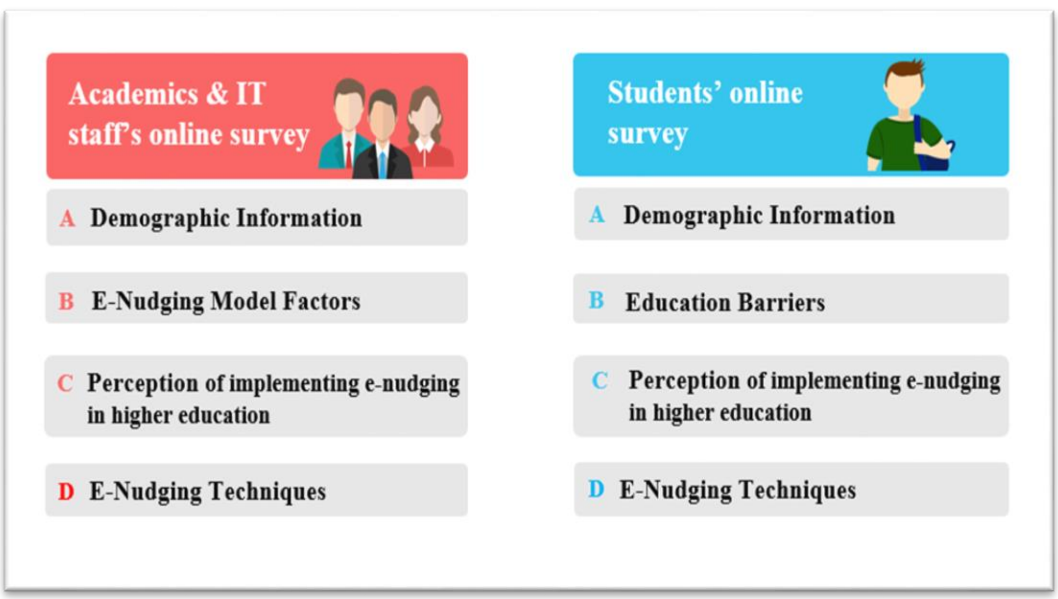


Figure 4.2: Survey sections for each target population (prepared by the researcher).

The first section of the survey collects demographic information to determine whether the participants constitute a representative sample of the survey target population. Also, it gives an indication of the level of knowledge and experience of the participants who assess the e-nudge model. For example, the job titles in the academic survey show the level of knowledge and teaching experience of participants. This enabled the researcher to determine the reliability and value of the participants' opinions, and informed the interview questions for the qualitative phase of the research. In addition, the item "*tick your year(s) of study at the University"* was included to indicate the educational decision-making experience of student participants. The demographic section for the academic and IT staff contains ten questions with single choice, whereas students have nine questions. The questions in this section were developed by the researcher and reviewed by the supervisor.

The items in section two of the academics and IT staff survey are intended to assess the initial e-nudging model and identify specific factors that must be considered at each stage of development when implementing an e-nudging model for the higher education sector in SA. An e-nudging model comprises five stages with each stage containing specific factors that must be implemented in order to meet model requirements (see Table 4.1 the mapping table). However, the implementation and evaluation stages are not addressed in the survey as these stages had few variables. Moreover, the researcher was concerned that the survey items might cause survey participants to misunderstand or confuse the design and implementation of e-nudging. Hence, these two stages (i.e., implementation and evaluation) were evaluated by the expert interviewees.

To measure the importance of each factor that must be considered when implementing an e-nudging, the researcher included many statements to measure each factor. The survey items were presented on a five-point Likert scale, anchored by 'strongly disagree' (1), 'disagree' (2), 'neutral' (3), 'agree' (4) and 'strongly agree' (5). This structure allowed respondents (i.e., academics and IT staff) to express the extent to which they agreed or disagreed with each statement. At the end of the section, an open-ended question was included to give respondents the opportunity to comment on other factors that might facilitate or influence the implementation of e-nudging.

The third section of the survey was intended to discover and measure the perception and opinions of university students, academics and IT staff in regard to the implementation of an e-nudging in SA's higher education sector. The section comprised two parts; one focused on what the implementation of e-nudging in SA's higher education was intended to do, and the other part focused on students' e-nudging interface features. The items in this section were presented on a five-point Likert scale. In addition, there was an open-ended question at the end of the section to give respondents the opportunity to express their opinions and thoughts regarding the implementation of an e-nudging.

The aim of the items in the next section was to determine whether the e-nudging model would meet the requirements of tertiary education students in SA. There are several issues that influence students' education-related decisions that need to be taken into consideration in order to develop a successful e-nudging for higher education in SA. This section examined the three factors that can influence students' academic-related decisions: behavioural, cognitive and environmental. This section was developed from the literature review and modified by the researcher based on the study's needs. It comprised three parts.

- **Behavioural barriers**: this part included two factors: self-regulation and bounded rationality. The self-regulation factor measures students' skill in terms of four essential components: plan, monitor, control and reflect (Gaumer Erickson, 2018). These components show the level of students' self-regulation. The bounded rationality questions were developed to measure three significant limitations: feedback given by the teacher, the student's thinking process, and time. For example, when a student does not receive adequate and timely feedback, s/he is likely to make irrational and unwise decisions. The questions assessed these three elements by focusing on the issue of assignment completion to assess students' bounded rationality (Watkins, 2012).
- **Cognitive barriers**: is the second part of this section, and concerns attention, memory, and confidence. The attention factor contains three important dimensions to evaluate students' attention effectively. The dimensions are: concentration ability, arousal and distractibility. The survey questions were designed to measure these dimensions to assess students' level of attention (Schepers, 2007). The

researcher included the memory factor to complement the attention factor and enable a more accurate evaluation of the attention factor that can negatively influence students' decisions. The memory question measured students' perceptions of memory, the use of memory strategies, and memory mistakes. The researcher included one more item to measure memory mistakes when students use the LMS to submit their assignments (Troyer & Rich, 2017). The last factor is self-confidence. The questions was designed to assess the level of confidence that students have in their own academic ability (Jones, 2001).

- **Environmental barriers**: is the last part of this section. The purpose of this part was to assess the complexity of current LMS that is used in Saudi universities. The questions were developed to evaluate the LMS functionality, HCI, Navigation and usability. The items were developed by the researcher, and some were derived from the literature (Thuseethan et al., 2014).

The last section of the survey was related to e-nudging techniques. The research proposed four digital nudging interventions (i.e., feedback, reminder, peer comparison, and reduced distance) to steer students' behaviour. The purpose of this section was to gather data about the perceptions of academics, IT staff and student in terms of the implementation of these four digital nudging interventions in the higher education sector of SA. The items were framed to determine the best intervention design for the LMS.

After the two surveys had been developed and approved by the supervisor and co-supervisors, ethics approval was sought from the Human Research Ethics Committee of Curtin University (HREC). Both surveys were approved (approval No. HRE2020-0060). Then, the final version of the online surveys was developed using the Qualtrics Online Survey platform. To improve the validity and reliability of the surveys, a pilot study was conducted via Qualtrics. Two check-lists were designed: one for academics and staff and one for students. The closed questions requiring 'yes' or 'no' responses were derived from the literature review (Kilpatrick et al., 2019; Oh et al., 2012) to evaluate both online surveys to ensure the questions were easy to understand, and the design was appropriate and free of defects for potential respondents. In addition, both pilot checklists contained open-ended questions to give respondents the opportunity to express their opinions and thoughts regarding the survey items and design. Also, a quick response (QR) code was used to make it easy for participants to access the surveys. The checklists were distributed to ten academics and ten students to evaluate the online surveys as recommended by (Fink, 2015). The pilot study results revealed that no changes were required for the survey items or the design. Most comments were in regard to the length of the online surveys. The pilot study checklist is presented in Appendix C. The online surveys were reviewed by supervisors after the pilot study. All stages of the survey development process are shown in Figure 4.3 below. The final copy of the online surveys is presented in Appendix D.

Figure 4.3: Developing the survey questions (prepared by the researcher).

4.2.3 Survey Population

The sample population for the online surveys comprised academics, technology staff (IT staff) and students from public and private universities in SA. It is important to have enough diversity when a sample is selected in order to explore the influence of certain characteristics (Ritchie et al., 2013). The hyperlinks to the two surveys were distributed to potential respondents through various social networking channels and the email addresses of academics and students, details of which are given in sub-section 4.2.2.

The data was collected from several universities in SA, mainly those that were the highest-ranking universities in the Arab world; two of these universities were ranked first and second in 2019. An adequate sample size was determined based on the Sample Size Calculator to ensure a confidence level of 95% in the data with 0.5 standard deviations, and a margin error of 5% (Smith, 2013). The total target population was determined based on five universities (three are public and two are private). The total number of academics and IT staff was 13,116. Hence, the valid sample size for this research was 373 participants as shown in Figure 4.4.

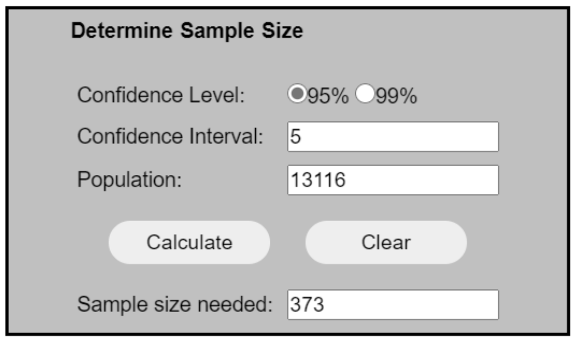


Figure 4.4: Academics and IT staff sample size. (Source: (Creative Research Systems, 2012).

The total number of students in these universities was 301,256. Hence, the valid sample size for was 384 participants as shown Figure 4.5. See Appendix B for more details about these universities.

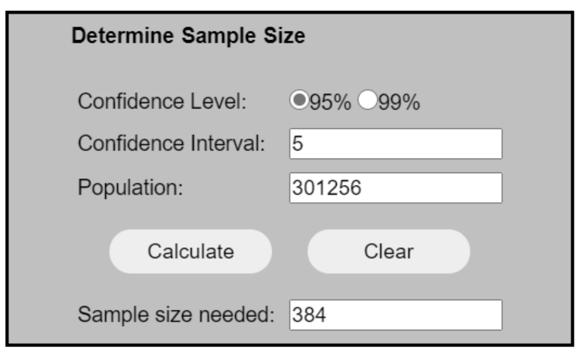


Figure 4.5: Students' sample size. Source: (Source: (Creative Research Systems, 2012).

Due to the Covid-19 pandemic, the researcher expanded the target populations and distributed the surveys to more than five universities. The number of responses from the first survey for academics and IT staff was 809 in total, 375 of which were valid and complete. The student survey returned 1089 responses, 408 of which were valid and complete. The number of student responses exceeded that of the sample size required for this research. The survey sample populations are given in Table 4.2. Hence, the final sample that was used for this research was obtained from many universities. There are valid 375 responses from academics and IT staff, and 408 from students.

Table 4.2: The target populations and response rates (prepared by the researcher).

Survey population	Number of received responses	Number of valid and completed response rate	Research sample size
Academics and IT staff	809	375	373
Student	1089	408	384

Both sample sizes exceeded the required 300; therefore, they were more than adequate for Exploratory Factor Analysis (Comrey & Lee, 2013; Hair et al., 2014; Jung & Lee, 2011; Williams et al., 2010; Yong & Pearce, 2013).

4.2.4 The Survey Data Collection Channels and Timeline

As mentioned above, the two online surveys were designed using the Qualtrics online survey platform. The two surveys were distributed using different methods in order to reach the valid sample size for academics, IT staff and students.

The first stage was conducted from 9 March to 12 March 2020. The survey for academics and IT staff was distributed via official emails asking them to participate and answer the survey questions, a copy of email letter in appendix A. A total of 570 emails were sent, and 30 responses were received from academics and IT staff.

The second stage was conducted from 11 March to 19 March 2020. The researcher sent messages via WhatsApp to her colleagues working at universities, inviting them to participate by completing the questionnaire for academics and IT staff, and asking them to announce and post the students' surveys on their LMS. Thirty-three academics and ten students responded. A few days into this stage, due to the pandemic, the Saudi governments announced on 12 March 2020 the closure of all schools and universities;

teaching would be conducted online with virtual classes. Because the response rate for the two surveys remained unchanged for two weeks, the researcher decided to use social media - LinkedIn, Twitter, and Facebook - and utilize the snowball technique to speed up the process.

Via LinkedIn, a direct message was sent to academics, IT staff and university students. LinkedIn enables the researcher to find and communicate easily with academics, students, and IT staff in Saudi universities. These direct messages enabled the researcher to access potential participants for the survey and ask them to distribute the surveys among their colleagues. A total of 736 direct messages were sent and most of the responses came from students. Via Facebook and Twitter, survey hyperlinks were posted on official university accounts and also on accounts that were interested in academic researches. This stage lasted for close to eleven weeks. The total number of responses from the first survey for academics and IT staff was 809, and 1089 for the students' survey were responses. The administration of the surveys is depicted in Figure 4.6.

The two surveys were run for 13 weeks, starting on 9 March 2020 and finishing on 5 June 2020. Most of the responses were obtained through LinkedIn and Twitter.

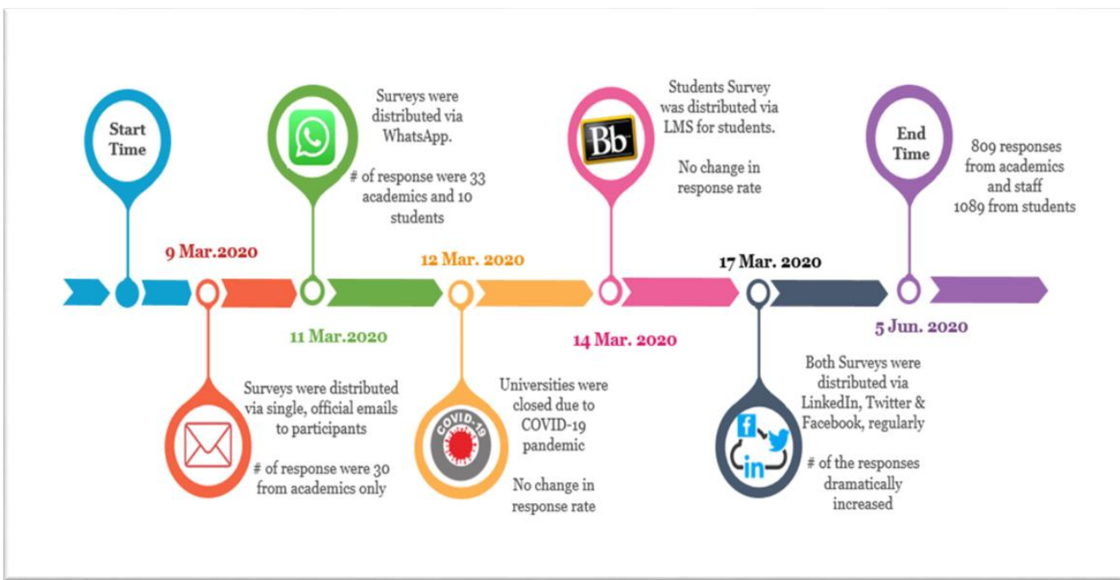


Figure 4.6: Survey data collection channels and timeline (prepared by the researcher).

4.3 Surveys Analysis Methods and Tools

Descriptive Statistics and Exploratory Factor Analyses (EFA) were conducted to analyse data from both surveys and examine the factors derived from the literature review. Each method will be explained in detail in the following sub-sections. The data collected from both surveys was analysed using Microsoft Excel 2016, SPSS software version 26 and NVivo 1.0. The following sub-section explains the analysis methods applied to the survey data.

4.3.1 Descriptive Statistics

As mentioned in chapter 3, descriptive statistics are utilized to summarize a given data set. This type of analysis helps to indicate the features of a specific simple size by providing short summaries and measurements of the sample. Moreover, the data presentation is helpful to discover patterns and relationships between the variables and is considered as an effective and convenient method for displaying the research results. Data can be presented succinctly in figures and tables (Nick, 2007).

4.3.2 Exploratory Factor Analyses

Exploratory Factor Analysis (EFA) is a statistical technique that enables the number of factors to be reduced and explored to generate a model from a relatively large set of variables (Osborne et al., 2014; Williams et al., 2010). EFA is applied in this research to reveal the factors that need to be retained in the e-nudging model. EFA comprises a five-step protocol proposed by Williams et al. (2010) and Zeynivandnezhad et al. (2019). Each step of this protocol is described below.

The first step is to check the suitability of data for factor analysis. This test measures three features: sample size, factorability of the correlation matrix and sample adequacy.

- **Sample size:**
  To obtain high quality results, the sample size should be at least 200. Here the sample sizes are 375 for academics and IT staff, 408 for students, both of which are adequate for factor analysis.
- **Factorability of the correlation matrix:** It is important to ensure that there is sufficient correlation among individual variables to provide a satisfactory solution. In this research, 0.3 is an acceptable correlation value.
- **Kaiser-Meyer-Olkin (KMO) and Bartlett's test**: Sufficiency of the sample is measured by utilizing Bartlett's test of sphericity (Bartlett, 1954) and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1974). To determine whether the factors are appropriate for analysis, Bartlett's test of sphericity should be significant (sig = .05 or less). The KMO result of 0.6 is the minimum score required for a good factor analysis result. Here, the researcher selected KMO ≥ 0.7 as a moderate value to measure sample adequacy.

The second step is the selection of a factor extraction method to determine the smallest number of factors that should be retained. There is a commonly reduction method used in EFA called Principal Component Analysis (PCA). The variables are correlated to each other and highly independent of other variables that are combined in other components. Thus, PCA is applied in this research as an appropriate extraction technique. To the best of the researcher's knowledge, no study to date has been conducted on digital nudging for students in Saudi Arabian universities. Therefore, the enhanced e-nudging model, which was generated after factor reduction, was further examined in the qualitative phase of the research.

Identifying the number of factors is the next step. In fact, it is important to strike a balance between finding a suitable and simple solution and retaining as few factors as possible (Pallant, 2011). There are many techniques that can assist the researcher to decide the number of factors to retain. In this research, the following techniques were utilized to identify the number of factors to retain in the e-nudging model:

- **Kaiser's criterion** is a commonly-used technique. The rule of thumb is to retain factors with an eigenvalue greater than 1.0 (Hadi et al., 2016; Pallant, 2011; Yong & Pearce, 2013).
- **Scree test** is a graph that represents the eigenvalues of the factors from largest to smallest in a downward carve. The curve eventually changes and flattens. In this graph, all factors above the elbow or break in the plot are retained (Pallant, 2011; Williams et al., 2010).

The final structure of factors was determined in the interpretation step. Therefore, an examination of several factor results with different numbers of factors was conducted before deciding on the final factors structure (Hair et al., 2014).

After the number of factors has been determined, factor rotation is the next important step. This helps the researcher to clarify and simplify the structure of factors for ease of interpretation. (Hair et al., 2014; Osborne, 2015; Pallant, 2011). This research adapted the orthogonal method with the Varimax technique for the main objective to provide easier interpretation of results, and to reduce large set variables to generate more meaningful factors to improve the initial e-nudging model.

The interpretation of rotation results is the final EFA step. In this step, variables are examined to determine those that are attributable to a particular factor, and to create a meaningful name or theme for that factor (Williams et al., 2010). To simplify the interpretation process, the researcher utilized four procedures:

- **Factor loading score:** factor loading indicates the correlation between variable and factor. A higher loading indicates that a variable has strong correlation and is a better representative of the factor (Hair et al., 2014; Yong & Pearce, 2013). The interpretation of factors depends on the significance of factor loadings. In this research, the cut-off point for interpretation for all loadings was 0.6 or above. When the variable had more than one significant loading (i.e., cross-loading), the highest loading was selected and assigned to that factor.
- **Communalities of the Variables:** After significance factor loadings have been identified, each variable’s communality is examined. The communalities provide

information on how much a variable has in common or shares with other variables in the retained factors (Hair et al., 2014; Pallant, 2011). In this research, each variable's communality was identified as 0.4 or above to provide sufficient explanation and decide the factors that should be retained in the e-nudging model.

- **Internal Consistency**

  Internal consistency is applied to test variables in the survey that measure the same construct or concept (Hair et al., 2014; Pallant, 2011). The most popular method used to measure internal consistency is the coefficient alpha which was developed by (Cronbach, 1951). The alpha values indicate the extent to which all variables are measuring the same component (i.e., factor). Values range between 0 to1, where 0 shows some consistency and 1 indicates a perfect consistent between variables (Pallant, 2011; Spiliotopoulou, 2009).

  In this research, the coefficient alpha has been applied to assess the internal consistency of both online surveys as a whole, and for each section. Additionally, the coefficient alpha was used to evaluate the internal consistency of each extracted factor as a final step to decide whether this factor should be retained. Table 4.3 shows the coefficient alpha for the research surveys. The coefficient alpha for the first three sections of both surveys is greater than 0.9, demonstrating excellent consistency. For the fourth section (Section D) of the academics and IT staff survey, the alpha is 0.86, indicating good consistency. For the fourth section of the student survey (Section D), the alpha is 0.763, indicating acceptable consistency. Section D of this survey comprised eleven variables, and this low number could affect the alpha result as explained by Pallant (2011).

Table 4.3: Reliability Test for both surveys (prepared by the researcher).

Academics and IT Staff Survey	Alpha Test	Student Survey	Alpha Test
Whole survey	0.971	**Whole survey**	0.932
Section(B): e-nudging Model Factor	0.981	**Section(B):** Education barriers	0.912
Section(C): Perceptions of implementing e-nudging	0.967	**Section(C):** Perceptions of implementing e-nudging	0.968
Section(D): Assess e-nudging Techniques	0.866	**Section(D):** Assess e-nudging Techniques	0.763

- **Labelling the retained factors:** after testing the internal consistency for the extracted factors, a name is given to these factors. The labelling of the factors is guided by the variables with the highest factor loadings (Hair et al., 2014; Williams et al., 2010; Zeynivandnezhad et al., 2019). This guideline was applied in this research.

4.3.2.1 Summary of EFA Five Step protocol

Table 4.4 summarizes the five steps and the value of each measurement used in each step. Figure 4.7 depicts the EFA flowchart, and the measurement criteria required to obtain an acceptable result that will enhance the e-nudge model.

Table 4.4: EFA five-step protocol summary (prepared by the researcher).

Step	Values
Test data suitability for factor analysis	Academics IT staff simple size = 375, Students simple size =408
	Variable correlations ≥ 0.3
	KMO ≥ 0.7
	Bartlett's test sig ≤ .05
Select Method for Factor Extraction	PCA
Determining number of factor extraction	Eigenvalue > 1
	Scree test
Select Rotation Method	orthogonal (Varimax)
Interpretation	Factor loading ≥ 0.6
	Communalities ≥ 0.4
	Cronbach's alpha (α) > 0.6

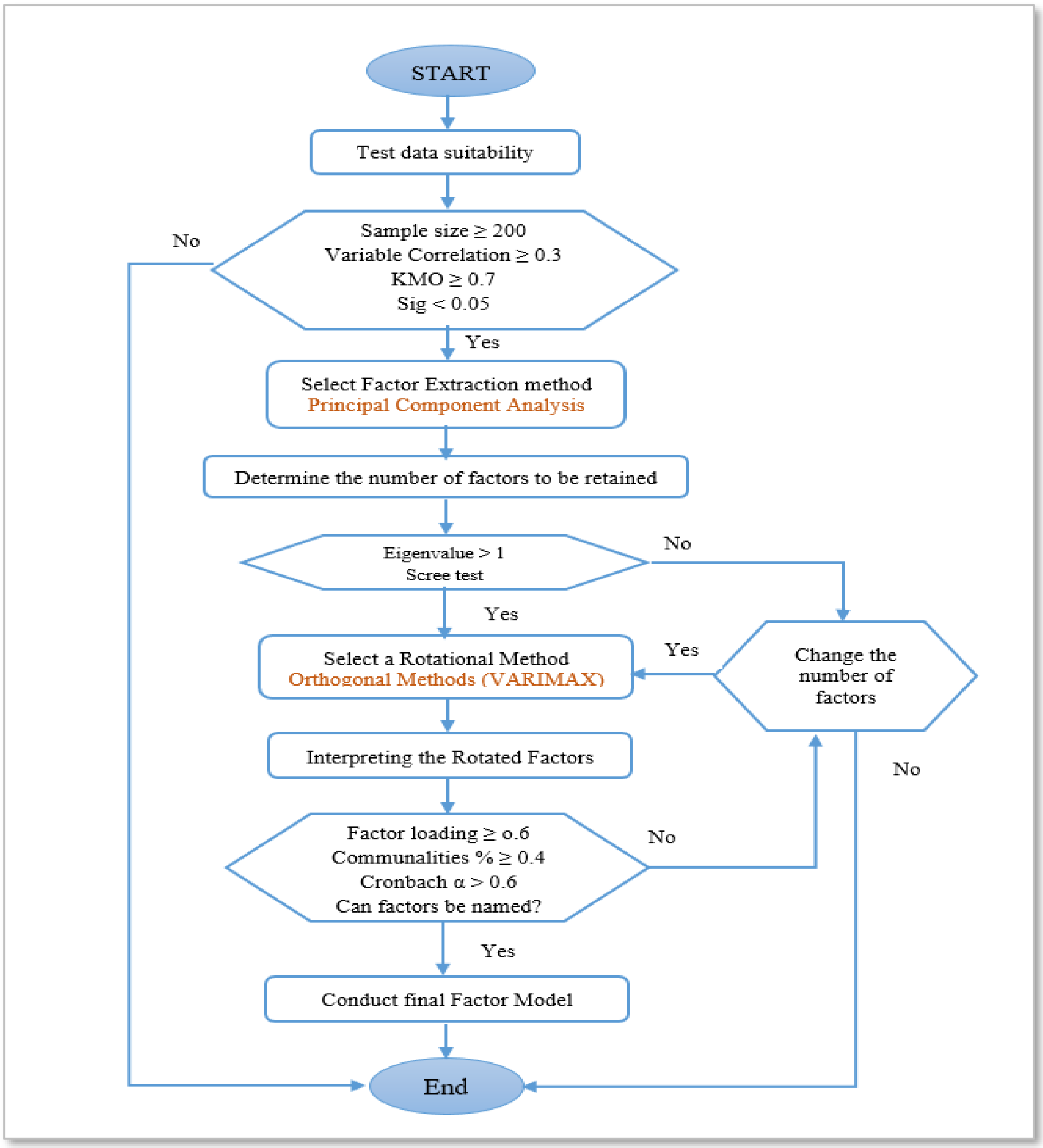


Figure 4.7: EFA flowchart for this research (prepared by the researcher).

4.4 Survey Analysis Results for Academic and IT Staff Analysis

This section presents the results of the analysis of data collected from academics and IT staff. The sample size is *n=375* (valid and completed responses). Descriptive statistics were applied to the demographics information section, while Exploratory Factor Analyses (EFA) were applied to e-nudging model factors, perception of implementing e-nudging in higher education, and e-nudging techniques. The following subsections will present in detail the results of data analysis for academics and IT staff online surveys.

4.4.1 Respondents' Demographic Profiles for Academics and IT Staff

The items in the demographic section collected participant information in regard to gender, age, education level, job title, field of work, type of university, type of LMS used in the participant's university, level of computer experience, usage of education-related technology, and level of knowledge about e-nudging techniques.

The total sample size (*n=375)* comprised academics and IT staff who work in Saudi Arabian universities. The majority of participants were male (72%) as shown in Figure 4.8.

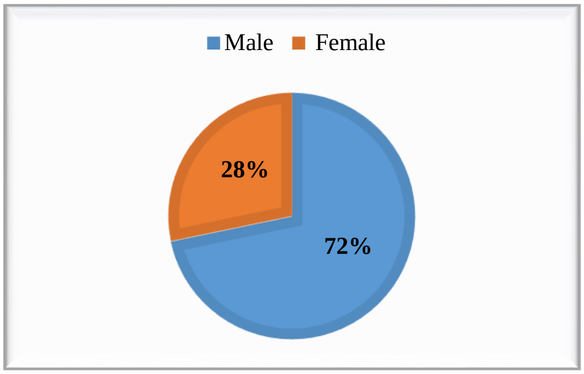


Figure 4.8: Academics and IT staff gender (prepared by the researcher).

In terms of participants' age, only 9.3% were aged between 24 and 28; 31.2% were aged between 29 and 33; and 25.3% were in the 34 to 38 age group. These statistics are depicted in Figure 4.9.

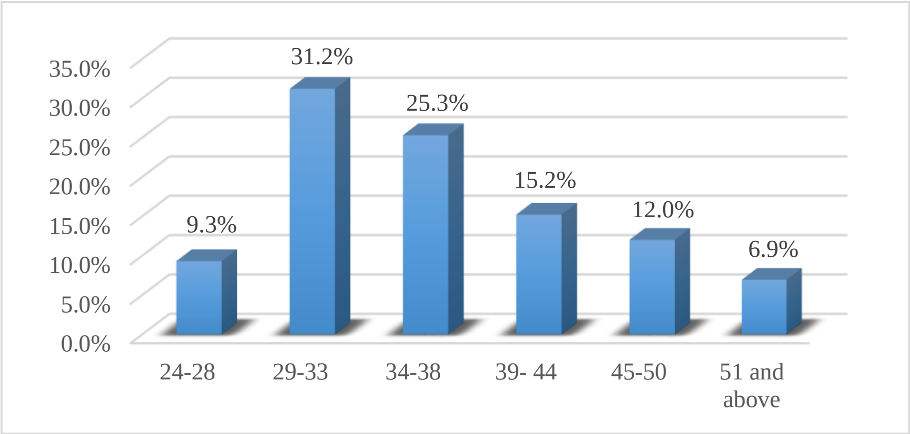


Figure 4.9: Ages of academics and IT staff (prepared by the researcher).

Figure 4.10 below shows that nearly half of the participants have a PhD degree. A master degree is held by 41.9%; for the bachelor degree, professional degree and post-graduate diploma, the percentages are 9.9%, 0.8%, and 0.3% respectively.

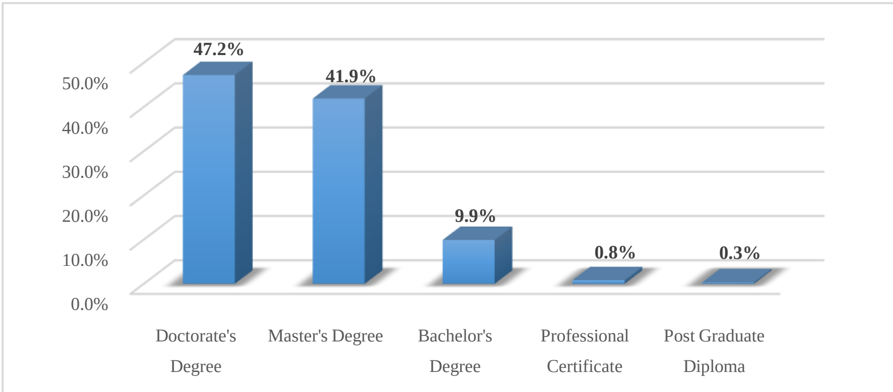


Figure 4.10: academics and IT staff's education level (prepared by the researcher).

The majority of participants were academics with job titles as follows: Lecturer (44.8%), Assistant Professor (27.2%), and Associate Professor (10.1%). Only 2.7% of participants were IT staff (see Figure 4.11). Other positions accounted for 15.2% of the sample: Teaching Assistant (6.1%), Full Professor (5.3%). The remaining job statistics are presented in Figure 4.12. Results indicated that 42.6% of participants were experts working in higher education in SA, making survey findings more valuable and more comprehensive when evaluating initial factors of the e-nudging model because of the experiences, skills, and knowledge of these participants.

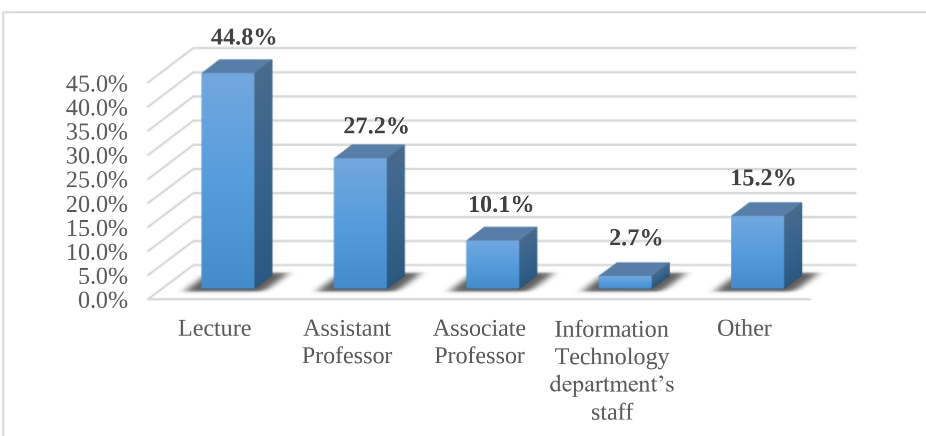


Figure 4.11: Job titles of academics and IT staff (prepared by the researcher).

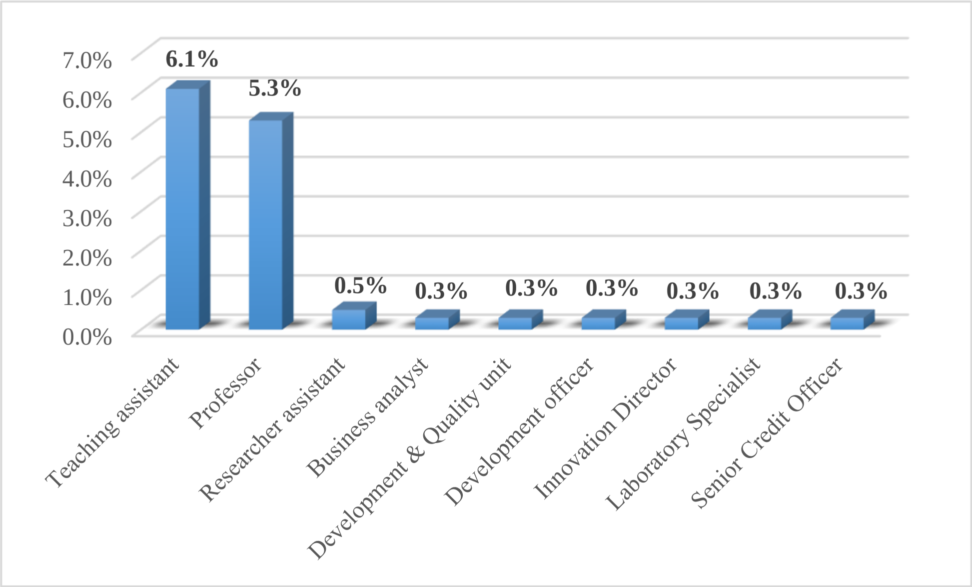


Figure 4.12: Job titles of other academics and IT staff (prepared by the researcher).

Most of the respondents were academics and IT staff who work in government universities (88.5%), whereas only 2.7% work in private universities. Participants from other education institutions such as colleges accounted for 8.8% of the sample as illustrated in Figure 4.13.

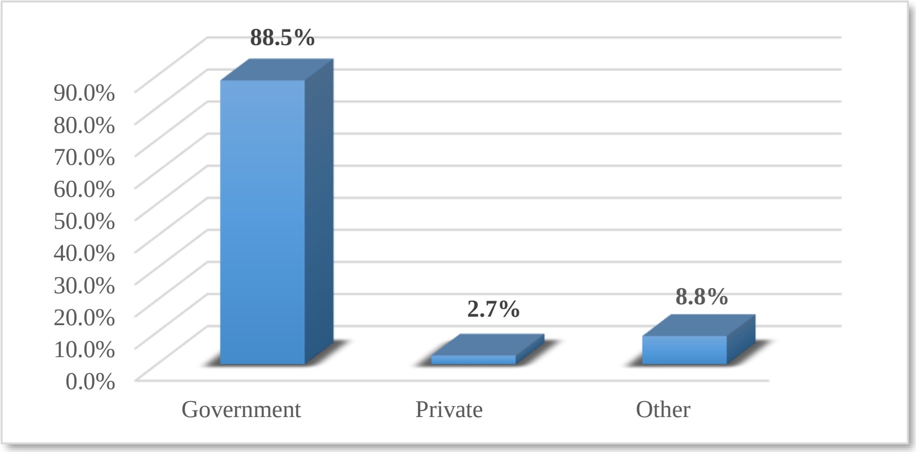


Figure 4.13: Employment sectors of academics and IT staff (prepared by the researcher).

As shown in Figure 4.14, a number of diverse fields of study are represented in the sample. The largest proportion of participants are in Health Sciences (15.2%). Computer Science and Humanities are almost equal (13.3% and 12.2% respectively). Science and

Engineering accounts for 10.9% followed by Information System at 9.3%. A relatively high number (12.8%) are from 'Other' fields.

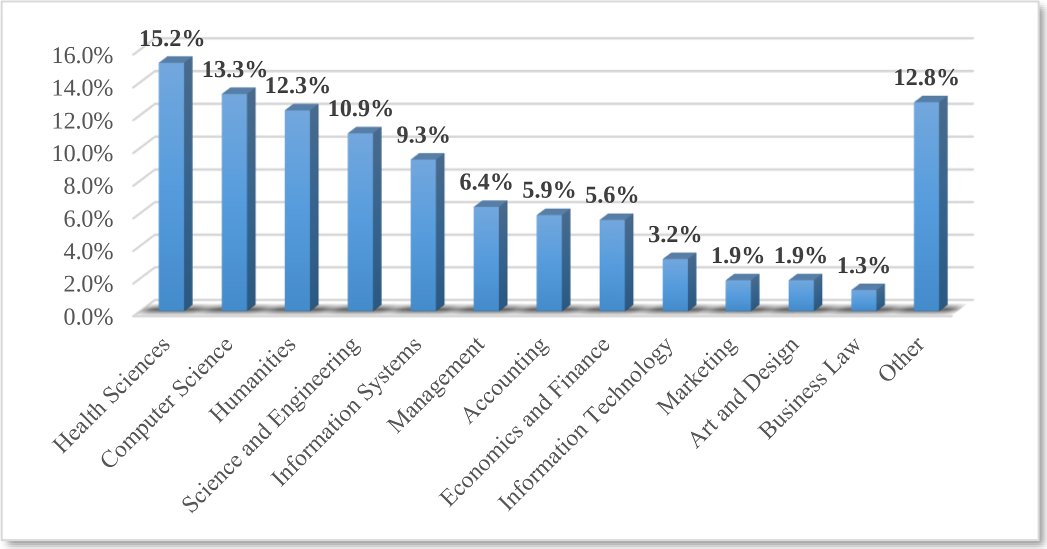


Figure 4.14. Main fields of study of academics and IT staff (prepared by the researcher).

In regard to the Learning Managements Systems in the universities, the majority (89.3%) of survey respondents use Blackboard, while Moodle is used by 6.1%. The survey results showed that other systems or applications were used in higher education, including Canvas, EvalTools, Google Classroom, Zoom, WhatsApp, Raffed, and Face to Face. The percentage for these is 4.5% as shown in Figure 4.15.

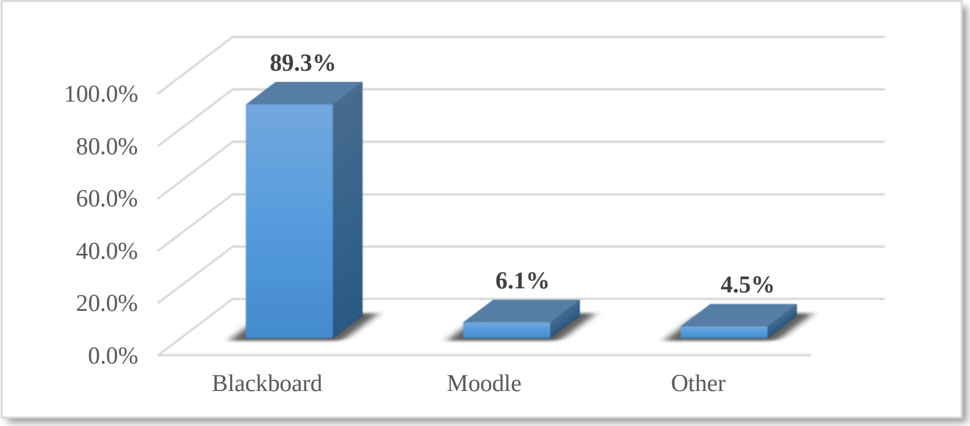


Figure 4.15: Types of LMS used by academics and IT staff (prepared by the researcher).

Participants' level of computer experience is presented in Figure 4.16. The level of computer experience of participants is between intermediate (30.7%) and advanced (47.2%). The expert level is 20.5%, while few (1.6%) are at the beginner level. This gave the researcher a general indication of the respondents' knowledge, skills and efficiency in using computers and technology. This also indicated the extent to which they feel comfortable about using computer programs.

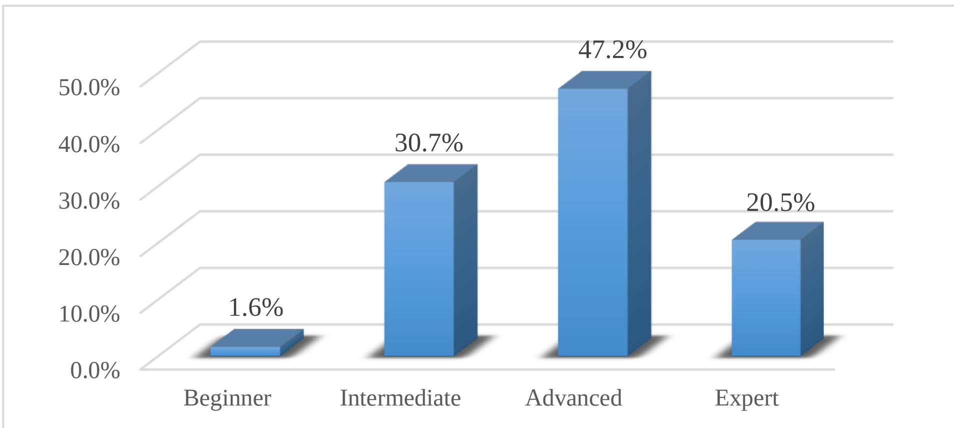


Figure 4.16: Academics and IT staff's level of computer experience (prepared by the researcher).

Participants' usage of education-related technology in their professional activities is an important component since students in higher education interact with faculties and university administration via the computer, and most courses require a certain level of computer skills. The participant usage of education-related technology ranges between high usage (45.8%) and medium usage (46.7%). There was a small percentage (7.5%) of participants with a low usage of education-related technology (see Figure 4.17). These results give the researcher an indication of the respondents' skills in regard to their efficient use of technology for education activities.

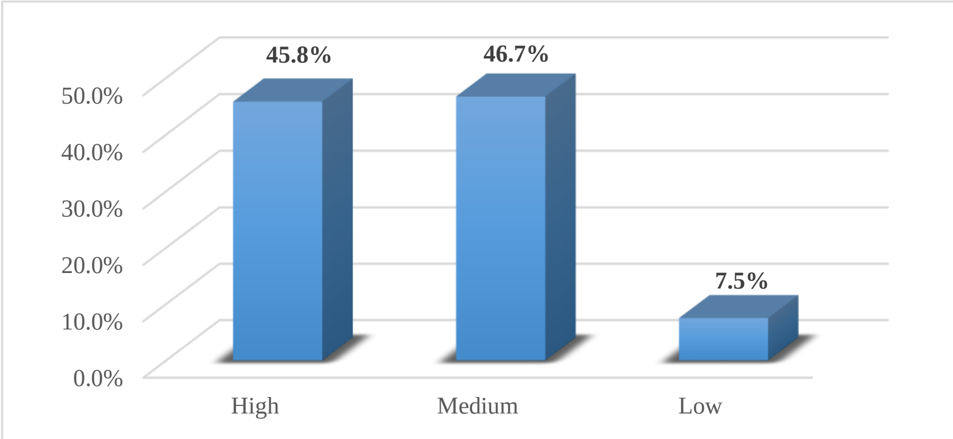


Figure 4.17: Academics and IT staff's usage of education-related technology in professional activities (prepared by the researcher).

Figure 4.18 illustrates participants' level of knowledge in regard to e-nudge techniques. These results indicate the extent to which participants are familiar with e-nudge and their ability to evaluate model factors. Approximately, half (57.3%) of the respondents have limited knowledge of e-nudge techniques. In addition, 33.3% respondents have medium knowledge, and only 9.3% have a high knowledge of e-nudge techniques.

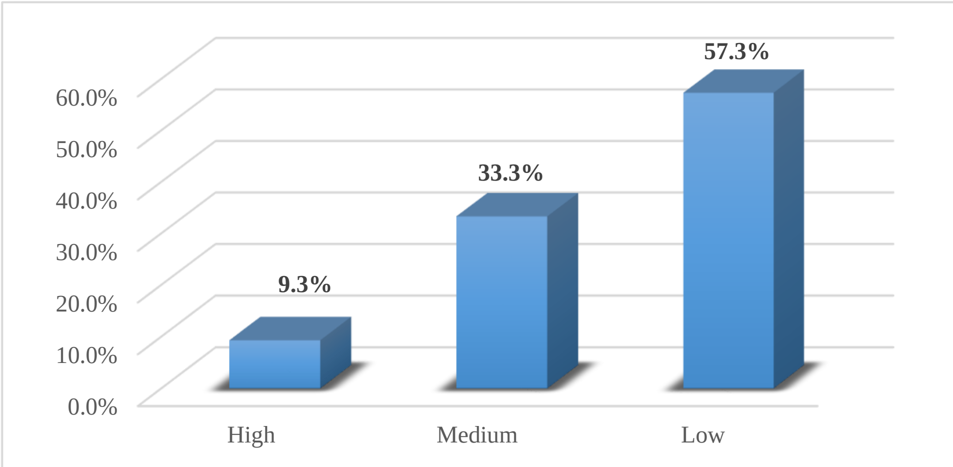


Figure 4.18 Academics and IT staff's level of knowledge of e-nudge techniques (prepared by the researcher).

The demographics information of academics and IT staff is summarized in Table 4.5

Table 4.5: Response rate and proportions for academics & IT staff demographic features (prepared by the researcher).

Demographic Feature	Respondents' options	Response rate	Proportion
Gender	Male	269	71.7%
	Female	106	28.3%
Age	24-28	35	9.3%
	29-33	117	31.2%
	34-38	95	25.3%
	39- 44	57	15.2%
	45-50	45	12.0%
	51 and above	26	6.9%
Education Level	Professional Certificate	3	0.8%
	Bachelor's Degree	37	9.9%
	Post Graduate Diploma	1	0.3%
	Master's Degree	157	41.9%
	Doctorate Degree	177	47.2%
Job Title	Lecture	168	44.8%
	Assistant Professor	102	27.2%
	Associate Professor	38	10.1%
	Information Technology department's staff	10	2.7%
	Other	57	15.2%
University Type	Government	332	88.5%
	Private	10	2.7%
	Other	33	8.8%
Main field	Health Sciences	57	15.2%
	Computer Science	50	13.3%
	Humanities	46	12.3%
	Science and Engineering	41	10.9%
	Information Systems	35	9.3%
	Management	24	6.4%

	Accounting	22	5.9%
	Economics and Finance	21	5.6%
	Information Technology	12	3.2%
	Marketing	7	1.9%
	Art and Design	7	1.9%
	Business Law	5	1.3%
	Other	48	12.8%
Learning Management System Type	Blackboard	335	89.3
	Moodle	23	6.1
	Other	17	4.5
Level of computer experience	Beginner	6	1.6%
	Intermediate	115	30.7%
	Advanced	177	47.2%
	Expert	77	20.5%
Usage of education-related technology	High	172	45.8%
	Medium	175	46.7%
	Low	28	7.5%
Level of knowledge in regard to e-nudge techniques	High	35	9.3%
	Medium	125	33.3%
	Low	215	57.3%
Total		375	100%

4.4.2 Analysis Results for e-Nudging Model Assessed by Academics and IT Staff

The initial e-nudging model was assessed by academics and IT staff in Saudi universities. The online survey items were designed to assess the initial e-nudging model and identify the specific factors that must be considered when implementing an e-nudging model for the higher education sector in SA. An e-nudging model comprises five stages with each stage containing specific factors that must be incorporated to generate a significant e-nudge model that meets higher education needs and improves students' educational decision in order to improve their academic performance.

The initial e-nudging model comprised five main stages: planning, analysis, design, implementation, testing and evaluation stages. The implementation stage is when the e-nudging is done, and the work is accomplished. This stage has one factor named "*implementing the e-nudging*". The evaluation stage aims to assess and examine the outcomes of each stage of the e-nudging model. This stage aims to provide a summative assessment for the final e-nudging intervention. However, the implementation and evaluation stages are not addressed in the survey as these stages had few variables. Moreover, the researcher was concerned that the survey items that might cause survey participants to misunderstand or confuse the design and implementation of e-nudging. Hence, these two stages (i.e., implementation and evaluation) were evaluated by the expert interviewees.

The academics and IT staff survey items assessed the factors in these stages: planning, analysis, design and testing. EFA was utilized to reduce and explore new factors in each of the e-nudging model stages.

4.4.2.1 EFA Results for the Planning Stage

The planning stage involved 33 variables (i.e., items). Table 4.6 lists the factor analysis results for this stage.

The first step was to determine whether the dataset was suitable for factor analysis by means of Kaiser-Meyer-Olkin (KMO) and Barlett's tests. The KMO score was 0.955 (marvellous), indicating adequate sampling. Barlett's test score of Sig < 0.05 was significant, indicating that the variables were significantly correlated. Therefore, factor analysis could proceed.

Then, the eigenvalue and scree test were used to determine the number of extracted factors. Table 4.6 shows five components with eigenvalues greater than 1 according to the table for total variance explained. Initially, five factors met the cut-off criterion and could possibly be retained in the e-nudging model.

The scree test produced different results. It is clear there is a break point between the first and second components. The scree test result indicated that only one component could be retained. Therefore, the researcher examined several results for two factors, three factors and four factors to explore the best structure that would provide easier interpretation with a minimum number of factors. The three rotated components represent the best solution as all the factor loadings were ≥ 0.6 for all variables in each component. The communality score was ≥ 0.4 which indicates the relationship between the variable and all other variables is good. Additionally, the internal consistency is excellent ($\alpha = 0.913$) for the first component and good ($\alpha = 0.851$ and $\alpha = 0.847$) for the second and third components respectively. The internal consistency of variables in the planning stage after factor analysis is excellent ($\alpha = 0.935$), thus meeting the established criterion (see sub-section 4.3.2). This result is easy to interpret, and each factor is labelled. Variables with high loadings were used to accurately name a factor. Table 4.7 lists the labels of the new factors for the "Planning Stage". The generated factors are named "Mapping the decision process", "e-nudging goals" and "e-nudge constraints".

Table 4.6: EFA Results for "Planning Stage" (prepared by the researcher).

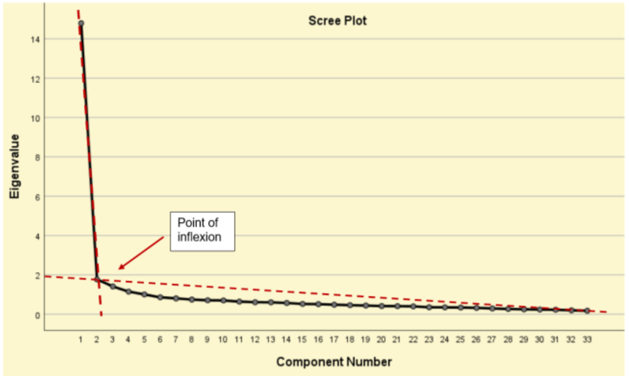
Planning Stage

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.790	44.818	44.818	14.790	44.818	44.818	4.984	15.103	15.103
2	1.771	5.365	50.183	1.771	5.365	50.183	4.941	14.972	30.075
3	1.411	4.276	54.459	1.411	4.276	54.459	4.802	14.551	44.625
4	1.148	3.479	57.938	1.148					
5	1.004	3.044	60.982	1.004					
6	0.859	2.602	63.583						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.955
Bartlett's Test of Sphericity	Approx. Chi-Square	7434.120
	df	528
	Sig.	0.000



Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading			Communalities
	1	2	3	
To communicate easily how e-nudging should be designed in LMS.	0.715			**0.596**
Understand education's barriers in LMS.	0.712			**0.612**
Identify the barriers that influence students' educational decision in LMS.	0.701			**0.614**
Identify the education-related barriers that prevent student from complete education task via LMS.	0.688			**0.568**
Determine the e-nudging actions that students need in order to complete an education task via LMS.	0.649			**0.546**
Determine when e-nudging could influence students to complete an education task via LMS.	0.649			**0.543**
Provide a complete visual overview showing how education's barriers influence students' educational decision-making in LMS.	0.642			**0.508**
Understand the type of e-nudging technique that could encourage students to complete education tasks via LMS.	0.624			**0.567**
Assist the designer to focus on students' needs in terms of using a LMS.	0.612			**0.484**
Understand where e-nudging could be located to encourage student to complete education task via a LMS.	0.607			**0.507**
Understand students' educational decisions in relation to the e-nudging goals.		0.721		**0.575**
Understand what the e-nudging is trying to achieve.		0.709		**0.544**
Ensure that the right team is responsible for the development of an e-nudging model.		0.69		**0.6**
Monitor the developmental stages of an e-nudging model.		0.683		**0.58**
Understand how students make their educational decisions via LMS.		0.619		**0.575**
Make effective decisions during the development of the e-nudging model.		0.611		**0.542**
Understand the cultural constraints influencing the development of an e-nudging model.			0.769	**0.677**
Understand the ethical constraints influencing the development of an e-nudging model.			0.686	**0.616**
Understand the time constraint influencing the development of an e-nudging model.			0.675	**0.646**
Understand the government constraints influencing the development of an e-nudging model.			0.667	**0.607**
Cronbach's Alpha	**0.913**	**0.851**	**0.847**	

Planning Stage internal Consistency

Cronbach's Alpha	**0.935**

Table 4.7: New factor labels for "Planning Stage" (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for planning Stage	Factor loading
Decision Mapping process	The variables in this factor are related to the mapping of the decision process. The first two variables enable the designer to easily understand how e-nudging should be designed in LMS and understand the educational barriers to select effective e-nudging. The third and fourth variables focus on identifying all barriers and factors that may influence the students' decision outcome. The fifth, sixth and seventh variables concentrated on when and for whom the e-nudge action is taken in order to improve students' decisions. The last three variables are related to where e-nudge should occur and the type of e-nudging that could encourage students to complete academic tasks via LMS. In general, these variables focus on understanding student decision-making, how the design can influence the success of e-nudging, and when and where the e-nudging could influence students' academic-related decisions. All these tasks are undertaken when the designer is creating the mapping for educational decisions-making.	Mapping the decision process with barriers	To communicate easily how e-nudging should be designed in LMS.	0.715
		Mapping the decision process with barriers	Understand education's barriers in LMS.	0.712
		Determine barriers and influences	Identify the barriers that influence students' educational decision in LMS.	0.701
		Determine barriers and influences	Identify the education-related barriers that prevent student from complete education task via LMS.	0.688
		Mapping the decision process with barriers:	Determine the e-nudging actions that students need in order to complete an education task via LMS.	0.649
		Mapping the decision process with barriers	Determine when e-nudging could influence students to complete an education task via LMS.	0.649
		Mapping the decision process with barriers	Provide a complete visual overview showing how education's barriers influence students' educational decision-making in (LMS).	0.642
		Understand the decision-making process	Understand the type of e-nudging that could encourage students to complete education tasks via LMS.	0.624
		Determine barriers and influences	Assist the designer to focus on students' needs in terms of using an LMS.	0.612

		Understand the decision-making process	Understand where e-nudging could be located to encourage student to complete education task via an LMS.	0.607
e-nudging goals	The variables in this factor relate to defining e-nudging goals. The variables concentrate on understanding what e-nudge tries to achieve, understanding students' educational decisions that could be influenced by e-nudging. When e-nudge goals are identified, it is easy to choose the correct development team and monitor their progress.	Define e-nudging model goals	Understand students' educational decisions in relation to the e-nudging goals.	0.721
		Define e-nudging model goals	Understand what the e-nudging is trying to achieve.	0.709
		Define e-nudging model goals	Ensure that the right team is responsible for the development of an e-nudging model.	0.69
		Define e-nudging model goals	Monitor the developmental stages of an e-nudging model.	0.683
		Understand the decision-making process	Understand how students make their educational decisions via LMS.	0.619
		Define e-nudging model goals	Make effective decisions during the development of the e-nudging model.	0.611
e-nudging constraints	The variables that loaded onto this factor concerned various constraints that should be considered when developing the e-nudge model.	Identify constraints	Understand the cultural constraints influencing the development of an e-nudging model.	0.677
		Identify constraints	Understand the ethical constraints influencing the development of an e-.nudging model	0.616
		Identify constraints	Understand the time constraint influencing the development of an e-nudging model.	0.646
		Identify constraints	Understand the government constraints influencing the development of an e-nudging model.	0.607

4.4.2.2 Results of EFA for Analysis Stage

The second part of the e-nudging model involved the analysis of eleven variables. Table 4.8 shows the EFA results.

The dataset is suitable for factor analysis according to Kaiser-Meyer-Olkin (KMO) and Barlett's test results. The KMO value is marvellous because the score = 0.909. This score indicates adequate sampling. Barlett's test result is Sig < 0.0 5 indicating that the variables are significantly correlated. Then the number of extracted factors was determined means of eigenvalues and a scree test. Table 4.8 shows that two components have eigenvalues greater than 1 as shown by the total variance explained. Initially, two factors met the cut-off criterion and could possibly be retained in the e-nudging model. The scree test curve flattens after two components (Table 4.8). The scree test shows two components to be retained. Therefore, the researcher examined these two factors to determine whether they will provide the best structure.

The result of the rotation of these two components showed that each had an adequate number of variables with factor loadings ≥ 0.6, and a communality score ≥ 0.4 which indicates a good relationship between the variables. Moreover, the internal consistency after factor analysis is good (α = 0.879). The internal consistency for both components is good with α = 0.834 and α = 0.84, respectively. These results meet the research criteria (see sub-section 4.3.2). The two factors were labelled, and the result are easy to interpret. Again, the labels of factors were determined by the variables with the highest loadings. Table 4.9 lists the labels for new factors derived from the Analysis Stage. The first generated factor is labelled “e-nudging techniques”; the second factor is named “optimal e-nudging moment”.

Table 4.8: EFA results for Analysis Stage (prepared by the researcher).

Analysis Stage

Total Variance Explained

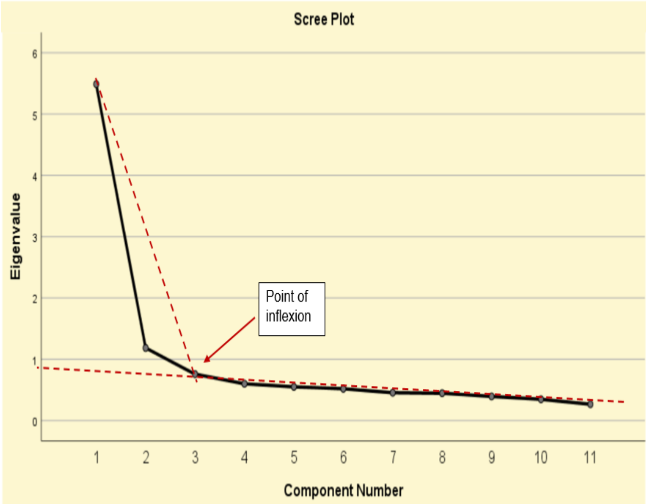
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.489	49.898	49.898	5.489	49.898	49.898	3.517	31.972	31.972
2	1.184	10.766	60.665	1.184	10.766	60.665	3.156	28.693	60.665
3	0.756	6.876	67.540						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.909
Bartlett's Test of Sphericity	Approx. Chi-Square	1882.487
	df	55
	Sig.	0

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading		Communalities
	1	2	
Identify e-nudging techniques that can effectively reduce the influence of identified education barriers on students' decisions in an LMS.	0.79		**0.65**
Identify e-nudging techniques that work with choices offered in the students' interface in a LMS.	0.786		**0.657**
Evaluate e-nudging techniques according to their location in decision mapping (i.e. nudging a student to recognize the importance of an education task is much important than nudging the student	0.717		**0.564**
Identify the choices in the students' interface that should be influenced by e-nudging in LMS.	0.714		**0.575**
Select all suitable e-nudging techniques that meet constraints.	0.6		**0.525**
Identify the nudge moment that should occur during action.		0.815	**0.713**
Identify the nudge moment that should occur after action.		0.801	**0.679**
Identify the nudge moment that should occur before action.		0.756	**0.658**
Identify how often a student needs to be nudged to complete each education task via LMS.		0.734	**0.627**
Cronbach's Alpha	**0.834**	**0.84**	



Analysis Stage internal Consistency

Cronbach's Alpha	**0.879**

Table 4.9: New factor labels for Analysis Stage (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Analysis Stage	Factor loading
e-nudging techniques	All variables relate to the selection of the best e-nudging techniques that can influence students' decision-making	The selection of an e-nudging methods	Identify e-nudging techniques that can effectively reduce the influence of identified education barriers on students' decisions in an LMS.	0.79
		The selection of an e-nudging methods	Identify e-nudging techniques that work with choices offered in the students' interface in an LMS.	0.786
		The selection of an e-nudging methods	Evaluate e-nudging techniques according to their location in decision mapping (i.e., nudging a student to recognize the importance of an education task is much important than nudging the student	0.717
		The selection of an e-nudging methods	Identify the choices in the students' interface that should be influenced by e-nudging in LMS.	0.714
		The selection of an e-nudging methods	Select all suitable e-nudging techniques that meet constraints.	0.6
optimal e-nudging moment	The variables in this factor relate to the best time for e-nudging to occur so that it is effective.	Identifying the optimal e-nudging moment	Identify the nudge moment that should occur during action.	0.815
		Identifying the optimal e-nudging moment	Identify the nudge moment that should occur after action.	0.801
		Identifying the optimal e-nudging moment	Identify the nudge moment that should occur before action.	0.756
		Identifying the optimal e-nudging moment	Identify how often a student needs to be nudged to complete each education task via LMS.	0.734

4.4.2.3 EFA Results for the Design Stage

The design stage is the third component of the e-nudging model. This stage comprises 33 variables analysed by means of EFA. Table 4.10 presents the EFA results.

The results obtained by the Kaiser-Meyer-Olkin (KMO) and Barlett's tests indicate that the dataset is suitable for analysis. The KMO result is 'marvellous'; the 0.959 score indicates sampling adequacy. Barlett's test score is significant (Sig < 0.05) and indicates a strong correlation of variables.

Table 4.10 for total variance explained shows that five factors have an eigenvalue greater than one. Hence, these five initial factors meet the minimum accepted value and could possibly be retained in the e-nudging model. However, the number of factors extracted by the scree test is different. According to the graph, only one component is above the "elbow" break point, indicating that it can be retained. Therefore, several experiments were conducted that included two factors, three factors and four factors to determine the number of factors that could provide a clear structure with a minimum number of factors.

The result of the rotation of these three components showed that each had an adequate number of variables with factor loadings equal to or above 0.6. The communality value exceeds 0.4 which indicates a good relationship between one variable and all other variables. Moreover, the factor analysis result for the internal consistency is excellent ($\alpha = 0.948$). The internal consistency of the first and third components is excellent ($\alpha = 0.920$) and ($\alpha = 0.912$) respectively. The Cronbach's result is $\alpha = 0.894$, which is a good score for internal consistency. This result met the research criterion (see sub-section 4.3.2).

The three factors were labelled, and the results were easy to interpret. The variables with the highest loadings were used to determine the labels of factors. Table 4.11 lists the extracted new factors for the Design Stage. The three generated factors were labelled "usability", "HCI" and "e-nudging prototype".

Table 4.10: EFA results for Design Stage (prepared by the researcher).

Design Stage

Total Variance Explained

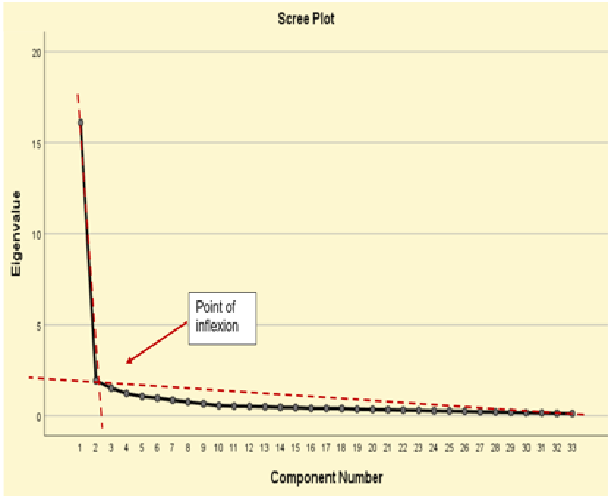
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.110	48.820	48.820	16.110	48.820	48.820	4.696	14.230	14.230
2	1.933	5.856	54.676	1.933	5.856	54.676	4.632	14.037	28.267
3	1.519	4.603	59.279	1.519	4.603	59.279	4.630	14.030	42.297
4	1.225	3.711	62.990	1.225	3.711	62.990	4.376	13.260	55.557
5	1.059	3.209	66.199	1.059	3.209	66.199	3.512	10.642	66.199
6	0.972	2.947	69.146						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.956
Bartlett's Test of Sphericity	Approx. Chi-Square	9273.829
	df	528
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading			Communalities
	1	2	3	
Easy to use.	0.782			0.519
Easy to learn.	0.748			0.686
Efficient.	0.739			0.715
Safe.	0.686			0.616
Effective.	0.674			0.637
Easy to remember.	0.669			0.569
Useful.	0.656			0.632
Evaluate how e-nudging will appear among other elements in the students' interface in LMS.		0.711		0.664
Access how e-nudging design is influence by the types of choices offered in the students' interface in LMS.		0.71		0.619
Save time during the development of an e-nudging model.		0.679		0.562
Provide a clear idea about the final design of the e-nudging model.		0.678		0.648
Determine the form of an e-nudging intervention (i.e. vibration, SMS text, prompt on students' interface).		0.668		0.563
Focus on important interface elements in LMS.		0.657		0.575
Has a suitable text style.			0.817	0.746
Has an appropriate font size.			0.817	0.779
Has suitable page layout.			0.717	0.757
Has appropriate graphics.			0.662	0.666
Has suitable colour.			0.617	0.624
Cronbach's Alpha	**0.920**	**0.894**	**0.912**	



Design Stage internal Consistency	
Cronbach's Alpha	0.948

Table 4.11: New factor labels for Design Stage (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Design Stage	Factor loading
Usability	All variables measured the usability for students' interface and these elements should be considered when designing an e-nudge model	Usability	Easy to use.	0.782
		Usability	Easy to learn.	0.748
		Usability	Efficient.	0.739
		Usability	Safe.	0.686
		Usability	Effective.	0.674
		Usability	Easy to remember.	0.669
		Usability	Useful.	0.656
e-nudging prototype	The variables focus on the design prototype for the e-nudging in order to assess and evaluate the effectiveness of e-nudging before final design.	Design e-nudging prototype	Evaluate how e-nudging will appear among other elements in the students' interface in LMS.	0.711
		Design e-nudging prototype	Access how e-nudging design is influenced by the types of choices offered in the students' interface in LMS.	0.71
		Design e-nudging prototype	Save time during the development of an e-nudging model.	0.679

		Design e-nudging prototype	Provide a clear idea about the final design of the e-nudging model.	0.678
		Design e-nudging prototype	Determine the form of an e-nudging intervention (i.e., vibration, SMS text, prompt on students' interface).	0.668
		Design e-nudging prototype	Focus on important interface elements in LMS.	0.657
HCI	All variables evaluated the HCI for students' interface and these elements should be considered when designing an e-nudge model	HCI	Has a suitable text style.	0.817
		HCI	Has an appropriate font size.	0.817
		HCI	Has suitable page layout.	0.717
		HCI	Has appropriate graphics.	0.662
		HCI	Has suitable colour.	0.617
		HCI	Has a suitable text style.	0.817

4.4.2.4 EFA Results for the Test Stage

The last part of the e-nudging model is the Test Stage. There are ten variables in this stage. Table 4.12 lists the EFA results for this stage.

The dataset is suitable for factor analysis according to the Kaiser-Meyer-Olkin (KMO) and Barlett's test results. There is adequate sampling since the KMO score is 0.9 (marvellous). The variables are significantly correlated because Barlett's test result is Sig < 0.05.

Then, the number of extracted factors is determined by using two techniques: eigenvalues and the scree test. There is one component with eigenvalues greater than 1 as shown in Table 4.12. The first test produced one factor that met the criterion and could be retained in the e-nudging model. It is clear that the scree curve flattens after two components (graph in Table 4.12). Two components from the scree test could possibly be retained. Therefore, the researcher examined these two factors to determine whether they would provide the best structure with the fewest factors making it easy to interpret.

The final result of the two rotated components is excellent as each component obtained a sufficient number of variables with factor loading ≥ 0.6, the communality score ≥ 0.4 which shows that the relationship between one variable and all other variables is good. Moreover, for the test stage, factor analysis showed that the internal consistency is excellent ($\alpha = 0.906$). The internal consistency for both components is good ($\alpha = 0.869$ and $\alpha = 0.891$ respectively). This result met the minimum accepted value established for this research (see sub-section 4.3.2). The two factors were labelled, and the results were easy to interpret. Table 4.13 lists the new factor labels for "Test Stage". The first factor is called "Environmental Influence". The second factor is labelled "Test e-nudging".

Table 4.12: EFA's results for Test Stage (prepared by the researcher).

Test Stage

Total Variance Explained

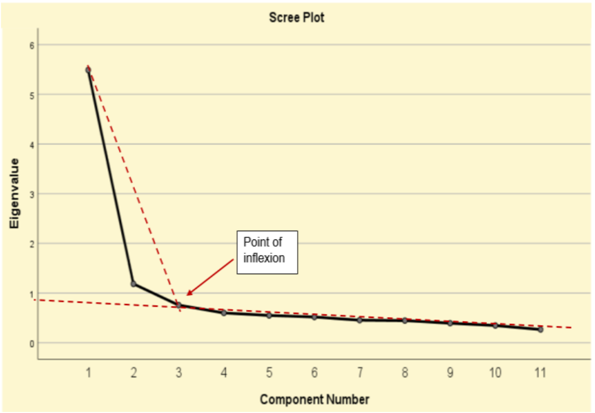
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.826	58.260	58.260	5.826	58.260	58.260	3.558		35.578
2	0.948	9.483	67.744	0.948	9.483	67.744	3.217		67.744
3	0.721	7.212	74.956						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.900
Bartlett's Test of Sphericity	Approx. Chi-Square	2346.0142
	df	45
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading		Communalities
	1	2	
Consider factors in the students' environment that may affect e-nudging' development.	0.845		**0.782**
Consider the influence of environmental changes on e-nudging development.	0.827		**0.725**
Consider changes in smart technologies that may impact on e-nudging development.	0.73		**0.642**
Obtain students' feedback by using a learning management system (LMS) with e-nudging.	0.644		**0.57**
Detect any errors during the development of the e-nudging model.	0.634		**0.546**
Measure the e-nudging delivery method on students' behaviour in real life.		0.852	**0.807**
Measure the impact of e-nudging on students' behaviour in real life.		0.85	**0.799**
Determine the optimal moment for e-nudging in terms of its impact on students' behaviour in real life.		0.813	**0.766**
Cronbach's Alpha	**0.869**	**0.891**	



Analysis Stage internal Consistency

Cronbach's Alpha	**0.906**

Table 4.13: New factor labels for Test Stage (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Test Stage	Factor loading
Environmental Influence	All the first three variables are related to environmental change and how it affects e-nudging development. The fourth variable focuses on student feedback. The last variable relates to the importance of the test stage.	Environment and Technology changing	Consider factors in the students' environment that may affect e-nudging' development.	0.845
		Environment and Technology changing	Consider the influence of environmental changes on e-nudging development.	0.827
		Environment and Technology changing	Consider changes in smart technologies that may impact on e-nudging development.	0.73
		Test nudging impact	Obtain students' feedback by using a learning management system (LMS) with e-nudging.	0.644
		Test usability	Detect any errors during the development of the e-nudging model.	0.634
Test e-nudge	The variables concentrate on test e-nudging on students' behaviour in real life by measuring delivery method, impact and optimal time for e-nudging	Test the delivery method of digital nudge	Measure the effect of the e-nudging delivery method on students' behaviour in real life.	0.852
		Test nudging impact	Measure the impact of e-nudging on students' behaviour in real life.	0.85
		Test the optimal moment	Determine the optimal moment for e-nudging in terms of its impact on students' behaviour in real life.	0.813

4.4.3 Analysis Results for Perceptions of Academics and IT Staff Regarding e-Nudging Implementation in Higher Education

This section is the third section in the survey. It aims to discover the perception and opinions of university academics and IT staff regarding the implementation of an e-nudging in SA's higher education sector. EFA was conducted to elicit and explore the most important data. The PCA was utilized for factor extraction method together with the orthogonal rotation method and the Varimax technique. This section comprised 29 variables. Results of analysis are given below in Table 4.14.

The first step was to check the suitability of the dataset for factor analysis by means of the Kaiser-Meyer-Olkin (KMO) and Barlett's tests. The KMO score was 0.957, considered marvellous. This value showed that sampling is adequate. Barlett's test score is Sig < 0.05. This meant that the variables were significantly correlated. Therefore, factor analysis could proceed. Then, the eigenvalue and scree test techniques were applied to determine the number of extracted factors. Table 4.14 shows that three components have eigenvalues >1, according to the total variance explained. Initially, three factors met the cut-off criterion and could be retained.

However, the scree test produced different results, as only two components were above break point, and could be retained. Therefore, several experiments were conducted that included two factors and three factors to determine how many factors could provide a clear structure with the fewest factors. Unfortunately, the results of two and three factors were not clear-cut. Therefore, the researcher examined factor results for four factors and five factors to obtain a clear structure with a fewer number of factors.

The three rotated components represent the best result since the number of variables in each component are appropriate and all factor loadings were equal to or above 0.6, the communality values exceeded 0.4, indicating a good relation between a variable and all other variables. Moreover, factor analysis showed the internal consistency for the section is excellent ($\alpha = 0.96$). The internal consistency for the first and second components are excellent ($\alpha = 0.951$ and $\alpha = 0.939$ respectively. The third and fourth components internal consistency $\alpha = 0.876$ and $\alpha = 0.879$ respectively.

This result indicates good internal consistency. This result was minimum accepted value for this research (see sub-section 4.3.2). The four factors were labelled, and the results were easy to interpret. The factors were named according to the variables with the highest loadings. Table 4.15 lists the extracted new factors for "perceptions of university academics and IT staff about implementing e-nudging in higher education". There are four features of the e-nudging that the majority of academics and IT staff consider important. They understand that e-nudging is intended to encourage and motivate students to improve their academic performance. In addition, they indicate that usability and HCI features are important for students' e-nudging interface and should be considered prior to implementing an e-nudging in higher education.

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Table 4.14: EFA's Results for "Academic and IT Staff's perception of implementing e-nudging in higher education" (prepared by the researcher).

Academics and IT Staff's Perception

Total Variance Explained

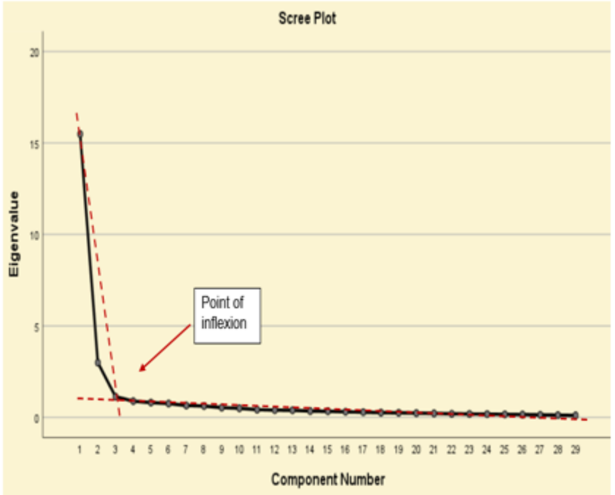
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.485	53.395	53.395	15.485	53.395	53.395	8.227	28.370	28.370
2	2.988	10.305	63.701	2.988	10.305	63.701	5.912	20.386	48.755
3	1.128	3.890	67.591	1.128	3.890	67.591	5.462	18.836	67.591
4	0.884	3.049	70.640	0.884	3.049	70.640	3.373	11.631	70.640

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.957
Bartlett's Test of Sphericity	Approx. Chi-Square	9845.054
	df	406
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading				Communalities
	1	2	3	4	
Efficient.	0.801				0.778
Effective.	0.761				0.718
Useful.	0.75				0.71
Easy to learn.	0.748				0.757
Practical.	0.745				0.768
Easy to use.	0.716				0.722
Easy to remember.	0.702				0.708
Safe.	0.689				0.641
Easy to see.	0.673				0.682
Easy to evaluate.	0.661				0.672
Color is suitable.		0.788			0.809
Font size is suitable.		0.777			0.783
Text style is suitable		0.74			0.721
Layout of the pages is suitable.		0.716			0.775
Graphics are appropriate.		0.668			0.745
Elements of a site are easy to find in the students' interface.		0.653			0.749
Encourage students to remember their educational tasks.			0.803		0.778
Encourage students to complete their educational tasks on time.			0.737		0.764
Encourage students to manage their educational tasks.			0.677		0.725
Motivate students to continue studying.				0.838	0.811
Motivate students to complete their course.				0.794	0.762
Improve student's confidence to make a better educational decisions.				0.717	0.702
Cronbach's Alpha	**0.951**	**0.939**	**0.876**	**0.879**	



Perceptions and attitudes of university academics internal Consistency

Cronbach's Alpha	**0.96**

Table 4.15: New factor labels for "Academic and IT Staff's perception of implementing e-nudging in higher education" (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Test Stage	Factor loading
Usability	Most of variables assessed the usability of the students' interface and Academics and IT staff considered several features that should be included in the model design.	The students' e-nudging interface should be	Efficient.	0.801
		The students' e-nudging interface should be	Effective.	0.761
		The students' e-nudging interface should be	Useful.	0.75
		The students' e-nudging interface should be	Easy to learn.	0.748
		The students' e-nudging interface should be	Practical.	0.745
		The students' e-nudging interface should be	Easy to use.	0.716
		The students' e-nudging interface should be	Easy to remember.	0.702
		The students' e-nudging interface should be	Safe.	0.689
		The students' e-nudging interface should be	Easy to see.	0.673
		The students' e-nudging interface should be	Easy to evaluate	0.661
HCI	The majority of variables assessed the HCI features of a students' interface. Academics and IT staff consider these features	The students' e-nudging interface should be	Colour is suitable.	0.788
		The students' e-nudging interface should be	Font size is suitable.	0.777
		The students' e-nudging interface should be	Text style is suitable.	0.74
		The students' e-nudging interface should be	Layout of the pages is suitable.	0.716

	important and should be available when applying e-nudge in higher education	The students’ e-nudging interface should be	Graphics are appropriate.	0.668
		The students’ e-nudging interface should be	Elements of a site are easy to find in the students’ interface.	0.653
Student encouragement	All variables concentrate on e-nudging and should encourage students by assisting them to remember, complete and manage educational tasks.	The implementation of an e-nudging model in SA’s higher education sector is intended to	Encourage students to remember their educational tasks.	0.803
		The implementation of an e-nudging model in SA’s higher education sector is intended to	Encourage students to complete their educational tasks on time.	0.737
		The implementation of an e-nudging model in SA’s higher education sector is intended to	Encourage students to manage their educational tasks.	0.677
Student motivation	Variables in this factor concern e-nudging as a means of motivating students to persist with their courses and be confident to make better decisions.	The implementation of an e-nudging model in SA’s higher education sector is intended to	Motivate students to continue studying.	0.838
		The implementation of an e-nudging model in SA’s higher education sector is intended to	Motivate students to complete their course.	0.794
		The implementation of an e-nudging model in SA’s higher education sector is intended to	Improve student’s confidence to make a better educational decision.	0.717

4.4.4 Analysis Results for Academics and IT Staff Assessments of e-Nudging Techniques

The last section of the academics and IT staff survey was intended to determine whether the e-nudging model would meet university students' requirements in university. Four digital nudging interventions (feedback, reminder, peer comparison, and reduced distance) are proposed to steer students' decision-making. The survey items were intended to determine the best design method for intervention via the LMS.

EFA was conducted to find the intervention method preferred by academics and IT staff. The PCA extraction method and orthogonal rotation were applied with the Varimax technique. This section of the survey contained eleven variables. Results of the analysis are given below in Table 4.16.

The dataset was deemed suitable for factor analysis given the results obtained by the Kaiser-Meyer-Olkin (KMO) test and Barlett's test of sphericity. The KMO score is meritorious as the score was 0.845, indicating sample adequacy. The variables are significantly correlated as indicated by the Barlett's test score (Sig < 0.05).

The researcher used eigenvalues and a scree test to determine the number of extracted factors. Table 4.16 shows that three components have eigenvalues >1 for the total variance explained. Initially, three factors met the cut-off criterion and could be retained. The scree test also showed three components above the break point. Hence, three factors could be retained. Therefore, the results for the three factors were examined to determine whether they would provide a comprehensible structure with fewer factors.

The three rotated components represent a great result since the number of variables in each component are appropriate and all factor loadings are equal to or above 0.6. The commonality values are over 0.4 which indicates a good relationship between a variable and all other variables. Moreover, internal consistency is good ($\alpha = 0.866$). The internal consistency of all factors is good ($\alpha = 0.830$, $\alpha = 0.871$ and $\alpha = 0.830$) respectively. The internal consistency of the third and fourth components is good ($\alpha = 0.876$ and $\alpha = 0.879$ respectively). The results met the minimum accepted value for this research.

The results were easy to interpret and the three factors were labelled based on variables with the higher loadings. Table 4.17 lists the extracted new factors for “Assessment of e-nudging techniques by academics and IT staff”. Academics and IT staff suggested three main intervention channels: LMS, SMS and e-mail.

Table 4.16: EFA results "Assessment of e-nudging techniques by academics and IT staff" (prepared by the researcher).

Assess e-Nudging Techniques by Academics and IT Staff

Total Variance Explained

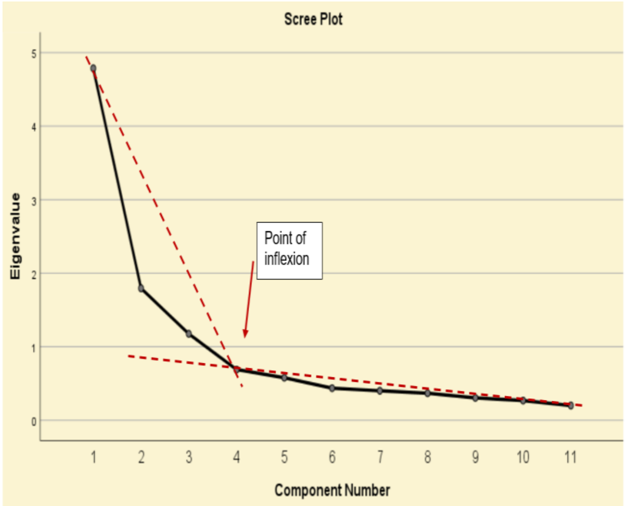
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.786	43.513	43.513	4.786	43.513	43.513	2.891	26.286	26.286
2	1.795	16.315	59.828	1.795	16.315	59.828	2.480	22.543	48.829
3	1.176	10.687	70.514	1.176	10.687	70.514	2.385	21.686	70.514
4	0.690	6.269	76.783						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.845
Bartlett's Test of Sphericity	Approx. Chi-Square	2021.591
	df	55.000
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading			Communalities
	1	2	3	
It is better to receive a reminder about education tasks by: - Receiving an electronic reminder via the students' interface in LMS.	0.828			**0.695**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Receiving an electronic notification via the students' interface in LMS.	0.783			**0.656**
It is better to receive a reminder about education tasks by: - My teachers posting announcements in LMS.	0.749			**0.624**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Teachers posting an announcement in LMS.	0.645			**0.634**
It is better to receive a feedback about my performance in relation to classmates by: - The teacher posting feedback privately in LMS.	0.635			**0.502**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Receiving an SMS on my phone.		0.895		**0.843**
It is better to receive a feedback about my performance in relation to classmates by: - Getting an SMS sent to my phone.		0.88		**0.829**
It is better to receive a reminder about education tasks by: - Receiving an SMS on my phone.		0.814		**0.719**
It is better to receive a feedback about my performance in relation to classmates by: - Email sent to me by the teacher.			0.83	**0.768**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Email sent to me by the teacher.			0.802	**0.78**
It is better to receive a reminder about education tasks by: - A reminder email sent to me by the teachers.			0.789	**0.707**
Cronbach's Alpha	**0.830**	**0.871**	**0.830**	



Assess e-Nudging Techniques by Academics and IT Staff internal Consistency

Cronbach's Alpha	**0.866**

Table 4.17: New factor labels for "Assessment of e-nudging techniques by academics and IT staff" (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Test Stage	Factor loading
Receive e-nudging technique via LMS	All variables focused on channels for all four e-nudging interventions through the students' interface in LMS. There are two ways to receive e-nudging: electronic intervention or teachers posting announcements in LMS	receive a reminder about education tasks	It is better to receive a reminder about education tasks via an electronic reminder via the students' interface in LMS.	0.828
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an electronic notification via the students' interface in LMS.	0.783
		receive a reminder about education tasks	It is better to receive a reminder about education tasks via teachers posting announcements in LMS.	0.749
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an announcement posted by teachers in LMS.	0.645
		receive feedback about my performance in relation to classmates	It is better to receive feedback about my performance in relation to classmates via the teacher posting feedback privately in LMS.	0.635
	All variable concentrate on	receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an SMS on my phone.	0.895

Receive e-nudging technique via SMS	receiving all four e-nudging interventions through the SMS on students' phone	receive feedback about my performance in relation to classmates	It is better to receive feedback about my performance in relation to classmates via an SMS sent to my phone.	0.88
		receive a reminder about education tasks	It is better to receive a reminder about education tasks via an SMS on my phone.	0.814
Receive e-nudging technique via Email	All variables focus on receiving all four e-nudging interventions through SMS on students' phone	receive feedback about my performance in relation to classmates	It is better to receive feedback about my performance in relation to my peers' performance via email sent to me by the teacher.	0.83
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via sent to me by the teacher.	0.802
		receive a reminder about education tasks	It is better to receive a reminder about education tasks via a reminder email sent to me by the teachers.	0.789

4.4.5 Analysis Results for Academics and IT Staff Comments

The academics and IT staff survey contained two open-ended questions. The main purpose of these was to give participants the opportunity to express opinions that could be extreme, unexpected, or might not have been thought of by the researcher when developing the survey items. Open-ended questions can increase dataset diversity and provide rich and relevant research information (Albudaiwi, 2017; Hyman & Sierra, 2016).

The comments text was analysed using word cloud via NVivo 1.0 software. The word cloud is a visualization method that gives an overview of the words that appear most frequently in a text (i.e. words with the highest frequency) (Heimerl, Lohmann, Lange, & Ertl, 2014).

The first open-ended question gave respondents the opportunity to suggest other factors that might facilitate or influence the e-nudging model. The number of academics and IT staff comments was 31. The word cloud for these comments is illustrated in Figure 4.19. The academics and IT staff recommend that training and support for both instructors and student must be included in an e-nudging model. Also, increasing the awareness of e-nudge is another factor that needs to be considered when designing an e-nudging model for the higher education sector in SA.

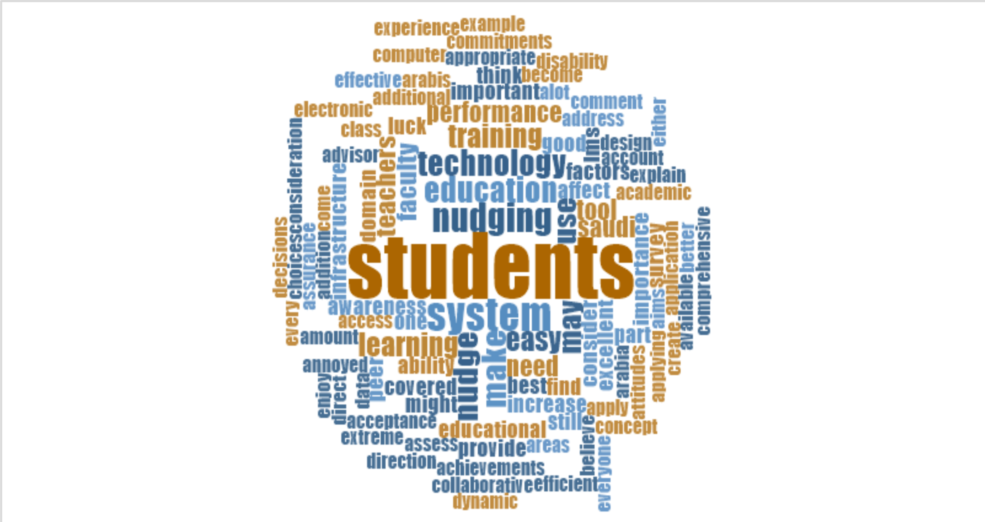


Figure 4.19: Word cloud result based on academics and IT staff regarding e-nudging model factors (prepared by the researcher).

The second open-ended question in the academic and IT staff survey gave respondents the opportunity to express their opinions and thoughts regarding the implementation of an e-nudging. Only five comments were made, making a word cloud unsuitable. The comments emphasised that an e-nudging system should be easy to use. Also, respondents suggested that e-nudging should contain a feature that encourages students to visit the academic advisor regularly. Finally, both students and instructors should have adequate training if e-nudge is to succeed.

4.5 Analysis Results for Student Surveys

This section presents the analysis of valid responses (*n=408)* collected from students. Descriptive statistics were used for the sections on demographics information and education barriers. Exploratory Factor Analyses (EFA) was applied to sections on the perception of implementing e-nudging in higher education, and e-nudging techniques. The following subsections present the data analysis for each section of the students' online survey.

4.5.1 Demographic Profiles of Student Respondents

Descriptive statistics was applied to data from the demographics and education barriers sections. The demographic information indicated the various characteristics of survey respondents: gender, age, education level, university type, main field of study, type of LMS that used in their universities, level of computer experience, usage of education-related technology, and level of knowledge of e-nudging techniques.

The proportion of males and females in the research sample was approximately equal for male (49.8%) and female (50.2%) as illustrated in Figure 4.20.

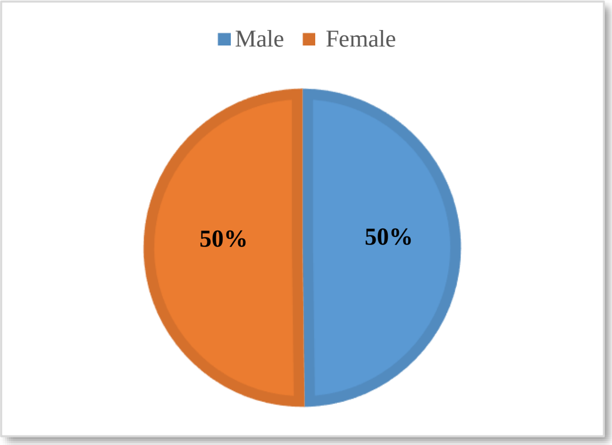


Figure 4.20: Students' gender (prepared by the researcher).

The majority (69.8%) of students were in the 18 to 23 age group, followed by 19.9% in the age group 24 to 28. As shown in Figure 4.21, a low percentage of respondents were in the other age groups.

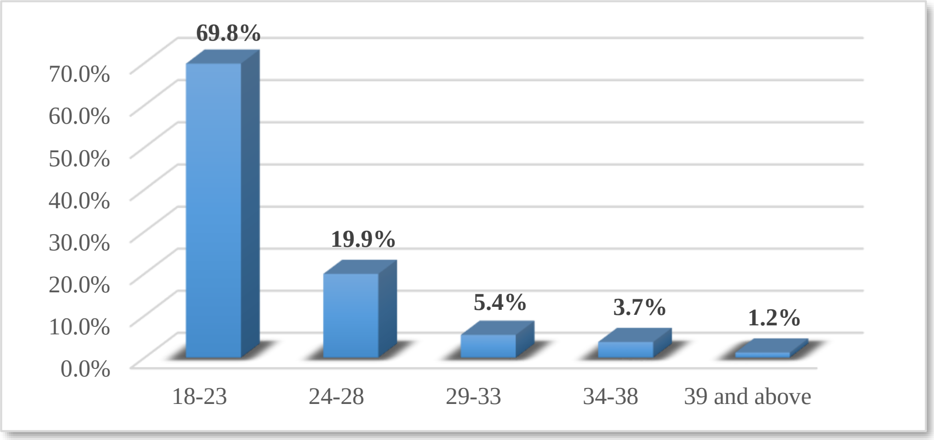


Figure 4.21: Students' age groups (prepared by the researcher).

Figure 4.22 below shows that over half of the student participants are in fourth year or above. The percentage of students in year 3 was 21.8%, while few of the participants are in second or first year, with percentages of 9.6%, and 9.3% respectively.

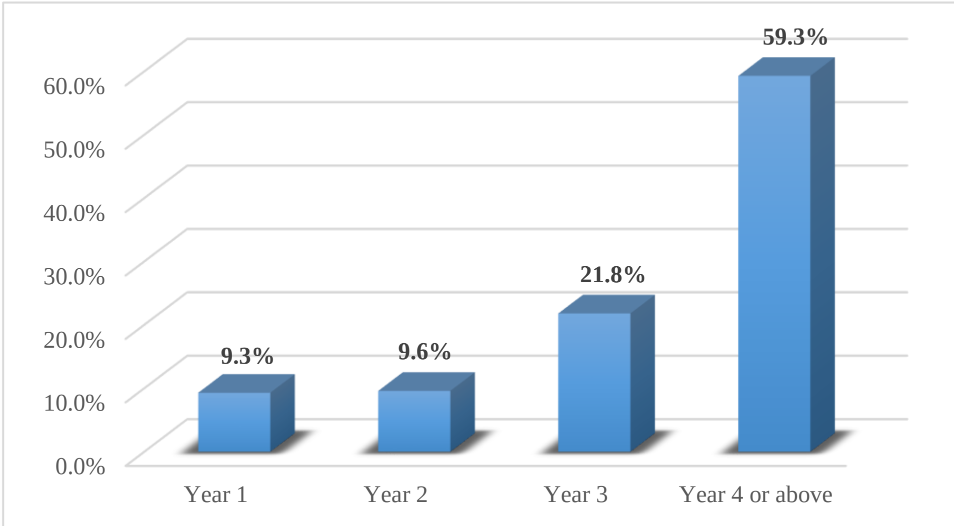


Figure 4.22: Students' education level (prepared by the researcher).

Most (87%) of the respondents were students in government universities; 10% were in private universities, and 2.9% were in other tertiary institutions such as colleges (see Figure 4.23).

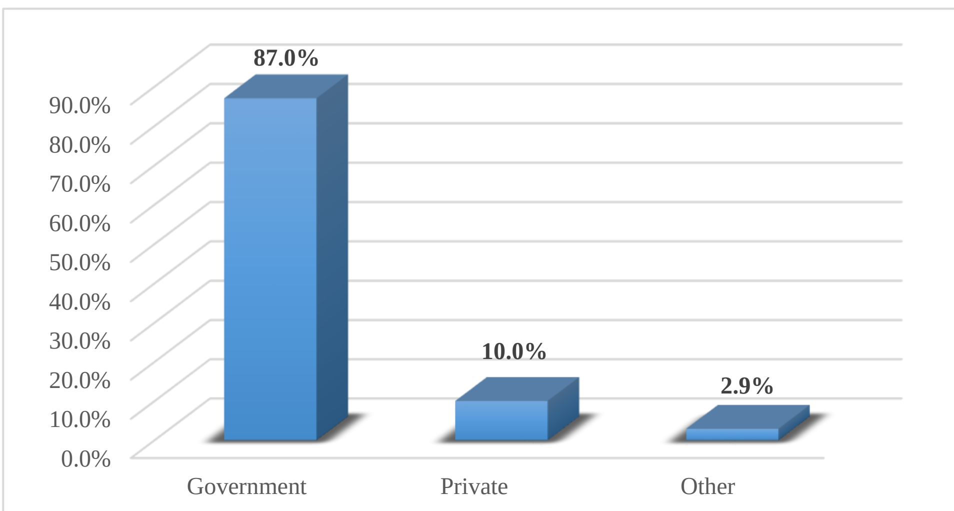


Figure 4.23: Students' tertiary institutions (prepared by the researcher).

Moreover, there was a great variety of fields of study. Most (15.7%) of the respondents were undertaking Health Sciences courses and an almost equal number (15.4%) were studying Computer Science. The proportion of students studying Information Systems was 10.5%. Health science accounted for 7.4%, followed by Economics and Finance with 6.1%. ‘Other’ main fields of study accounted for 23.5% as shown in Figure 4.24.

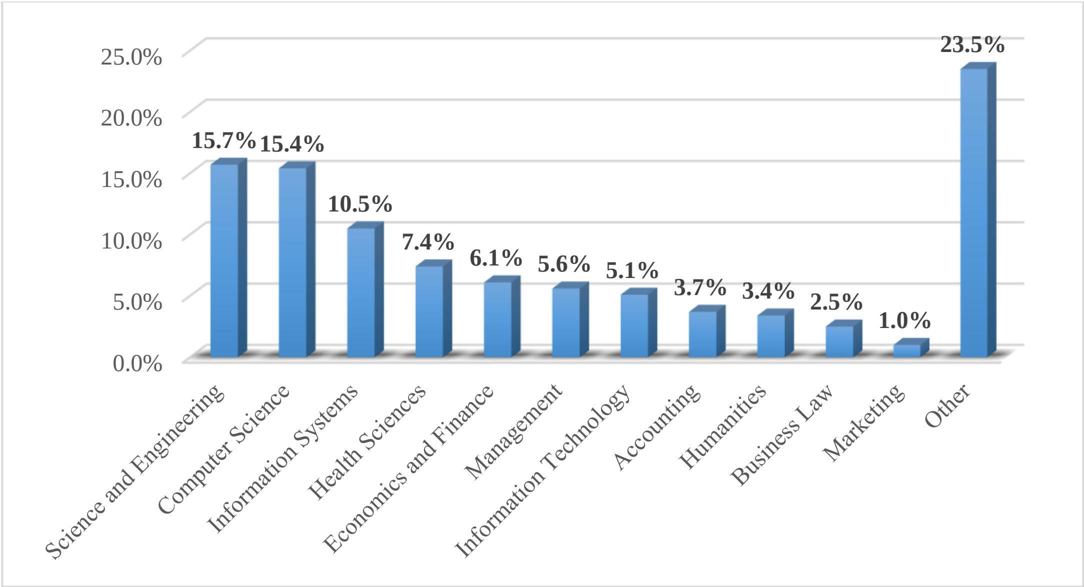


Figure 4.24: Students’ main fields of study (prepared by the researcher).

In regard to learning management systems (LMSs), the majority of student respondents use Blackboard (85.3%) while Moodle is used by 11% of students. Other systems or applications utilized in universities include Canvas, the university website, Google Meet, Zoom, Hangout and Face to face. These account for 3.7% as shown in Figure 4.25.

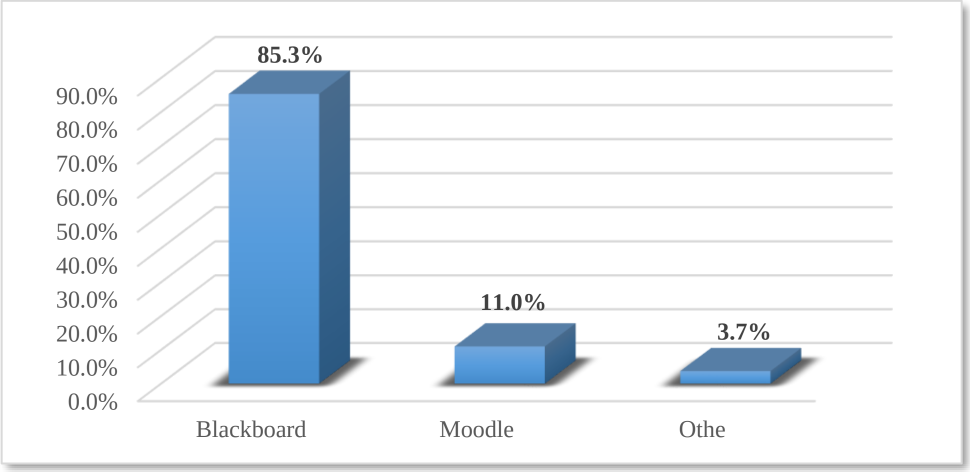


Figure 4.25: Type of LMS used higher education in SA regarding students’ response (prepared by the researcher).

Students' level of computer experience is shown in Figure 4.26. Participants' levels of experience are: intermediate (36.5%), advanced (45.3%), expert (15%) and beginner (3.2%). This gives the researcher a general indication of the students' ability to use computers efficiently, and their familiarity with computer programs.

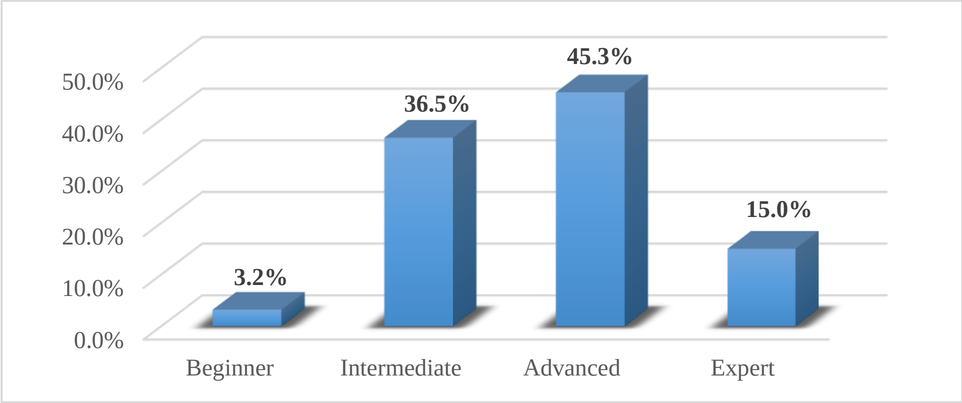


Figure 4.26: Students' level of computer experience (prepared by the researcher).

Students' usage of education-related technology for academic activities is an important component since students in higher education interact with faculty and universities via computer, and most courses now require students to have computer skills. The participant usage of education-related technology is: high usage (46.6%), medium usage (47.5%) and low usage (5.9%) as depicted in Figure 4.27. This result gives the researcher some indication of the level of respondents' skills in terms of using technology efficiently for academic activities and for applying e-nudging techniques successfully.

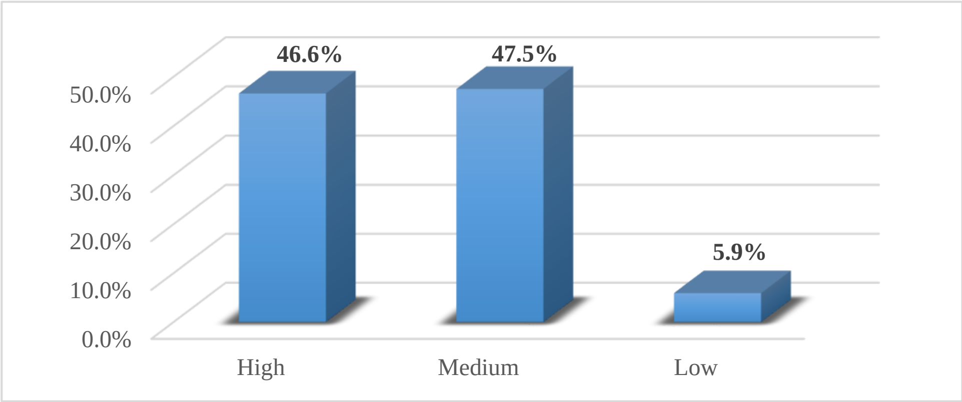


Figure 4.27: Students' usage of education-related technology for academic activities (prepared by the researcher).

Figure 4.28 below indicates students' level of knowledge about e-nudge techniques. These results show the extent to which participants are familiar with the e-nudge concept, and their ability to determine whether the e-nudging model will meet the requirements of university students in SA. Results indicate that more than half (62%) of the students have poor knowledge of e-nudge techniques, while 31.6% of students have medium knowledge, and only 6.4% have a good knowledge of e-nudge techniques.

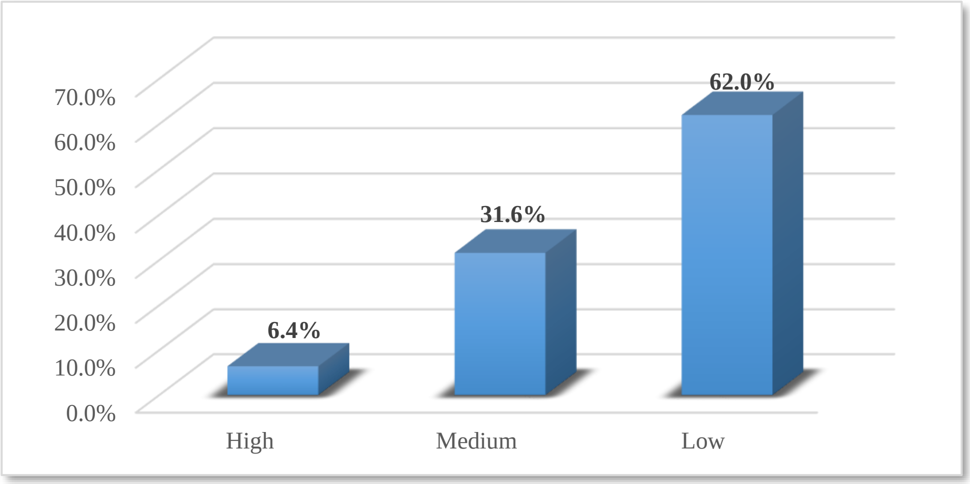


Figure 4.28: Students' level of knowledge in regard to e-nudge techniques (prepared by the researcher).

The response rate and students' demographic data are given in Table 4.18.

Table 4.18: Response rate and student demographics (prepared by the researcher).

Demographic Feature	Respondents' options	Response rate	Proportion
Gender	Male	203	49.8%
	Female	205	50.2%
Age	18-23	285	69.9%
	24-28	81	19.9%
	29-33	22	5.4%
	34-38	15	3.7%
	39 and above	5	1.2%
Education Level	Year 1	38	9.3%
	Year 2	39	9.6%

	Year 3	89	21.8%
	Year 4 or above	242	59.3%
University Type	Government	355	87%
	Private	41	10%
	Other	12	2.9%
Main field	Science and Engineering	64	15.7%
	Computer Science	63	15.4%
	Information Systems	43	10.5%
	Health Sciences	30	7.4%
	Economics and Finance	25	6.1%
	Management	23	5.6%
	Information Technology	21	5.1%
	Accounting	15	3.7%
	Humanities	14	3.4%
	Business Law	10	2.5%
	Marketing	4	1.0%
	Other	96	23.5%
Learning Management System Type	Blackboard	348	85.3%
	Moodle	45	11.0%
	Other	15	3.7%
Level of computer experience	Beginner	13	3.2%
	Intermediate	149	36.5%
	Advanced	185	45.3%
	Expert	61	15.0%
Usage of education-related technology	High	190	46.6%
	Medium	194	47.5%
	Low	24	5.9%
Level of knowledge in regard to e-nudge techniques	High	26	6.4%
	Medium	129	31.6%
	Low	253	62.0%
Total		408	100%

4.5.2 Analysis Results for Educational Barriers Evaluated by Students

The aim of this section was to determine whether the e-nudging model will meet the requirements of students in the higher education. The results help to identify the barriers that influence students' education-related decisions. The barriers can be classified as behavioural, cognitive and environmental. The data in this section are presented as descriptive statistics that indicate the barriers that have the most significant influence on students' decision-making.

The total sample size was 408. Figure 4.29 shows that 36% of students did not complete and submit at least one assignment during their time at university.

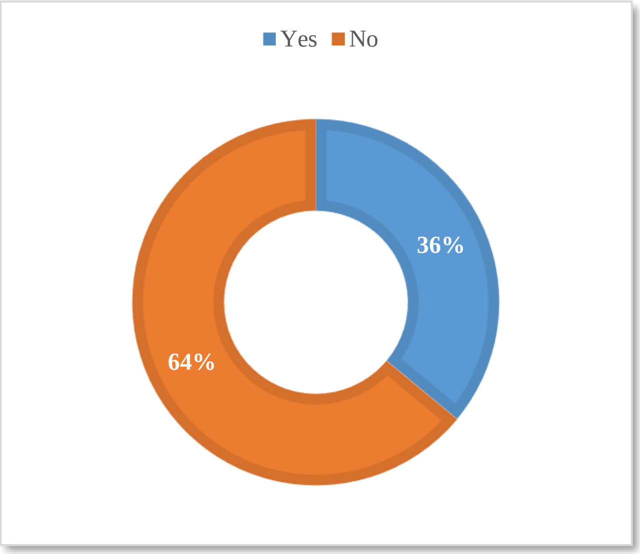


Figure 4.29: the proportion of students have not complete educational task via LMS (prepared by the researcher).

The reasons for this high rate are given in Table 4.19 and Figure 4.30. The majority (51%) of students claimed that sometimes they did not complete a task because it took too long; 34% did not complete the task if its purpose was not clear; 38% claimed a lack of teacher feedback deterred them; 33.3% blamed lack of time; 34.7% claimed that they tended to forget; and 31.3% did not complete or submit tasks because the LMS was too complex.). Students also mentioned that they often were busy with other tasks (40.8%), while 43.50% of students never ignore the tasks. Students who ticked 'never' for *I don't believe that it* *is important to do such tasks* accounted for 32%, while 63.67% of students sometimes have acceptable reasons for not submitting an assignment via LMS.

Table 4.19: Students' reasons for not completing an educational task (prepared by the researcher).

Reason for have not complete an educational task		Always	Often	Sometimes	Rarely	Never	Mean	Std. D
The task took too long to complete.	Freq.	12	25	**75**	22	13	2.99	1.003
	Percent	8.2%	17.%	**51.%**	15.%	8.8%		
The purpose of the task was unclear.	Freq.	9	31	**50**	39	18	3.18	1.09
	Percent	6.1%	21.1%	**34.%**	26.5%	12.2%		
The teacher provides insufficient feedback.	Freq.	30	34	**38**	34	11	2.74	1.234
	Percent	20.40%	23.10%	**25.9%**	23.10%	7.50%		
There was insufficient time to complete the task.	Freq.	22	37	**49**	29	10	2.78	1.132
	Percent	15.00%	25.20%	**33.30%**	19.70%	6.80%		
I was busy with other assessment tasks.	Freq.	26	**60**	38	17	6	2.44	1.041
	Percent	17.70%	**40.80%**	25.90%	11.60%	4.10%		
I don't believe that it is important to do such tasks.	Freq.	11	19	31	39	**47**	3.63	1.262
	Percent	7.50%	12.90%	21.10%	26.50%	**32%**		
I forgot to do the task.	Freq.	9	23	**51**	35	29	3.35	1.146
	Percent	6.10%	15.60%	**34.70%**	23.80%	19.70%		
I ignored the task.	Freq.	3	13	32	35	**64**	3.98	1.095
	Percent	2.00%	8.80%	21.80%	23.80%	**43.50%**		
The LMS is complex for me.	Freq.	9	16	**46**	35	41	3.56	1.182
	Percent	6.10%	10.90%	**31.30%**	23.80%	27.90%		
Weighted mean							3.1837	
							63.67%	
Std. Deviation							0.5723	

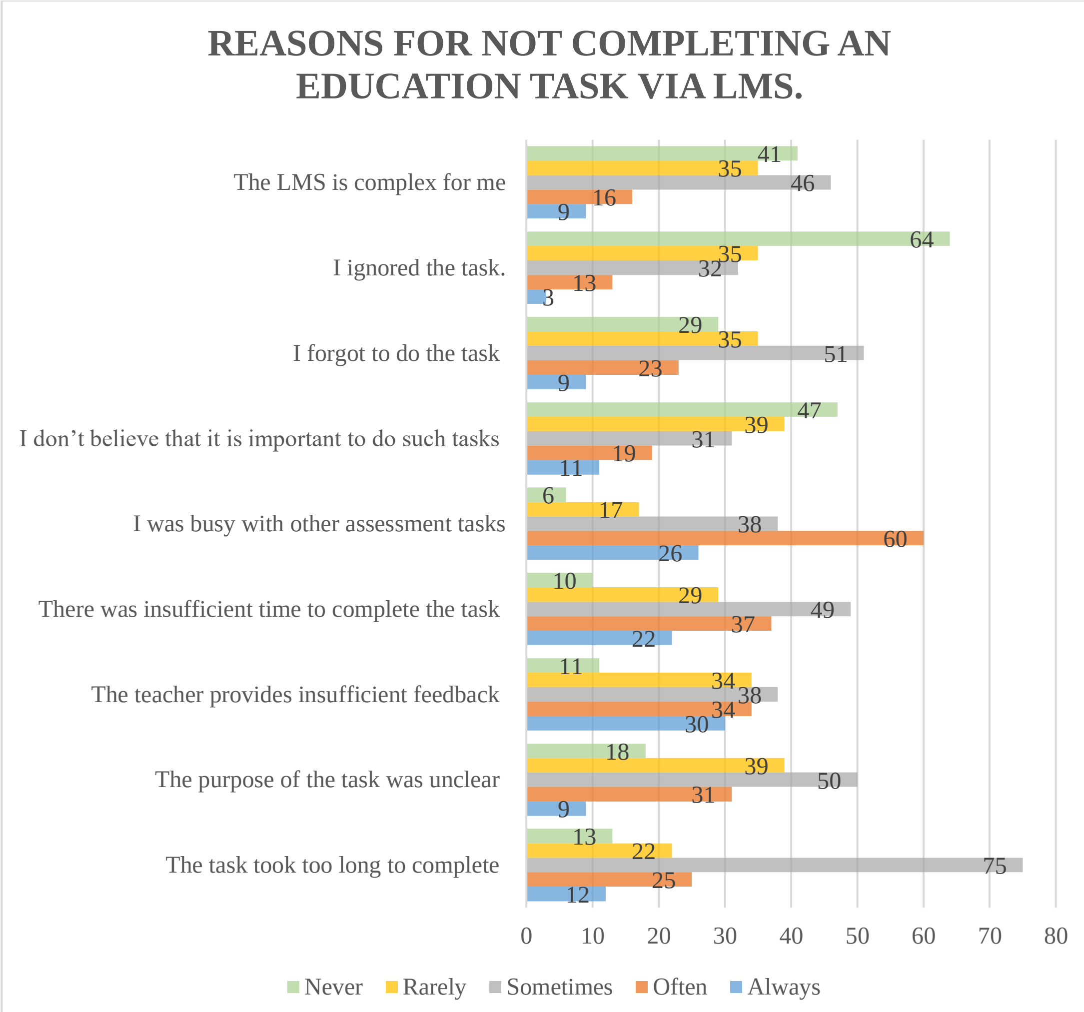


Figure 4.30: Students' reasons for not completing an educational task (prepared by the researcher).

There are several barriers that influence students' education-related decisions. This research examined selected factors from three different type of barriers (behavioral, cognitive and environmental) to be considered when developing a successful e-nudging model for higher education in SA. These selected factors (i.e., barriers) can be affected by informational nudging (feedback, peer comparisons, reminder, and reduce distance). The descriptive analysis is applied by reversing the Likert score for negative items (Field, 2013; Roszkowski & Soven, 2010) and finding the interval level (Pimentel, 2010). The following sub-section presents the results for the barriers that influence students' academic outcomes.

4.5.2.1 Analysis Results for Behavioural Barriers

The behavioural barriers consisted of two factors: self-regulation and bounded rationality. First, the researcher reversed the Likert score for negative items in the students' survey (the statements are highlighted in yellow in each table below) before calculating the mean and standard deviation. Table 4.20 and Figure 4.31 show that 75.99% of students agreed that they have self-regulation and are able to plan, monitor, control and reflect on what worked and what needed to change so that they worked better in future. Around 24% of students are unable to self-regulate.

Table 4.20: Descriptive results for students' self-regulation (prepared by the researcher).

Self-regulation		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
I plan out my education tasks that I want to complete by which one need to be done first	Freq.	8	15	88	**179**	118	3.94	0.909
	Percent	2.00%	3.70%	21.60%	**43.90%**	28.90%		
I can usually estimate how much time my education task will take to complete.	Freq.	9	57	103	**181**	58	3.54	0.973
	Percent	2.20%	14.00%	25.20%	**44.40%**	14.20%		
I have trouble making plans to achieve my education goals	Freq.	26	106	112	**124**	40	3.11	1.096
	Percent	6.40%	26.00%	27.50%	**30.40%**	9.80%		
I keep track of my education tasks.	Freq.	8	44	79	**166**	111	3.8	1.019
	Percent	2.00%	10.80%	19.40%	**40.70%**	27.20%		
I know when I am behind on an education task.	Freq.	10	34	55	**195**	114	3.9	0.98
	Percent	2.50%	8.30%	13.50%	**47.80%**	27.90%		
I have trouble remembering the tasks I need to accomplish.	Freq.	40	87	90	**132**	59	3.2	1.212
	Percent	9.80%	21.30%	22.10%	**32.40%**	14.50%		
I know what my education task that need to be done on time.	Freq.	7	24	66	**211**	100	3.91	0.889
	Percent	1.70%	5.90%	16.20%	**51.70%**	24.50%		
I make choices that will help me succeed.	Freq.	6	30	72	**213**	87	3.85	0.891
	Percent	1.50%	7.40%	17.60%	**52.20%**	21.30%		
When I get behind in my work, I often give up.	Freq.	24	51	65	**163**	105	3.67	1.158
	Percent	5.90%	12.50%	15.90%	**40.00%**	25.70%		
I think about how well I am doing on my assignments.	Freq.	4	22	47	**215**	120	4.04	0.845
	Percent	1.00%	5.40%	11.50%	**52.70%**	29.40%		
I feel a sense of accomplishment when	Freq.	5	11	22	87	**283**	4.55	0.816
	Percent	1.20%	2.70%	5.40%	21.30%	**69.40%**		

I get everything done on time.								
When I fail at something, I try to learn from my mistakes.	Freq.	7	22	52	**185**	142	4.06	0.919
	Percent	1.70%	5.40%	12.70%	**45.30%**	34.80%		
Weighted mean							3.7994	
							75.99%	
Std. Deviation							0.55834	

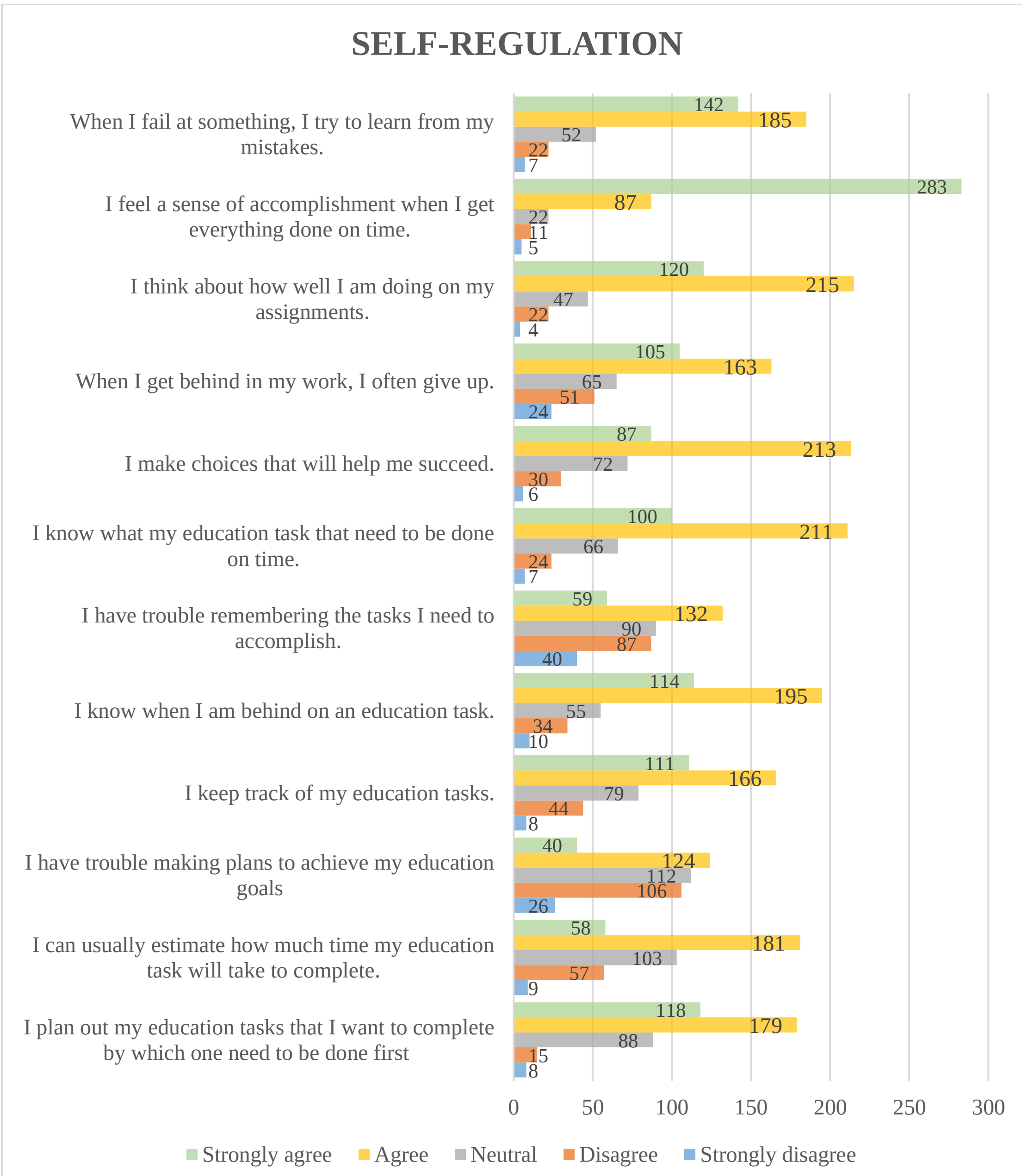


Figure 4.31: Descriptive results for students' self-regulation (prepared by the researcher).

The second measured behaviour is bounded rationality. Most (74.50%) students agreed that they have bounded rationality regarding the completion of assignments. These students claimed that they can make rational decisions according to feedback given by the teacher, and the student thinking process, and time. According to results, 25.50% of students made unwise academic decisions. Table 4.21 and Figure 4.32 give the details.

Table 4.21: Descriptive results for students' bounded rationality (prepared by the researcher).

Bounded Rationality		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
Doing assignments helps me understand what's going on in class.	Freq.	13	38	78	**169**	110	3.8	1.04
	Percent	3.20%	9.30%	19.10%	**41.40%**	27.00%		
Doing assignments improves my professional skills such as reading, writing, research, critical thinking, decision making, and teamwork	Freq.	10	28	67	**167**	136	3.96	0.997
	Percent	2.50%	6.90%	16.40%	**40.90%**	33.30%		
Doing assignments improves my personal skills including personal motivation, leadership, negotiation, communication, problem solving, time management, reflection, self-management and self-appraisal	Freq.	11	51	89	**166**	91	3.67	1.039
	Percent	2.70%	12.50%	21.80%	**40.70%**	22.30%		
Doing assignments helps me to obtain a good grade.	Freq.	12	26	64	**162**	144	3.98	1.016
	Percent	2.90%	6.40%	15.70%	**39.70%**	35.30%		
Graded assignments contain comments (feedback) from the teacher intended to improve subsequent submissions.	Freq.	44	55	91	**128**	90	3.4	1.266
	Percent	10.80%	13.50%	22.30%	**31.40%**	22.10%		
Graded assignments contain comments (feedback) from the teacher intended to help me to correct my mistakes.	Freq.	39	54	80	**140**	95	3.49	1.248
	Percent	9.6	13.2	19.6	**34.3**	23.3		
I do not complete assignments because I do not see the benefit	Freq.	12	34	64	**149**	**149**	3.95	1.059
	Percent	2.9	8.3	15.7	**36.5**	**36.5**		

of completing such tasks.								
I would complete homework in order to obtain further knowledge.	Freq.	20	47	103	**164**	74	3.55	1.066
	Percent	4.90%	11.50%	25.20%	**40.20%**	18.10%		
Weighted mean							3.72549	
							74.50%	
Std. Deviation							0.717357	

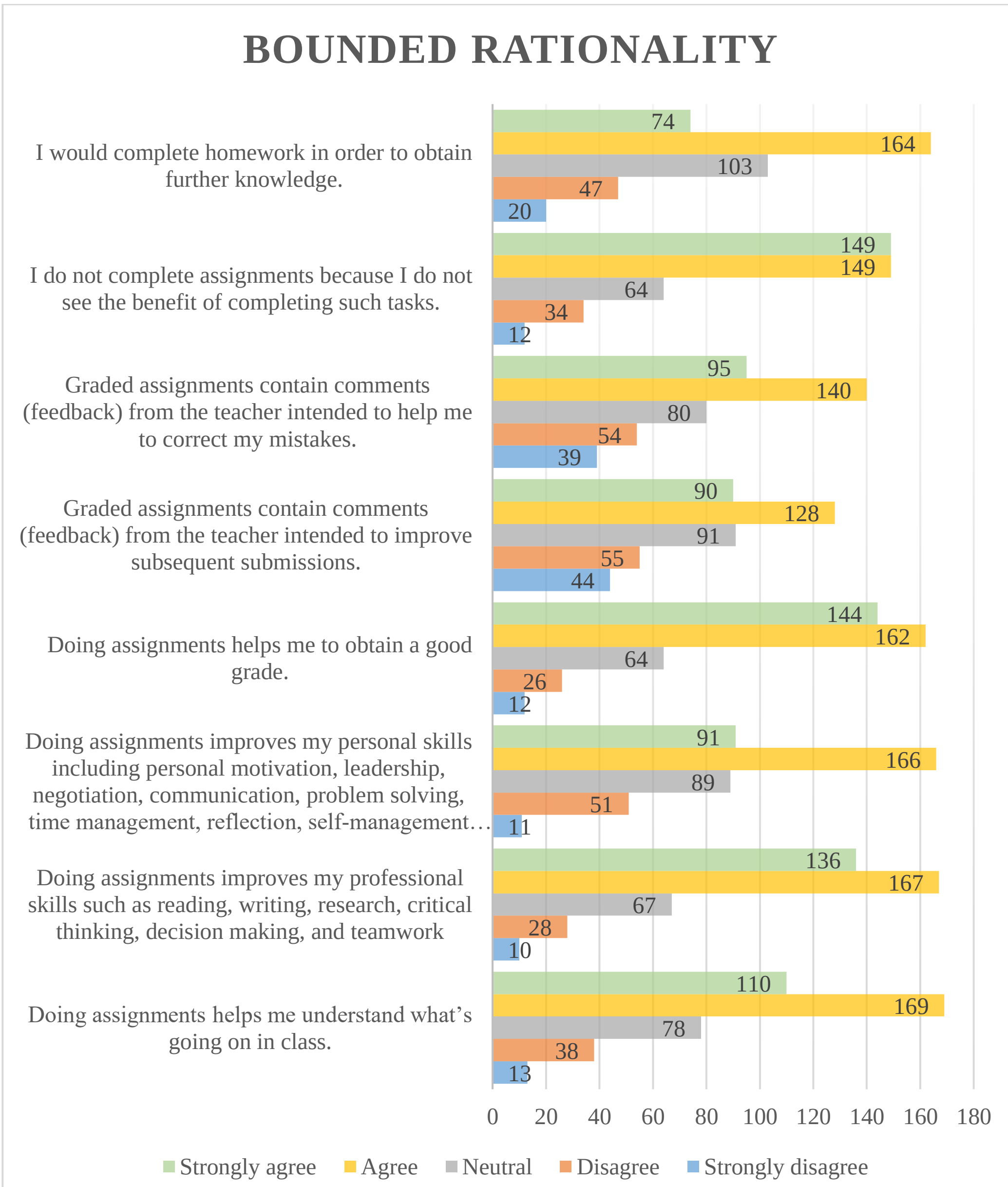


Figure 4.32: Descriptive results for students' bounded rationality (prepared by the researcher).

4.5.2.2 Analysis Results for Cognitive Barriers

The three cognitive barriers - attention, memory and confidence – were addressed in the student survey. First, the researcher reversed the Likert score for negative items in the students' survey (the statements are highlighted in yellow in each table below) before calculating the mean and standard deviation. The students' responses for these factors are neutral, 54.70% of students believing that they have a good attention level as shown in Table 4.22 and Figure 4.33. The results indicated that 45.30% of students were able to concentrate and not be distracted, whereas about half of the students have attention issues that negatively influence their decision-making.

Table 4.22: Descriptive results for students' Attention (prepared by the researcher).

Attention		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std.D
I am able to concentrate when doing boring work	Freq.	51	150	**107**	82	18	2.67	1.068
	Percent	12.50%	36.80%	**26.20%**	20.10%	4.40%		
I am able to concentrate when worried.	Freq.	82	**149**	89	73	15	2.49	1.11
	Percent	20.10%	**36.50%**	21.80%	17.90%	3.70%		
I am able to concentrate if you have to switch from one task to another	Freq.	31	93	122	**138**	24	3.08	1.05
	Percent	7.60%	22.80%	29.90%	**33.80%**	5.90%		
I am able to pay attention to one specific issue for a long period of time.	Freq.	20	62	79	**166**	81	3.55	1.116
	Percent	4.90%	15.20%	19.40%	**40.70%**	19.90%		
I am able to give continuous attention if the volume of information is very large	Freq.	52	114	**122**	93	27	2.83	1.12
	Percent	12.70%	27.90%	**29.90%**	22.80%	6.60%		
I am able to give my full attention to something after a short interruption.	Freq.	12	55	117	**184**	40	3.45	0.945
	Percent	2.90%	13.50%	28.70%	**45.10%**	9.80%		
I am able to concentrate if I have little time to finish the task.	Freq.	36	95	89	**127**	61	3.2	1.208
	Percent	8.80%	23.30%	21.80%	**31.10%**	15.00%		
I am able to concentrate on more than one thing at the same time.	Freq.	47	**116**	115	105	25	2.87	1.11
	Percent	11.50%	**28.40%**	28.20%	25.70%	6.10%		
I am able to plan ahead and pay attention to fine detail.	Freq.	18	46	97	**165**	82	3.61	1.065
	Percent	4.40%	11.30%	23.80%	**40.40%**	20.10%		
	Freq.	57	**151**	106	78	16	2.62	1.066

My ability to concentrate decreases if the subject matter is very complex	Percent	14.00%	**37.00%**	26.00%	19.10%	3.90%		
I am able to concentrate if level of complexity of material is very low.	Freq.	12	40	103	**161**	92	3.69	1.02
	Percent	2.90%	9.80%	25.20%	**39.50%**	22.50%		
My ability to concentrate is affected: when I am cold	Freq.	62	**162**	81	83	20	2.6	1.117
	Percent	15.20%	**39.70%**	19.90%	20.30%	4.90%		
My ability to concentrate is affected: when I am hungry	Freq.	114	**166**	62	49	17	2.24	1.111
	Percent	27.90%	**40.70%**	15.20%	12.00%	4.20%		
My ability to concentrate is affected: when I am too warm	Freq.	119	**156**	74	45	14	2.21	1.086
	Percent	29.20%	**38.20%**	18.10%	11.00%	3.40%		
Sleep deprivation affects my ability to concentrate.	Freq.	171	**130**	63	35	9	1.97	1.057
	Percent	41.90%	**31.90%**	15.40%	8.60%	2.20%		
Background noise and distraction affect my ability to concentrate	Freq.	135	**152**	58	49	14	2.15	1.114
	Percent	33.10%	**37.30%**	14.20%	12.00%	3.40%		
Noise in my immediate environment disturbs my concentration.	Freq.	133	**161**	58	42	14	2.13	1.084
	Percent	32.60%	**39.50%**	14.20%	10.30%	3.40%		
In order to study effectively, I must have a quiet environment.	Freq.	**186**	125	63	25	9	1.89	1.022
	Percent	**45.60%**	30.60%	15.40%	6.10%	2.20%		
Weighted mean							2.73543	
							54.70%	
Std. Deviation							0.447589	

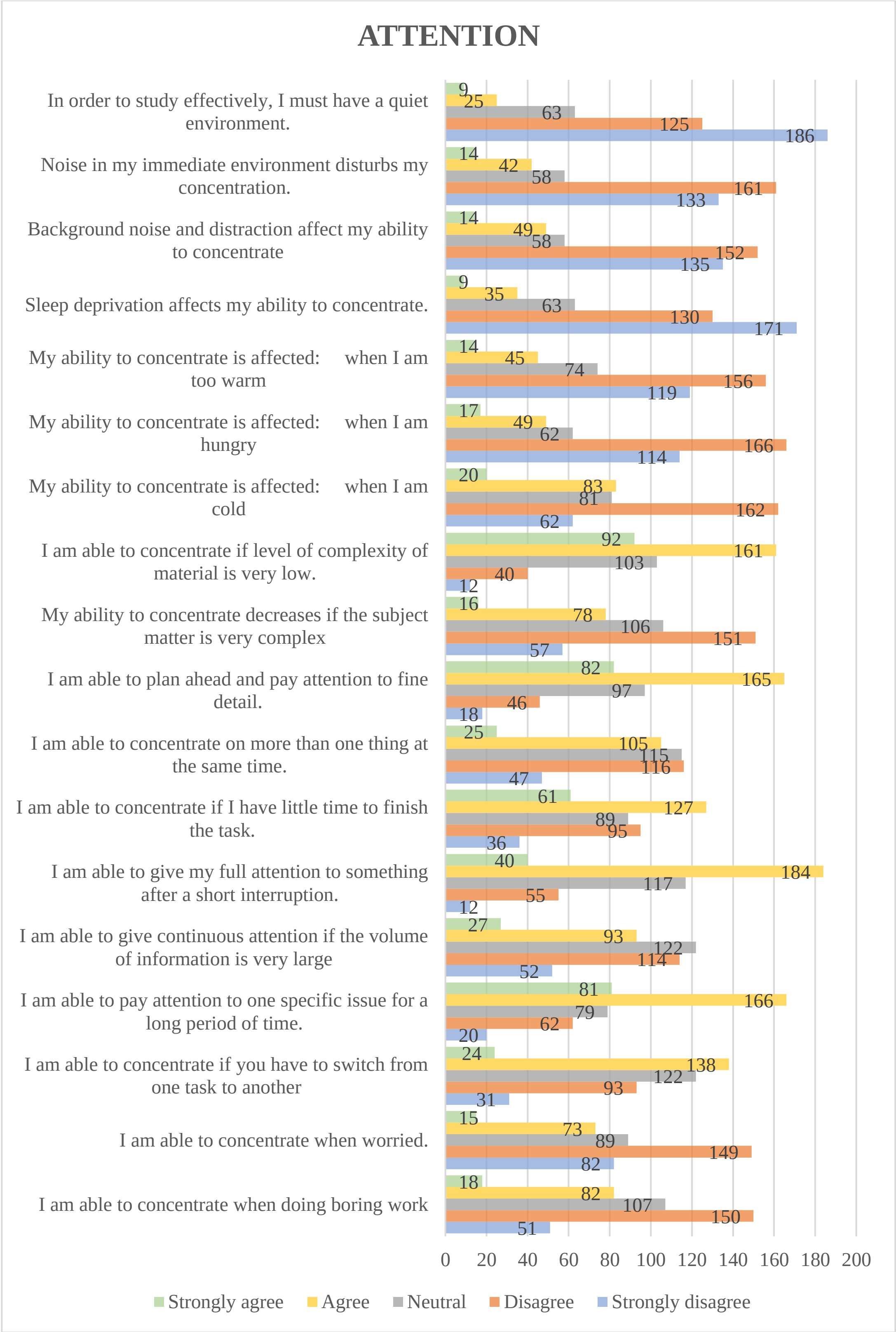


Figure 4.33: Descriptive results for students' attention (prepared by the researcher).

The next cognitive barrier is memory. The memory factor was included in the students' survey to support the attention factor and make the result more accurate, as students' limited attention is a factor that negatively influence students' decision-making. Table 4.23 and Figure 4.34 show that most (70.44%) students believe that they have a good memory when it comes to completing academic tasks. However, a relatively high (29.66%) number of students have memory issues.

Table 4.23: Descriptive results for students' memory (prepared by the researcher).

Memory		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std.D
I am confident in my ability to remember things	Freq.	23	57	98	**171**	59	3.46	1.076
	Percent	5.60%	14.00%	24.00%	**41.90%**	14.50%		
I do not get upset when I forget to do set academic tasks	Freq.	20	51	59	**160**	118	3.75	1.147
	Percent	4.90%	12.50%	14.50%	**39.20%**	28.90%		
I use a special method to help me remember the set academic tasks (like set a reminder, take notes etc.).	Freq.	19	42	67	**154**	126	3.8	1.125
	Percent	4.70%	10.30%	16.40%	**37.70%**	30.90%		
I ask my friend(s) to remind me to do the set academic tasks.	Freq.	56	**130**	87	80	55	2.87	1.261
	Percent	13.70%	**31.90%**	21.30%	19.60%	13.50%		
I forget to complete set tasks on time.	Freq.	14	81	95	**136**	82	3.47	1.121
	Percent	3.40%	19.90%	23.30%	**33.30%**	20.10%		
I completed my assignment but forgot to submit it via LMS.	Freq.	23	50	49	**153**	133	3.79	1.185
	Percent	5.60%	12.30%	12.00%	**37.50%**	32.60%		
Weighted mean							3.522467	
							70.44%	
Std. Deviation							0.626317	

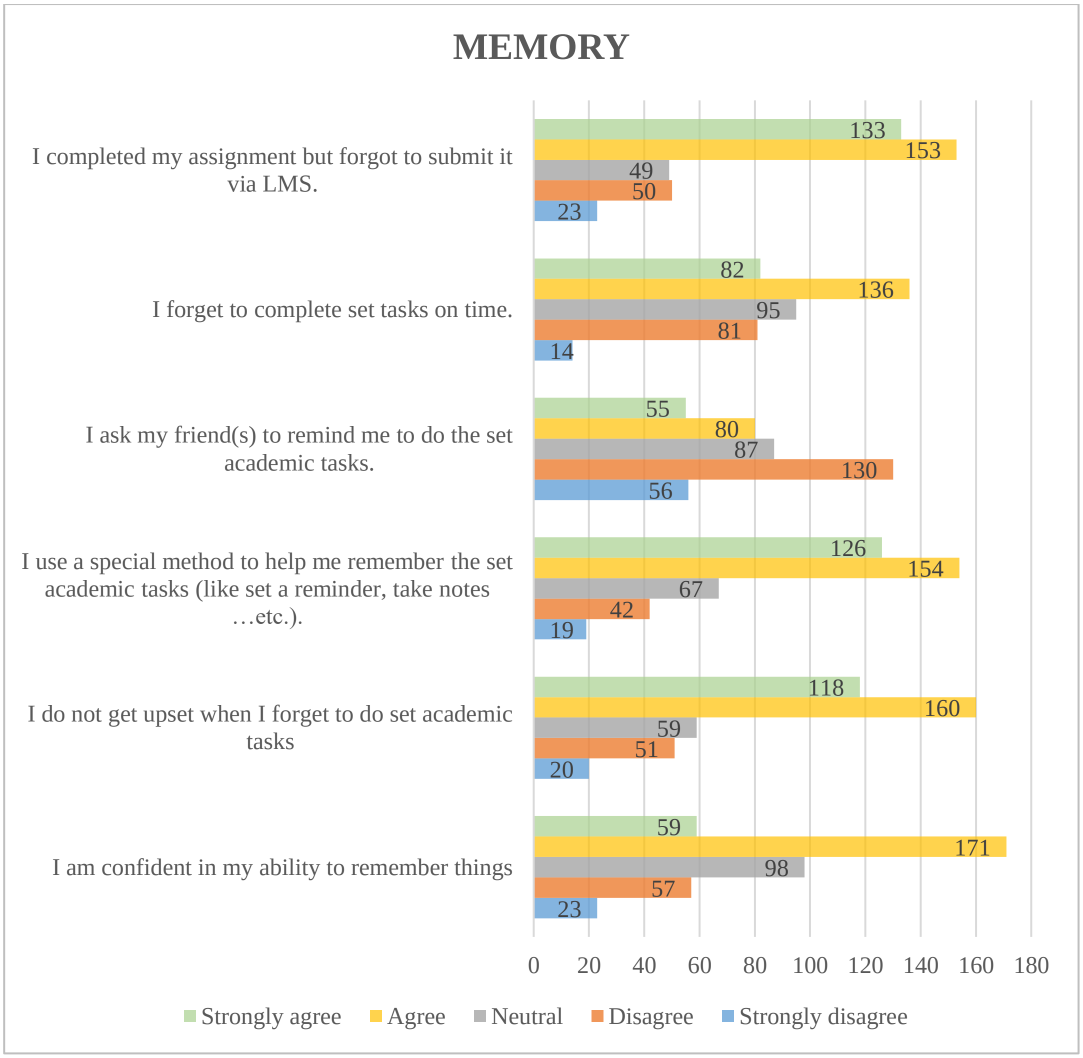


Figure 4.34: Descriptive results for students' memory (prepared by the researcher).

The last factor in this section is self-confidence. This factor assesses the level of confidence that students have in their own academic ability. More than half (69.50%) of the students believe that they have a high level of confidence in their academic ability. The results are presented in Table 4.24 and Figure 4.35.

Table 4.24: Descriptive results for students' confidence (prepared by the researcher).

Confidence		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
I feel that I can do the work that my teachers assign me	Freq.	12	18	60	**190**	128	3.99	0.951
	Percent	2.90%	4.45%	14.70%	**46.60 %**	31.40%		
I am an extremely confident person	Freq.	11	31	95	**156**	115	3.82	1.015
	Percent	2.70%	7.60%	23.30%	**38.20 %**	28.20%		
I am very sure of myself before an exam	Freq.	19	81	115	**116**	77	3.37	1.136
	Percent	4.70%	19.90%	28.20%	**28.40 %**	18.90%		
I remind myself about exams	Freq.	3	13	45	**186**	161	4.2	0.813
	Percent	0.70%	3.20%	11.00%	**45.60 %**	39.50%		
I never expect high grades	Freq.	34	77	85	**107**	105	3.42	1.281
	Percent	8.30%	18.90%	20.80%	**26.20 %**	25.70%		
I am always apprehensive about graded work	Freq.	69	**134**	135	49	21	2.56	1.066
	Percent	16.90%	**32.80%**	33.10%	12.00 %	5.10%		
I feel comfortable leading academic groups	Freq.	37	66	89	**114**	102	3.44	1.272
	Percent	9.10%	16.20%	21.80%	**27.90 %**	25.00%		
The grade I expect is higher than my actual grade	Freq.	39	106	**122**	94	47	3.01	1.156
	Percent	9.60%	26.00%	**29.90%**	23.00 %	11.50%		
Weighted mean							3.474877	
							69.50%	
Std. Deviation							0.530892	

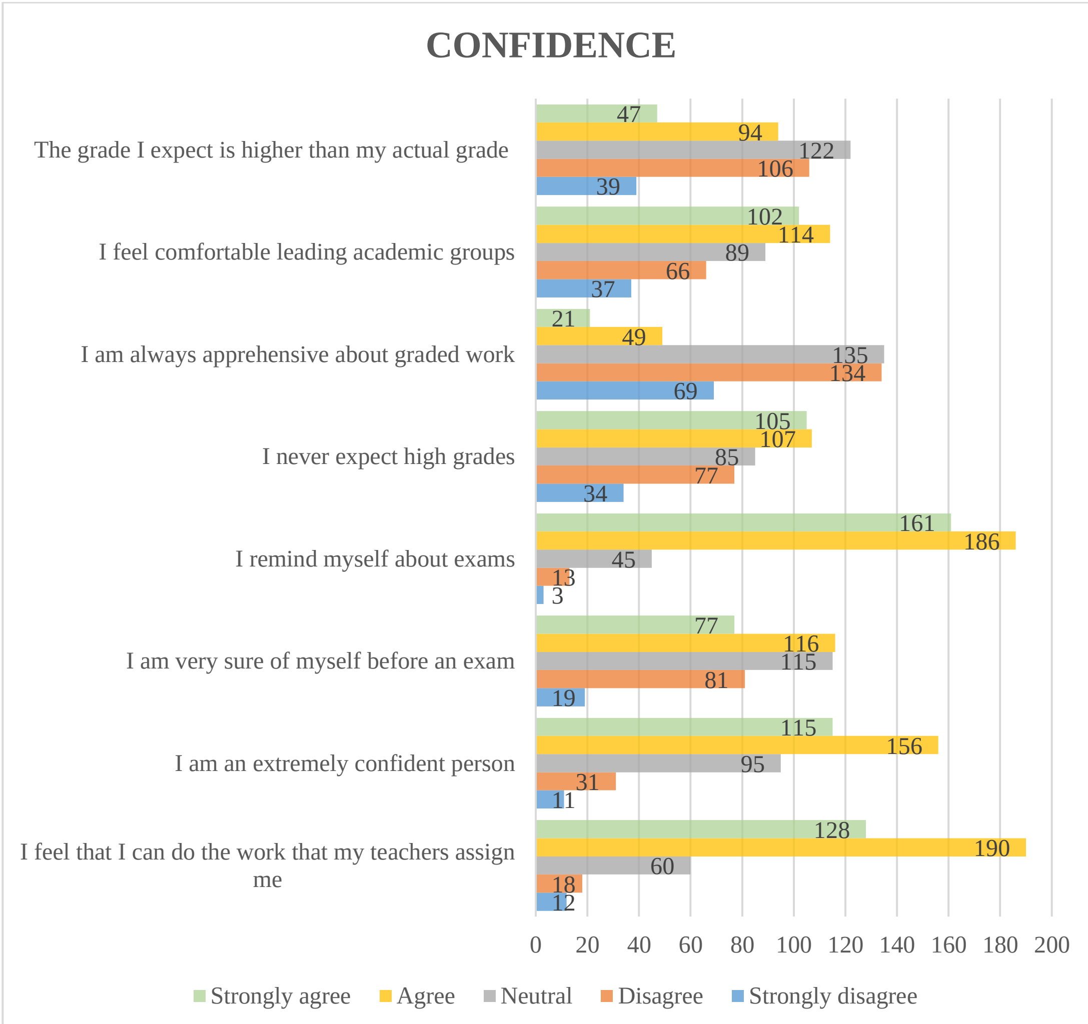


Figure 4.35: Descriptive results for students' confidence (prepared by the researcher).

4.5.2.3 Analysis Results for Environmental Barriers

The last educational barrier is environmental. The items in this section were intended to determine the complexity of current LMSs being used in Saudi universities. The students evaluated the functionality, HCI, navigation and usability features of the LMS in their institution. For LMS functionality, the students' responses were neutral. Only 65.66% of students use their university's LMS, whilst the rest experienced difficulties with LMS functions. The results for the assessment of LMS functionality are presented in Table 4.25 and Figure 4.36.

Table 4.25: Descriptive results for current LMS functionality (prepared by the researcher).

Assessment of the functionality of university's current LMS		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
I liked using the interface of the LMS system.	Freq.	43	69	126	**129**	41	3.14	1.137
	Percent	10.50%	16.90%	30.90%	**31.60%**	10.00%		
I believe I could become more productive using this system.	Freq.	27	68	132	**139**	42	3.25	1.061
	Percent	6.60%	16.70%	32.40%	**34.10%**	10.30%		
The system gave error messages.	Freq.	33	116	**121**	104	34	2.98	1.095
	Percent	8.10%	28.40%	**29.70%**	25.50%	8.30%		
Whenever I made a mistake using the system, I could recover easily and quickly.	Freq.	38	112	**133**	101	24	2.9	1.06
	Percent	9.30%	27.50%	**32.60%**	24.80%	5.90%		
I can access the learning activities at times convenient to me.	Freq.	20	39	99	**193**	57	3.56	1.007
	Percent	4.90%	9.60%	24.30%	**47.30%**	14.00%		
The online material is available at locations suitable for me.	Freq.	7	30	103	**203**	65	3.71	0.882
	Percent	1.70%	7.40%	25.20%	**49.80%**	15.90%		
LMS enables me to interact with other students and the tutor asynchronously	Freq.	34	96	**124**	120	34	3.06	1.093
	Percent	8.30%	23.50%	**30.40%**	29.40%	8.30%		
I use this technology confidently.	Freq.	11	41	105	**164**	87	3.67	1.006
	Percent	2.70%	10.00%	25.70%	**40.20%**	21.30%		
Weighted mean							3.2831	
							65.66%	
Std. Deviation							0.59169	

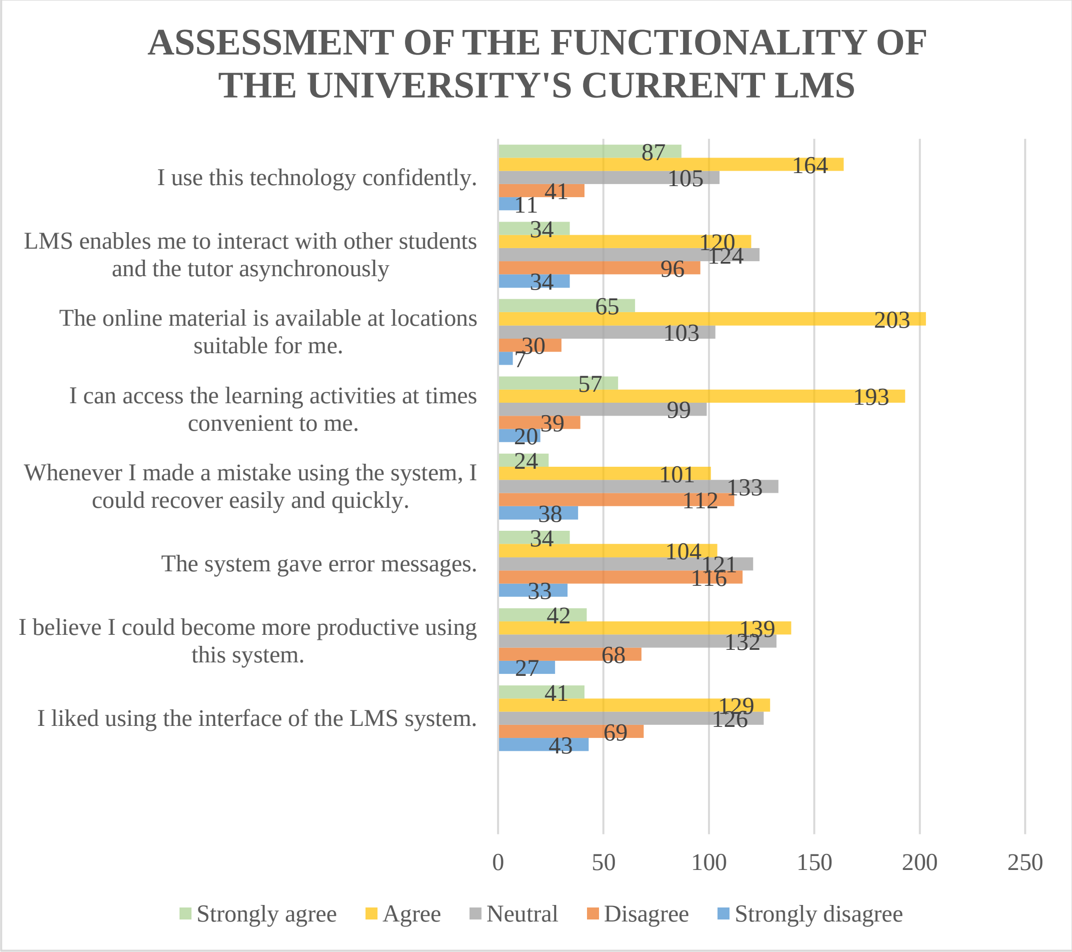


Figure 4.36: Descriptive results for current LMS functionality (prepared by the researcher).

The students assessed the HCI of the current LMS. Results show that 71.23% of students agreed that the current LMS in their university had most of the HCI features, as Table 4.26 and Figure 4.37 show.

Table 4.26: Descriptive results for the HCI of the current LMS (prepared by the researcher).

Assess HCI for current LMS that use in university		**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Mean**	**Std. D**
Easy to use.	Freq.	14	30	102	**192**	70	3.67	0.959
	Percent	3.40%	7.40%	25.00%	**47.10%**	17.20%		
Practical.	Freq.	19	56	113	**148**	72	3.49	1.077
	Percent	4.7	13.7	27.7	**36.3**	17.6		
Easy to see.	Freq.	14	35	92	**188**	79	3.69	0.99
	Percent	3.40%	8.60%	22.50%	**46.10%**	19.40%		

Ensures student satisfaction.	Freq.	33	78	**149**	103	45	3.12	1.094
	Percent	8.10%	19.10%	**36.50%**	25.20%	11.00%		
Text style is suitable.	Freq.	5	35	90	**201**	77	3.76	0.898
	Percent	1.20%	8.60%	22.10%	**49.30%**	18.90%		
Font size is appropriate.	Freq.	7	30	96	**196**	79	3.76	0.907
	Percent	1.70%	7.40%	23.50%	**48.00%**	19.40%		
Layout of pages is suitable.	Freq.	19	59	99	**166**	65	3.49	1.068
	Percent	4.70%	14.50%	24.30%	**40.70%**	15.90%		
Graphics are appropriate.	Freq.	24	48	121	**155**	60	3.44	1.064
	Percent	5.9	11.8	29.7	**38**	14.7		
Colour is suitable.	Freq.	19	30	103	**184**	72	3.64	1.007
	Percent	4.70%	7.40%	25.20%	**45.10%**	17.60%		
Weighted mean							3.5615	
							71.23%	
Std. Deviation							0.77269	

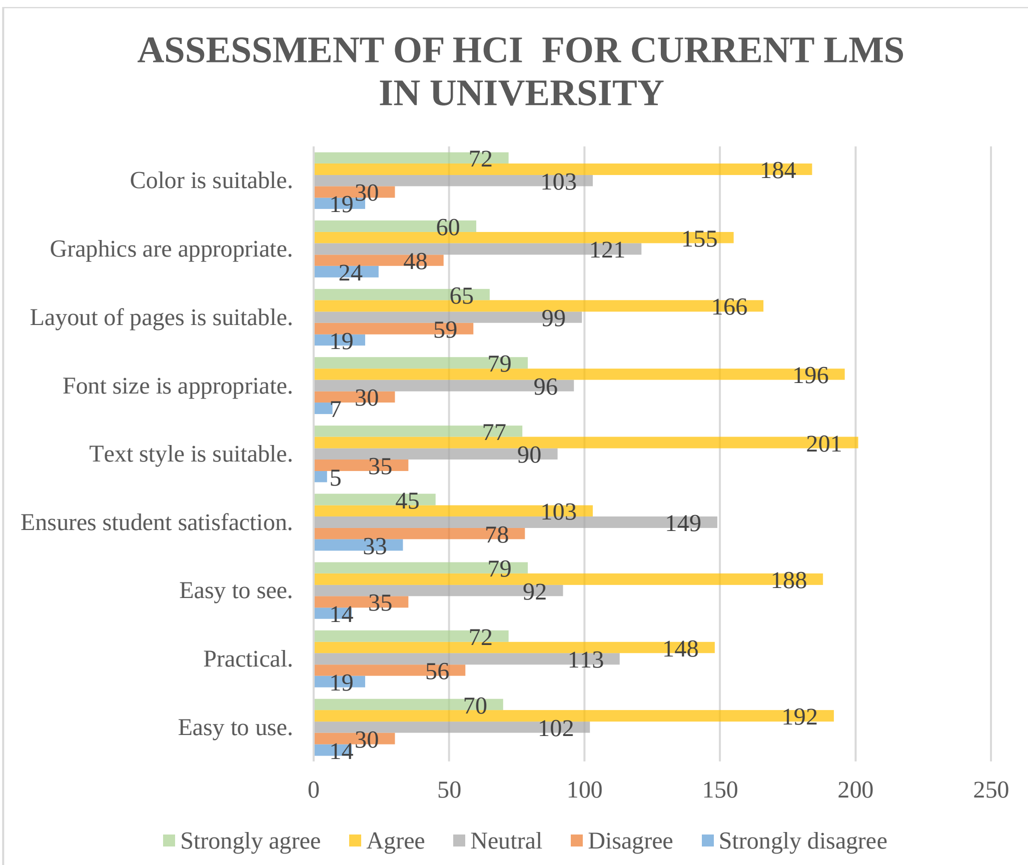


Figure 4.37: Descriptive results for the HCI of the current LMS (prepared by the researcher).

Table 4.27 and Figure 4.38 show the survey results for the navigation feature. Over half (68.39%) of the students agreed that the LMS is easy to navigate, the site elements, links and Hypermedia are easy to find, and the interface is appropriate and user-friendly.

Table 4.27: The descriptive results for navigation of current LMS (prepared by the researcher).

Assess Navigation for current LMS that use in university		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
Elements of the site are easy to find	Freq.	19	72	93	**160**	64	3.44	1.093
	Percent	4.70%	17.60%	22.80%	**39.20%**	15.70%		
Links are easy to find.	Freq.	20	72	99	**158**	59	3.4	1.086
	Percent	4.90%	17.60%	24.30%	**38.70%**	14.50%		
Hypermedia applications are easy to find.	Freq.	22	58	138	**142**	48	3.33	1.033
	Percent	5.40%	14.20%	33.80%	**34.80%**	11.80%		
Interface is appropriate and user-friendly.	Freq.	17	57	99	**172**	63	3.51	1.044
	Percent	4.20%	14.00%	24.30%	**42.20%**	15.40%		
Weighted mean							3.4197	
							68.39%	
Std. Deviation							0.91037	

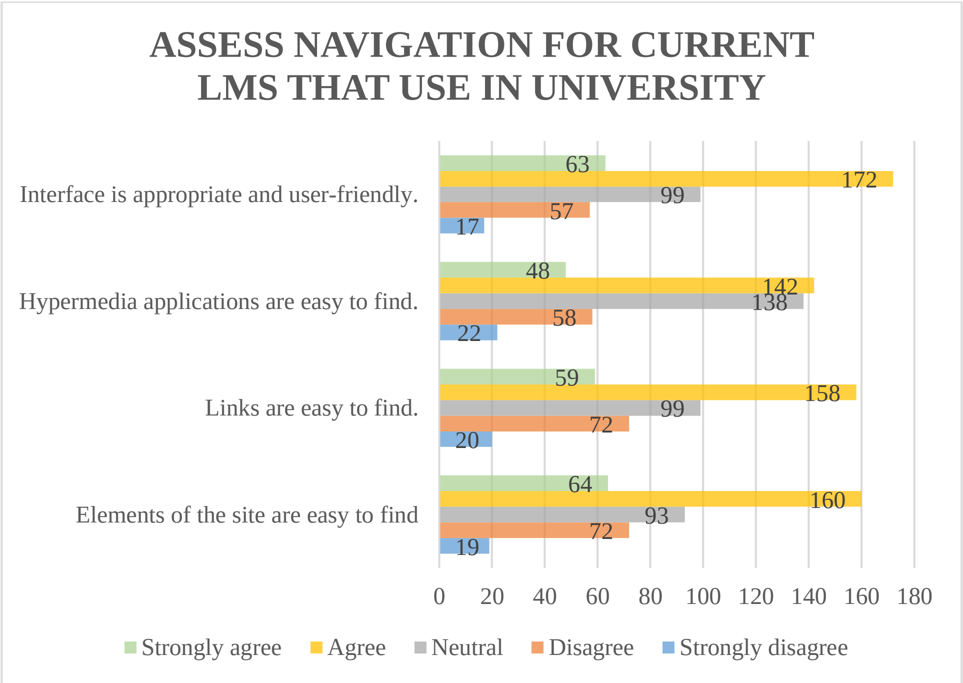


Figure 4.38: Descriptive results for navigation of current LMS (prepared by the researcher).

The last factor for environmental barriers is usability. The students evaluated the usability of their current LMS, with 73% of students agreeing that the LMS is usable. The results of the students' assessment are shown in Table 4.28 and Figure 4.39.

Table 4.28: Descriptive results for current LMS usability (prepared by the researcher).

Assessment of usability of current LMS in university		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D
Effective	Freq.	11	43	120	**175**	59	3.56	0.954
	Percent	2.70%	10.55	29.40%	**42.90%**	14.50%		
Efficient	Freq.	12	54	125	**167**	50	3.46	0.968
	Percent	2.90%	13.20%	30.60%	**40.90%**	12.30%		
Safe	Freq.	9	22	102	**184**	91	3.8	0.921
	Percent	2.20%	5.40%	25.00%	**45.10%**	22.30%		
Useful	Freq.	8	17	94	**205**	84	3.83	0.868
	Percent	2.00%	4.20%	23.00%	**50.20%**	20.60%		
Easy to learn	Freq.	11	34	102	**178**	83	3.71	0.972
	Percent	2.70%	8.30%	25.00%	**43.60%**	20.30%		
Easy to remember	Freq.	15	34	112	**176**	71	3.62	0.986
	Percent	3.70%	8.30%	27.50%	**43.10%**	17.40%		
Easy to evaluate	Freq.	13	43	120	**159**	73	3.58	1.003
	Percent	3.20%	10.50%	29.40%	**39.00%**	17.90%		
Weighted mean							3.6516	
							73%	
Std. Deviation							0.74579	

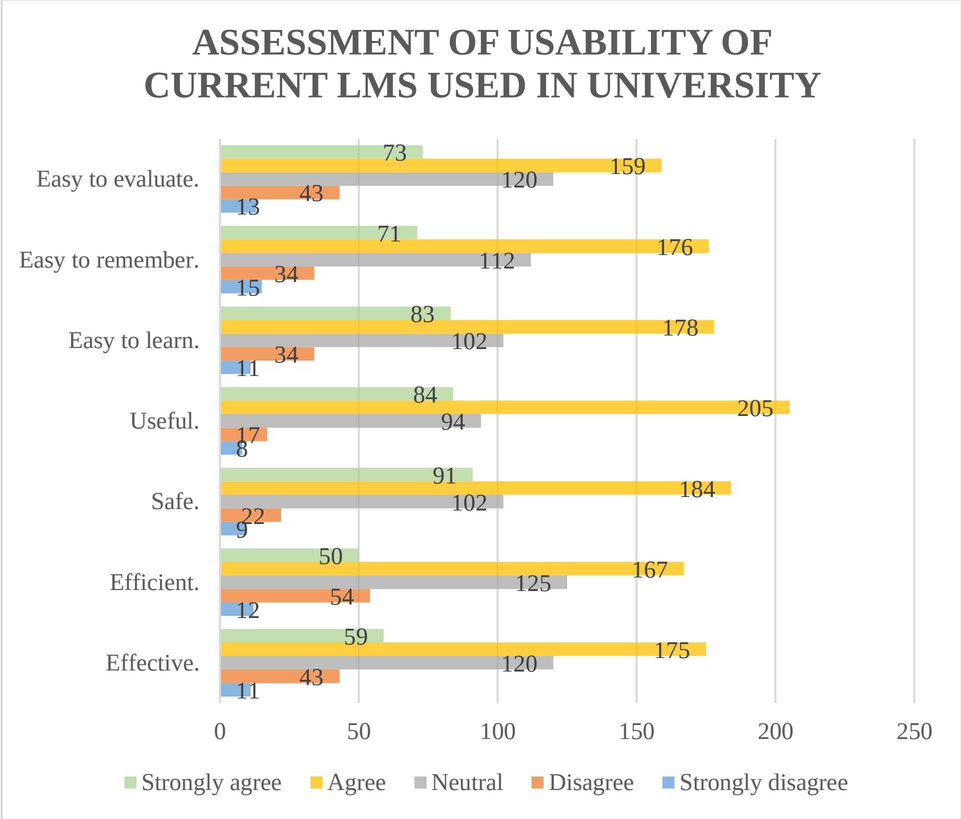


Figure 4.39: Descriptive results for current LMS usability (prepared by the researcher).

4.5.2.4 Analysis Results for Educational Barriers According to Gender and Year of Study

This section was intended to discover the relationship between educational barriers and study year of students, and to determine whether there was any relationship between gender and the educational barriers. Table 4.29 below shows the students' study year and the percentage of each barrier. The majority of participants (242) were in fourth year or above. Only 38 participants were in their first year. The majority (79.1%) of first-year students have high self-regulation scores as they are struggling with attention issues (53%). The same phenomenon is found in years 3, 4 or above. The bounded rationality is the highest for second-year students, who are also facing attention problems similar to students in other years. Generally, the results for the educational barriers in each year are quite similar.

Table 4.29: Descriptive results for educational barriers according to study year (prepared by the researcher).

Year of study at the University.	Educational Barriers	N	Percent	Mean	Std. D
Year 1	Self-regulation	38	**79.1**	3.9539	.50808
	Bounded Rationality	38	71.8	3.5921	.80365
	Attention	38	53.0	2.6477	.49189
	Memory	38	71.9	3.5965	.63864
	Confidence	38	69.3	3.4671	.50394
	LMS interface complexity	38	70.4	3.5216	.64374
Year 2	Self-regulation	39	74.7	3.7372	.50889
	Bounded Rationality	39	**77.8**	3.8878	.57052
	Attention	39	53.8	2.6895	.49209
	Memory	39	72.9	3.6453	.52032
	Confidence	39	69.0	3.4487	.55586
	LMS interface complexity	39	68.1	3.4048	.70403
Year 3	Self-regulation	89	**75.6**	3.7809	.57972
	Bounded Rationality	89	72.9	3.6433	.74060
	Attention	89	55.5	2.7747	.43361
	Memory	89	69.6	3.4775	.65674
	Confidence	89	70.2	3.5084	.49061
	LMS interface complexity	89	70.0	3.5004	.60586
Year 4 or above	Self-regulation	242	**75.8**	3.7920	.56454
	Bounded Rationality	242	75.0	3.7505	.71281
	Attention	242	54.8	2.7422	.43838
	Memory	242	70.2	3.5076	.62881
	Confidence	242	69.4	3.4680	.54754
	LMS interface complexity	242	69.7	3.4852	.64396

These results are presented in Figure 4.40. The pie chart shows each study year. The inner segment shows the educational barriers for fourth year students or above, and the second segment shows year 3, and so on. Each colour in the figure represents an educational barrier. The research determined that there are seven barriers that could influence students' decisions. Most of the students in each year appear to have high levels of self-regulation, while more than half of the students faced attention-related difficulties.

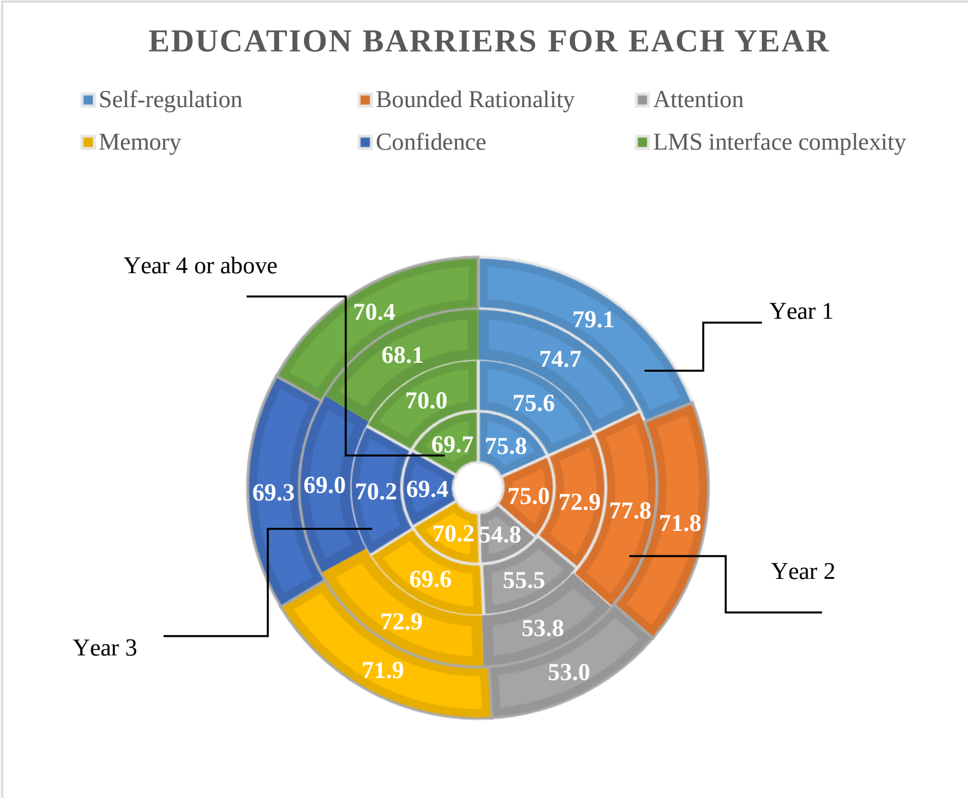


Figure 4.40: Descriptive results for educational barriers according to study year (prepared by the researcher).

In regard to gender, the results in Table 4.30 show there are only small differences between male and female regarding educational barriers.

Table 4.30: Descriptive results for educational barriers according to gender (prepared by the researcher).

Gender		N	Percent	Mean	Std. Deviation
Male	Self-regulation	203	75	3.7512	.52753
	Bounded Rationality	203	73	3.6687	.70438
	Attention	203	57	2.8415	.39877
	Memory	203	69	3.4631	.61529
	Confidence	203	70	3.5092	.50292
	LMS interface complexity	203	69	3.4291	.58768
	Self-regulation	205	77	3.8472	.58463

Female	Bounded Rationality	205	76	3.7817	.72733
	Attention	205	53	2.6304	.46897
	Memory	205	72	3.5813	.63306
	Confidence	205	69	3.4409	.55635
	LMS interface complexity	205	71	3.5389	.68507

Female respondents had slightly higher levels than males in terms of self-regulation, bounded rationality, and memory. However, males had slightly higher levels for attention and confidence (see Figure 4.41).

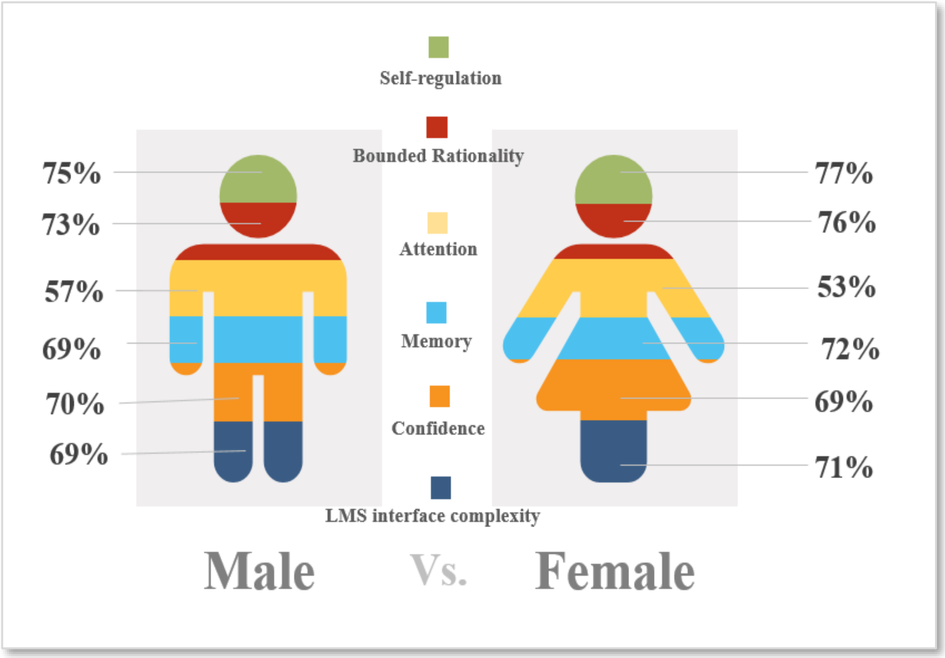


Figure 4.41: Descriptive results for educational barriers according to gender (prepared by the researcher).

4.5.2.5 Summary of the Results for Education Barriers

To sum up, the research showed that barriers can be affected by the four informational nudging methods proposed: feedback from instructors, peer comparison, reminders, and reduced distance. These cognitive, behavioral and environmental factors can influence students' decisions, and may go some way to explaining why students drop out or perform poorly. Therefore, understanding the cognitive, behavioral and environmental barriers is essential in order to design successful e-nudging interventions that reduce the detrimental impact of such barriers, because they secure the student's attention and could prevent unwise decision-making.

Table 4.31 below lists the educational barriers and the proportion of students who believe that they are affected by these barriers. These proportions are high even though the majority of participants are in fourth year or above, and have had a good deal of academic experience. Additionally, most of the data was collected from students in high-ranking universities in SA, and provide a high level of academic knowledge, educational skills and learning experience to their students.

Table 4.31: Educational barriers and the proportion of students (prepared by the researcher).

Educational barriers		**Proportion of students**
Behavior	Self-regulation	24%
	Bounded Rationality	25.50%
Cognitive	Attention	45.30%
	Memory	29.66%
	Confidence	30.50%
Environment	Current LMS interface functionality	34.34%
	HCI for Current LMS	28.77%
	Navigation for Current LMS	31.61%
	Usability for Current LMS	27%

4.5.3 Analysis Results for Students' Perception of the Implementation of e-Nudging in Higher Education

The third section in the students' survey questionnaire was intended to discover the perception of university students in regard to the implementation of an e-nudging model in higher education. EFA was applied to educe and explore the most important student opinions about the implementation of e-nudging. The extraction method utilized here was PCA, and the orthogonal rotation method was chosen with the Varimax technique. This section of the questionnaire contained 29 items. The data analysis results are given in Table 4.32. Factor analysis is appropriate for the dataset according to the scores obtained by the Kaiser-Meyer-Olkin (KMO) and Barlett's tests. The KMO score (0.959) was marvellous, indicating adequate sampling. Barlett's test score was Sig < 0.05, indicating a significant correlation between variables.

To determine the number of extracted factors, the researcher used eigenvalues and a scree test. Table 4.32 shows that three components have eigenvalues >1 for total variance explained. Hence, these three factors could be retained as they meet the cut-off criterion. The scree test gave a different result. There are two components above the break point, indicating that two factors can be retained. Therefore, several experiments were conducted to determine whether two or three factors needed to be retained and that could provide a clear structure with fewer factors.

The three rotated components represent an excellent result since the number of variables in each component were appropriate with all factor loadings being equal to or above 0.6. The communality values exceeded 0.4, indicating a good correlation among all variables. Moreover, internal consistency is excellent ($\alpha = 0.960$). The internal consistency of the first component is excellent ($\alpha = 0.978$). The second and third components had good consistency, with $\alpha = 0.853$ and $\alpha = 0.893$ respectively. These results achieved the established research standards. The three factors were labelled based on the variables with the highest loadings.

Table 4.33 lists the extracted new factors for “student’s perception of the implementation of e-nudging in higher education”. The majority of students understand that e-nudging is intended to encourage and motivate them to improve their academic performance. In addition, students indicated that an e-nudging model should be easy to use and navigate, and that HCI features should be taken into account and integrated in the design e-nudging.

Table 4.32: EFA results for “students’ perception of the implementation of e-nudging in higher education" (prepared by the researcher).

Perceptions of university Students

Total Variance Explained

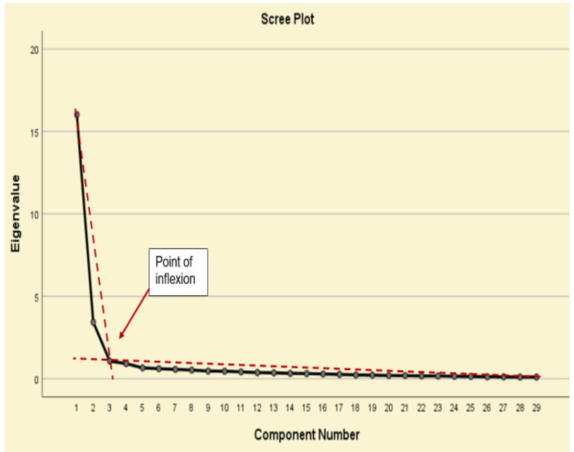
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.021	55.245	55.245	16.021	55.245	55.245	13.279	45.790	45.790
2	3.428	11.822	67.067	3.428	11.822	67.067	3.629	12.514	58.304
3	1.072	3.698	70.765	1.072	3.698	70.765	3.614	12.461	70.765
4	0.921	3.177	73.941					q	

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.959
Bartlett's Test of Sphericity	Approx. Chi-Square	11839.258
	df	406
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading 1	2	3	Communalities
Layout of the pages is suitable.	0.851			**0.784**
Text style is suitable	0.827			**0.765**
Font size is suitable.	0.827			**0.739**
Links are easy to find in the students’ interface.	0.825			**0.725**
Page layout is appropriate.	0.823			**0.732**
Hypermedia applications are easy to find in the students’ interface.	0.822			**0.763**
Easy to see.	0.817			**0.732**
Graphics are appropriate.	0.816			**0.717**
Efficient.	0.804			**0.747**
Elements of a site are easy to find in the students’ interface.	0.801			**0.687**
Easy to learn.	0.798			**0.692**
Useful.	0.797			**0.695**
Effective.	0.795			**0.707**
Safe.	0.792			**0.717**
Color is suitable.	0.791			**0.67**
Easy to remember.	0.782			**0.716**
Easy to evaluate.	0.781			**0.682**
Practical.	0.776			**0.732**
Easy to use.	0.774			**0.716**
Satisfying for students.	0.749			**0.634**
Motivate students to continue studying.		0.863		**0.793**
Motivate students to complete their course.		0.79		**0.734**
Improve student’s confidence to make a better educational decisions.		0.716		**0.69**
Assess students’ achievements privately among classmates during the semester (ex. You got 12 out of 15 in the midterm, you are higher than 10 student in your class, the average mark is 8)		0.653		**0.561**
Encourage students to manage their educational tasks.			0.766	**0.774**
Improve students’ educational decisions.			0.743	**0.678**
Encourage students to remember their educational tasks.			0.733	**0.751**
Encourage students to complete their educational tasks on time.			0.662	**0.688**
Cronbach's Alpha	**0.978**	**0.853**	**0.893**	



Perceptions and attitudes of university Students internal Consistency

Cronbach's Alpha	**0.968**

Table 4.33: New factor labels for "students' perception of the implementation of e-nudging in higher education" (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Test Stage	Factor loading
Students' e-nudging interface	Most of variables assessed the features for students' interface and students considered these features should be available when implementing e-nudge in higher education	The students' e-nudging interface should be	Layout of the pages is suitable.	0.851
		The students' e-nudging interface should be	Text style is suitable	0.827
		The students' e-nudging interface should be	Font size is suitable.	0.827
		The students' e-nudging interface should be	Links are easy to find in the students' interface.	0.825
		The students' e-nudging interface should be	Page layout is appropriate.	0.823
		The students' e-nudging interface should be	Hypermedia applications are easy to find in the students' interface.	0.822
		The students' e-nudging interface should be	Easy to see.	0.817
		The students' e-nudging interface should be	Graphics are appropriate.	0.816
		The students' e-nudging interface should be	Efficient.	0.804
		The students' e-nudging interface should be	Elements of a site are easy to find in the students' interface.	0.801
		The students' e-nudging interface should be	Easy to learn.	0.798
		The students' e-nudging interface should be	Useful.	0.797
		The students' e-nudging interface should be	Effective.	0.795
		The students' e-nudging interface should be	Safe.	0.792

		The students' e-nudging interface should be	Colour is suitable.	0.791
		The students' e-nudging interface should be	Easy to remember.	0.782
		The students' e-nudging interface should be	Easy to evaluate.	0.781
		The students' e-nudging interface should be	Practical.	0.776
		The students' e-nudging interface should be	Easy to use.	0.774
		The students' e-nudging interface should be	Satisfying for students.	0.749
Student motivation	Variables in this factor focus on e-nudging and should motivate students to continue to complete the course and be confident about making better decisions.	The implementation of an e-nudging model in SA's higher education sector is intended to	Motivate students to continue studying.	0.863
		The implementation of an e-nudging model in SA's higher education sector is intended to	Motivate students to complete their course.	0.79
		The implementation of an e-nudging model in SA's higher education sector is intended to	Improve student's confidence to make a better educational decision.	0.716
		The implementation of an e-nudging model in SA's higher education sector is intended to	Assess students' achievements privately among classmates during the semester (ex. You got 12 out of 15 in the midterm, you are higher than 10 students in your class, the average mark is 8)	0.653
Student encouragement	All variables concentrate on e-	The implementation of an e-nudging model in SA's higher education sector is intended to	Encourage students to manage their educational tasks.	0.766

	nudging and should encourage students by assisting them to remember, complete and manage educational tasks.	The implementation of an e-nudging model in SA's higher education sector is intended to	Improve students' educational decisions.	0.743
		The implementation of an e-nudging model in SA's higher education sector is intended to	Encourage students to remember their educational tasks.	0.733
		The implementation of an e-nudging model in SA's higher education sector is intended to	Encourage students to complete their .educational tasks on time	0.662

4.5.4 Analysis Results for Student Assessments of e-Nudging Techniques

The last section of the survey concerned the e-nudging techniques, and the student survey data related to the implementation of the four proposed digital nudging interventions. The survey questions were designed to assess the best method for designing four digital nudging interventions (i.e., feedback, reminder, peer comparisons, and reduced distance) in the LMS. EFA was conducted to determine the students' preferred intervention methods. The PCA extraction method and the orthogonal rotation method with the Varimax technique were applied. Eleven variables were included in this section. According to the results obtained by the Kaiser-Meyer-Olkin (KMO) and Bartlett tests, the dataset was suitable for factor analysis. The KMO score was middling (0.741), but indicated adequate sampling. Barlett's test score (Sig < 0.05) showed that the variables were significantly correlated. The analysis results are summarized below in Table 4.34.

Then, the researcher used eigenvalues and the scree test to determine the number of extracted factors. Table 4.34 shows that three components have eigenvalues >1 for total variance explained. To start with, three factors can be retained as they meet the cut-off criterion. The scree test also showed there are three components above the break point. Hence, three factors can be retained. The researcher examined the results to determine whether these three factors would provide an appropriate structure with fewer factors.

The three factors rotation yielded a good result as the number of variables in each component were suitable and all factor loadings were equal to or above 0.6. The communality values exceeded 0.4 which indicated a good correlation between the variable and all other variables. Moreover, factor analysis showed that internal consistency was acceptable ($\alpha = 0.763$). The internal consistency for the first factor was acceptable ($\alpha = 0.758$). The second factor's internal consistency was good ($\alpha = 0.868$). The internal consistency for the third factor was questionable ($\alpha = 0.876$ and $\alpha = 0.879$ respectively). This result achieved the established research standards. Three factors were extracted and labelled based on the variables with the highest loadings.

Table 4.35 sums up the extracted new factors for “Assess e-Nudging Techniques by Students”. There are three methods that are favoured by the majority of students: LMS, SMS and e-mail. This was taken into account in the design of the e-nudging model.

Table 4.34: EFA results for "assessment of e-nudging techniques by students" (prepared by the researcher).

Assess e-Nudging Techniques by Students

Total Variance Explained

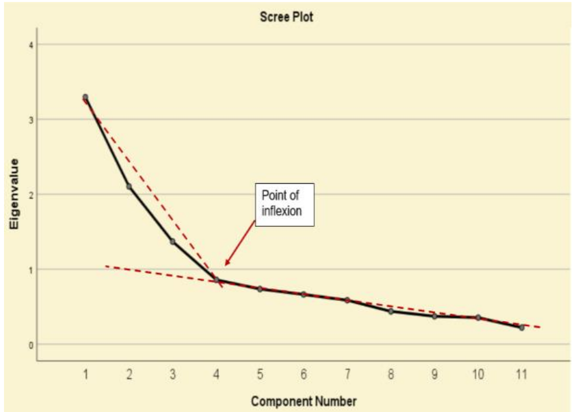
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.295	29.959	29.959	3.295	29.959	29.959	2.542	23.107	23.107
2	2.104	19.127	49.086	2.104	19.127	49.086	2.454	22.312	45.419
3	1.369	12.442	61.527	1.369	12.442	61.527	1.772	16.109	61.527
4	0.858	7.804	69.331						

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.741
Bartlett's Test of Sphericity	Approx. Chi-Square	1411.886
	df	55
	Sig.	0.000

Rotated Component Matrixa

Variables for Collaboration	Component/ Factor Loading			Communalities
	1	2	3	
It is better to receive a reminder about education tasks by: - Receiving an electronic reminder via the students' interface in LMS.	0.759			**0.578**
It is better to receive a reminder about education tasks by: - My teachers posting announcements in LMS.	0.752			**0.575**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Receiving an electronic notification via the students' interface in LMS.	0.723			**0.553**
It is better to receive a feedback about my performance in relation to classmates by: - The teacher posting feedback privately in LMS.	0.683			**0.493**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Teachers posting an announcement in LMS.	0.596			**0.436**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Receiving an SMS on my phone.		0.905		**0.828**
It is better to receive a feedback about my performance in relation to classmates by: - Getting an SMS sent to my phone.		0.9		**0.822**
It is better to receive a reminder about education tasks by: - Receiving an SMS on my phone.		0.822		**0.707**
It is better to receive a reminder about education tasks by: - A reminder email sent to me by the teachers.			0.786	**0.63**
It is better to receive a notification about the number of weeks remaining before the end of the course by: - Email sent to me by the teacher.			0.753	**0.656**
It is better to receive a feedback about my performance in relation to classmates by: - Email sent to me by the teacher.			0.674	**0.491**
Cronbach's Alpha	**0.758**	**0.868**	**0.633**	



Assess e-Nudging Techniques by Students internal Consistency	
Cronbach's Alpha	**0.763**

Table 4.35: New factor labels for "assessment of e-nudging techniques by students" (prepared by the researcher).

New Factor Labels	Description of Factor Labels	Original Factors for each variable from initial e-nudging model for higher education for SA	Variables for Test Stage	Factor loading
Receive e-nudging technique via LMS	All variables focus on receiving all four e-nudging interventions through the students' interface in LMS. There are two ways to receive e-nudging: via electronic intervention or teachers posting announcements in LMS	receive a reminder about education tasks	It is better to receive a reminder about education tasks via an electronic reminder on the students' interface in LMS.	0.759
		receive a reminder about education tasks	It is better to receive a reminder about education tasks via teachers' postings in LMS.	0.752
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an electronic notification on the students' interface in LMS.	0.723
		receive feedback about my performance in relation to classmates	It is better to receive feedback about my performance compared to that of peers via the teacher posting feedback privately in LMS.	0.683
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an LMS posting by teachers	0.596
Receive e-nudging	All variable concentrate on	receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course via an SMS on my phone.	0.905

technique via SMS	receiving all four e-nudging interventions through the SMS on students' phone	receive feedback on my performance in relation to classmates	It is better to receive feedback about my performance compared to that of peers via an SMS sent to my phone.	0.9
		receive a reminder about education tasks	It is better to receive a reminder about education tasks via SMS on my phone.	0.822
Receive e-nudging technique via email	All variables focus on receiving all four e-nudging interventions through the SMS on students' phone	receive a reminder about education tasks	It is better to receive a reminder about education tasks via email from my teachers.	0.786
		receive notification about the number of weeks remaining before the end of the course	It is better to receive a notification about the number of weeks remaining before the end of the course by email sent to me by the teacher.	0.753
		receive feedback about my performance compared with that of peers	It is better to receive feedback about my performance in relation to classmates by email sent to me by the teacher.	0.674

4.5.5 Analysis Results for Students' Comments

The students' survey contained one open-ended question to give participants the opportunity to express their opinions on issues that the researcher might not have thought of when developing the survey. Open-ended questions increase dataset diversity and provide rich and relevant information for research (Albudaiwi, 2017; Hyman & Sierra, 2016).

The open-ended question in the student survey gave respondents the opportunity to express their opinions and thoughts regarding the implementation of an e-nudging. The comments were analysed by using word cloud via NVivo 1.0 software. The word cloud is a visualization method that gives an overview what words are more often appears in your text (i.e. words with highest frequency) (Heimerl et al., 2014).

There were 22 comments provided in the survey by university students. The word cloud for the student's comments is illustrated in Figure 4.42. The most frequent word found in these comments were "students" followed by "instructors". The comments pertained to the role of instructors in improving students' academic performance. Students commented that they received inadequate feedback from their instructors. Moreover, the students liked the idea of e-nudging and hoped that it would be easy to use, would help them to track their grades, and would be efficient and effective. Also, they suggested that e-nudging should facilitate communication between students and lecturers. Also, there is a lack of knowledge on how to use computers, so the students and lecturers need to be trained.

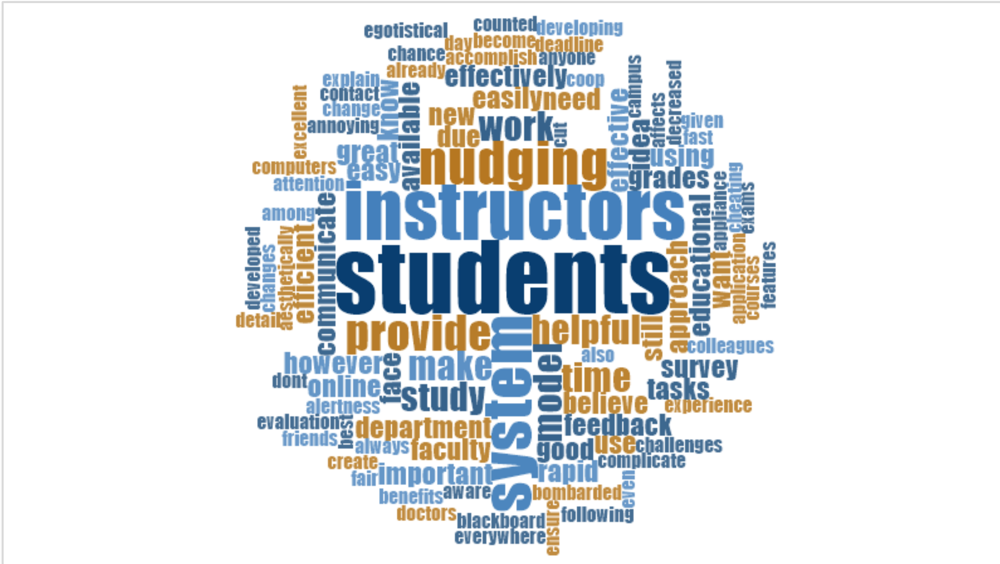


Figure 4.42: Word cloud based on students' comments on the implementation of an e-nudging model (prepared by the researcher).

4.6 Summary of Findings from Surveys of Academics, IT Staff and Students

The online survey analysis was the first phase in the research method and is used to assess the effectiveness of e-nudging model for higher education in SA. The analysis results indicate the factors that should be included in the e-nudging model. Also, the online surveys were intended to evaluate the perceptions of university students, academics, and IT staff regarding the implementation of an e-nudging in SA's higher education sector and to determine whether the e-nudging model will meet the requirements of university students.

The data collected from both surveys (i.e., academics, IT staff and students) was analysed using descriptive statistics and Exploratory Factor Analyses (EFA) methods.

The factors in the initial e-nudging model were analysed via EFA. The first step was to check the suitability of the data for factor analysis by testing sample size, factorability of the correlation matrix and sufficiency of the sample via Kaiser-Meyer-Olkin (KMO) and Bartlett's test. Then, Principal Component Analysis (PCA) was applied for factor analysis.

Two techniques were utilized to identify the number of factors to retain in the e-nudging model: the eigenvalue greater than 1.0 and the scree test. This research adapted the orthogonal method with the Varimax technique to make it easier to interpret results. In addition, the factor loading for each variable should equal six or above to provide a strong correlation and better representation of the factor. Moreover, to ensure that all variables measured the same component, the minimum for Cronbach's coefficient alpha value was determined as $\alpha > 0.6$. The solution was assessed to ensure that it met the research criteria (see sub-section 4.3.2). After EFA, the factors in the initial e-nudging model were changed. These changes are explained below:

- The planning stage contained three factors named "Mapping the decision process", "e-nudging goals" and "e-nudge constraints" with $\alpha = 0.913$, $\alpha = 0.851$ and $\alpha = 0.847$ respectively. The internal consistency for the planning stage after factor analysis was excellent ($\alpha = 0.935$).
- The second stage was the analysis stage. This stage included two factors: "e-nudging techniques" and "optimal e-nudging moment" with $\alpha = 0.843$ and $\alpha = 0.84$ respectively. The internal consistency after factor analysis for analysis stage was good ($\alpha = 0.879$).
- The third stage is design. This stage comprised three generated factors called "usability", "HCI" and "e-nudging prototype" with $\alpha = 0.920$, $\alpha = 0.912$ and $\alpha = 0.894$ perceptively. The design stage internal consistency was excellent as $\alpha = 0.948$.
- The final stage was the testing stage. The first factor is "environmental influence" with $\alpha = 0.869$. The second factor was labelled "test e-nudging" with $\alpha = 0.891$. The internal consistency after factor analysis for this was excellent ($\alpha = 0.906$).

Additionally, two new factors emerged from the responses to the open-ended questions: training and support for both instructors and students, and awareness of e-nudge and its purpose.

Table 4.36 shows the changes made to the e-nudging model based on the results from the academics and IT staff survey. The red colour shows the new factors generated by EFA.

Table 4.36: Summary of factor analysis results from academics and IT staff survey (prepared by the researcher).

Stage	Before factor analysis (Initial e-nudging model for higher education in SA)	After factor analysis
Planning Stage	Identify e-nudging model goals	e-nudging goals
	Identify constraints	e-nudging constraints
	Understand decision process	Mapping the decision process.
	Determine barriers and influences	
	Mapping decision process with barriers identified	
Analysis Stage	Select nudging methods	e-nudging techniques
	Identifying the optimal digital nudge moment	optimal e-nudging moment
Design Stage	HCI	HCI
	Navigation	
	Usability	Usability
	Design e-nudging prototype	Design e-nudging prototype
	Ethics	
Test Stage	Test nudging impact	Test e-nudging
	Test the delivery method of digital nudge	
	Test the optimal moment	
	Test usability	
	Environment and Technology changing	Environmental influence
Training and support Stage		Training instructors and students
		Support instructors and students

The aim of the students' online survey was to determine whether the e-nudging would meet the requirements of students in higher education. The students' survey was analysed by applying descriptive statistics to discover the barriers that students are most struggling with and that possibly influence their educational decision-making (see sub-section 4.5.2). This research focused on behavioural, cognitive, and environmental barriers. Results show that 24% of university students lack self-regulation. Regarding bounded rationality, 25.50% of university students have problems related to behaviour. The proportion of students who are struggling to maintain attention is 45.30%. Moreover, 29.66% of university students have issues with memory. The percentage of university students with low levels of confidence is 30.50%. Between 25% and 34% of students face issues related to the LMS environment, such as system functionality, HCI, navigation and usability. These factors might be help to explain why students drop out or perform poorly. Therefore, understanding the cognitive, behavioural and environmental barriers is essential in order to design successful e-nudging interventions that reduce the detrimental impact of these factors on students' decision making.

The online surveys sought the opinions and perception of academics, IT staff and students in regard to the implementation of e-nudging in SA higher education. The majority of respondents understand that e-nudging is intended to encourage and motivate student to improve their academic performance. In both surveys, respondents indicated that usability and HCI features should be taken into account when designing an e-nudge model.

Moreover, the open-ended questions sought answers regarding the implementation of an e-nudging. The academics and IT staff suggested that e-nudging should be easy to implement and could include a feature that encourages students to visit the academic advisor regularly. The students' comments indicated that there was a lack of adequate feedback from their lecturers. The students liked the e-nudging model and indicated that e-nudging should be easy to use, help students track their grades, and be efficient and effective. Finally, all participants believed that both students and lecturers should be trained in the use of e-nudging.

Both of the online surveys aimed to determine the best method for designing the four digital nudging interventions (i.e., feedback, reminder, peers comparison, and reduced distance) (see sub-section 4.4.4 and sub-section 4.5.4). The majority of participants (i.e., academics, IT staff and students) prefer to receive the e-nudging through LMS, SMS and e-mail.

Finally, the e-nudging model is highly likely to meet the requirements of students in the higher education sector for several reasons. First, it has been shown that behavioural, cognitive and environmental factors pose significant challenges to tertiary students and can influence their education-related decisions. However, these issues can be resolved by integrating e-nudging in the LMS. It is essential to know and understand the issues that are detrimental to students' academic performance, and to discover the reasons for students' poor academic performance or their dropping out of university. Interventions via e-nudging could help to overcome or mitigate the influence of these issues. Second, the majority of participants (i.e., academics, IT staff and students) understand that the purpose of e-nudging is to encourage and motivate students to improve their academic performance. The students' comments reveal that e-nudging is an excellent idea that will help them to make better decisions in order to improve academic achievement. The majority of all participants prefer to receive the e-nudging through LMS, SMS and e-mail.

4.7 The Enhanced E-nudging Model after the Quantitative Phase

The purpose of this phase was to assess factors of the e-nudging model for higher education in SA derived from the literature review. The research applied EFA to analyse the data from academics and IT staff survey. The results indicated the factors that should be retained and the new ones that should be added to the e-nudging model. Moreover, there are factors generated from the analysis of participants' comments in response to the open-ended question in the academics and IT staff survey.

The modified e-nudging model is depicted in Figure 4.43. Ten improved factors were derived from the EFA. Two new factors emerged from comments made by academics and IT staff regarding factors that might facilitate or influence the e-nudging model.

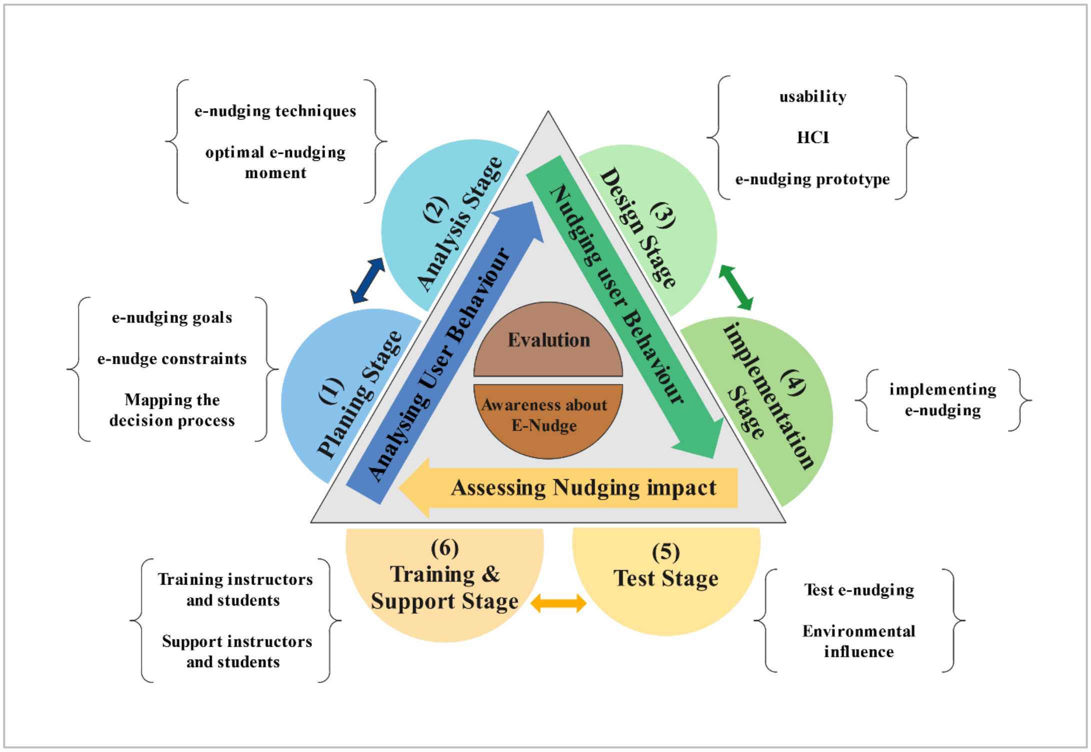


Figure 4.43: Enhanced e-nudging model for higher education in SA (prepared by the researcher).

The factors extracted after applying the EFA method are described below.

- **The planning stage**

  The first factor is named "e-nudging goals" which must be established to avoid any possible conflict with the goals of the university or the students. Moreover, by understanding the e-nudge goals, the designer can understand which educational decisions and barriers should be considered in order to achieve these goals.

  The second factor is called "e-nudge constraints". Identifying e-nudge constraints such as culture, ethics, government, is an important step before developing an e-nudging system.

The last factor is named “mapping the decision process”. This factor aims to analyze the context and the educational tasks by understanding how and when students make decisions and their particular circumstances when they make educational decisions in order to design an effective e-nudge. In addition, key educational barriers and influences that may affect the students’ decisions, need to be identified.

- **The analysis stage**

  The first factor is labelled “e-nudging techniques”. This relates to the development of an e-nudging system that can significantly overcome barriers (behavioral, cognitive, and environmental) to improve students’ educational decision and, ultimately, their academic success. The second factor named “optimal e-nudging moment”. The time of the nudging must be considered, which is essential in the e-nudging model as explained by (Purohit & Holzer, 2019).

- **The design stage**

  The first factor is called “usability” and the third factor is called “HCI”. When designing e-nudge, it is important to consider and implement the HCI and usability design principles in order to meet students’ requirements and improve their educational decisions. The second factor is labelled “e-nudging prototype”. This factor aims to give an overview of the final design of the e-nudging model and show how e-nudging will appear among other elements in the students’ interface in LMS.

- **The test stage**

  The first factor is labelled “test e-nudging”. This factor relates to the measurement of the effectiveness of the nudging and how the nudge appears in the system among other elements in the interface. The delivery method of the nudging (i.e., notification, sound, vibration or message) and the timing of nudging must be measured to ascertain their influence on student behavior. The second factor is labelled “environmental influence”. This factor relates to the changing nature of the environment and technology that should be considered when developing effective e-nudging that meets the students' requirements.

Two new factors were generated from open-ended questions regarding factors that might facilitate or influence the initiating e-nudging. These factors emerged from comments made by academics and IT staff. The factors extracted after analysing the comments are:

- **Training and support for both instructors and student**

  Training helps users adapt to changes in a new system and also the changes in their roles after implementing e-nudge, as training can improve computer skills and user confidence when using an e-nudging system. Adequate support provided from the very beginning will help users avoid mistakes and associated nudge issues. Support can help users to complete their work efficiently and effectively.

- **Awareness about e-nudge**

  This is a controversial issue. If people resist e-nudging or prefer not to be monitored, they will resist the e-nudge even though it is tailored to their preferences. In this case, awareness of the nudge would be likely to reduce its effect. On other hand, when the person appreciates the effort that has gone into developing the nudge, this awareness might increase the influence of the nudge so that students can make better decisions (Cutler, 2016).

However, the implementation and evaluation stages remained in the same place without any changes in the enhanced model in order to examine them in the interview research phase.

The enhanced e-nudging model presented in Figure 4.43 will be examined and evaluated again following the results obtained from the qualitative phase (i.e., interviews) presented in chapter 5. The factors in the enhanced e-nudge model were assessed by experts in order to validate and confirm those that should be retained in the final e-nudging model.

4.8 Chapter 4 Summary

The aim of this chapter was to present the main changes in the initial model resulting from the quantitative phase of the mixed-methods approach used in this research. The chapter explained the survey design and the development of the surveys question, and described the target population and how and where data was distributed and collected. Moreover, the results from the analysis of the survey were presented, and these led to the improved e-nudging model. It explained the main changes made to the initial e-nudging model and why certain factors were retained and others deleted based on the survey analysis. The main outcome was the enhanced e-nudging model for higher education in SA.

This chapter leads into the next phase of this research which is the qualitative phase (i.e., interviews). The interviews were conducted with university academics (considered as experts) in order to validate and confirm the factors that should be retained in the final e-nudging model.

Chapter 5. Qualitative Data Analysis

5.1 Introduction

The previous chapter explained the quantitative phase of the research. It explained the design of this phase, the target population, and how and where the survey questionnaires were distributed and the data collected. The online survey data was analysed using Microsoft Excel 16 and IBM SPSS Statistics software (version 24). The analysis results were presented, and these led to improvements to the initial e-nudging model. The main outcome was the enhanced e-nudging model for higher education in SA.

In this chapter, the second phase (i.e., interview phase) of this research is discussed. The chapter presents the procedures for designing and conducting the semi-structure interviews. Interview data was used to refine and assess factors in the refined e-nudging model derived from the quantitative phase. As mentioned, this research involves two sequential phases for the data collection. The quantitative method was conducted first to provide a wide view of the research problem, followed by the qualitative method to provide a comprehensive and in-depth knowledge in order to refine and enhance the research results and answer research questions.

Furthermore, the semi-structured interview examined the expert academics' perception of the enhanced e-nudging model. The purpose of the interviews was to improve the enhanced model by validating the relevance of factors which were derived from the quantitative phase, and extracting new factors based on the interview data.

In this chapter, details of the interview design are presented in section 5.2, followed by the interview analysis methods in section 5.3, while section 5.4 provides the interview results. Finally, the chapter describes the main changes that were made to the enhanced model. It explains how certain factors remained unchanged and how other factors were deleted based on the analysis of the interview data. Section 5.6 modifies and presents the final e-nudging model. The chapter concludes with a summary in section 5.7.

5.2 Interview Design

For this stage, the enhanced research model was designed based on the results of the survey analysis. This research study applied an explanatory sequential design using a mixed-methods approach to achieve research objectives and to answer the research questions. Then, Thematic Analysis (TA) was used to code and explore themes to address the research problem.

The outcome of this stage was a final e-nudging model after confirming relevant factors and removing factors based on the results of the interview data analysis. To achieve this, a semi-structure interview was designed for the expert academics who work in Saudi universities and are interested in educational development or nudge theory. The following sub-sections present the interview structure and interview questions, the interviewees, and channels used for data collection, the interview timeline and the interview outcomes prior to releasing the final e-nudging model.

5.2.1 Interview Structure

In this research, the interview was conducted online using the Qualtrics platform. Thus, it is important to structure an interview to ensure that it is simple and with easy-to-answer questions in order to address the research questions effectively. A well-designed interview will increase the response rate. The online interview covered the following themes: factors for the e-nudge model and participants' perceptions, as shown in Table 5.1.

Table 5.1: Mapping table for interview (prepared by the researcher).

Interview Themes	Expert academics	Research Objective	Research Question
Factors for e-Nudging Model	√	**RO1**	**RQ1**
Planning Stage			
▪ e-nudging goals			
▪ e-nudge constraints			
▪ Mapping the decision process			
Analysis Stage			

▪ e-nudging techniques			
▪ optimal e-nudging moment			
Design Stage			
▪ Human Computer Interaction (HCI)			
▪ Usability			
▪ e-nudging prototype			
Implementation Stage			
▪ Implementing e-nudging			
Testing Stage			
▪ Test nudging			
▪ Environmental influence			
Training and support Stage			
▪ Training instructors and students			
▪ Support instructors and students			
Evaluation Factor			
Awareness Factor			
Perception of:	√	**RO2**	**RQ2**
▪ **Factors of the enhanced e-nudging model for higher education in SA.**			

The interview was divided into three sections; each section pertained to specific themes based on what the research was seeking from expert academics. The first section contained multiple choices with single-answer questions, and two open-ended questions to collect demographic information about participants and their knowledge and experiences of e-nudging in the education field. The second section contained a five-point Likert scale to rate the importance of each factor to be considered by participants for inclusion in the final design of an e-nudging model for the SA higher education sector. The scale was anchored by ‘extremely important’, ‘very important’, ‘moderately important’, ‘slightly important’, and ‘unimportant’, with values ranging from 5 to 1 respectively. As indicated in chapter 4 sub-section 4.2.1, the five-point scale is familiar to participants and is therefore a popular measurement instrument. It is an effective way of capturing a significant amount of the true variance in the participants’ opinions and reducing frustration level. The section also contained one open-ended question inviting participants to comment on the importance of the factors in the enhanced e-nudging model. The last question required a ‘yes’ or ‘no’ response, with one open-ended question to assess the relationship between factors and whether they belonged to the right stage. The open question gave interviewees the opportunity to explain their opinions regarding factor relationships.

The third section sought participants’ perceptions of the enhanced e-nudging model. This section comprised a figure of the enhanced model and one multiple choice question with a single answer, to assess the model then participants gave reasons for their assessment. Also, the section contained questions requiring ‘yes’ or ‘no’ responses to determine participants’ perceptions of the enhanced e-nudging model by evaluating the relationship between stages in the model. In addition to the ‘yes’ and ‘no’ questions, open-ended questions were included to give respondents the opportunity to express their opinions of e-nudging factors, and to suggest other factors that should be included to facilitate or influence the e-nudging model, or factors that should be deleted or placed in a different position.

The interviews were conducted online using the Qualtrics platform. The online interview contained 37 questions and the estimated time required for completion was 20 minutes. Finally, a letter was attached to inform participants about the aim of the research and to give a brief explanation of the e-nudging. The interviews were conducted in the English language since the participants are expert academics.

5.2.2 Developing the Interview Questions

The online interview was developed according to the research needs. The interview comprised three sections as depicted in Figure 5.1. The interview contained sections for: demographic information and background experience, e-nudging model factors, perception of e-nudging model factors. Each section is described in detail below.

The first section of the interview collected demographic information to determine whether the participants constituted a representative sample of the interview target population. Also, it gave an indication of the level of knowledge and experience of the participants who assessed the e-nudge model. The demographic information section contained three questions with one single-choice and two open-ended questions. The questions in this section were developed by the researcher and reviewed by the supervisor.

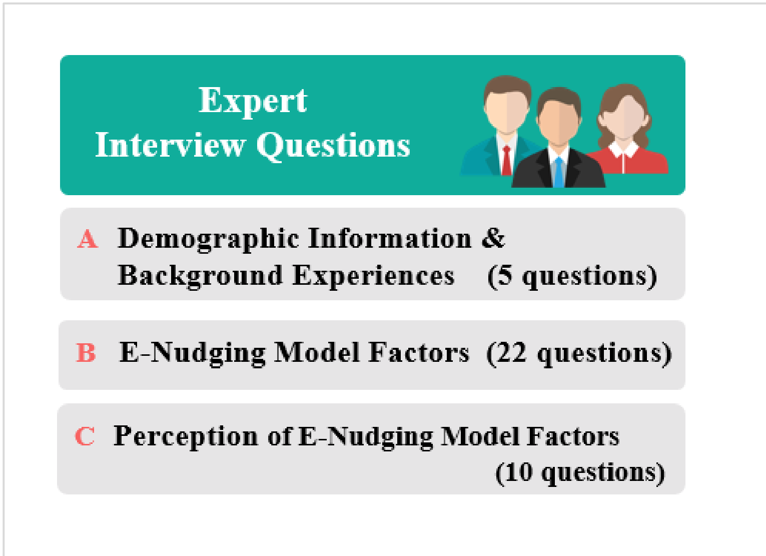


Figure 5.1: Interview sections for target population (prepared by the researcher).

The questions in section two were intended to assess the enhanced e-nudging model and identify specific factors that must be considered at each stage. The enhanced e-nudging model comprised six stages with each stage containing specific factors that should be implemented in order to meet model requirements (see Table 5.1).

To measure the importance of each factor that must be considered when implementing an e-nudging, each factor was measured by rating statements to measure the importance of each factor in each stage. The interview items were presented on a five-point Likert scale, anchored by ‘extremely important’ (5), ‘very important’ (4), ‘moderately important’ (3), ‘slightly important’ (2), and ‘unimportant’ (1) (Passmore et al., 2002).. This structure allowed respondents to rate the importance of each factor. After this, one open-ended question asked participants to give reasons for their rating of the importance of the factors in the enhanced e-nudging. At the end of the section, yes and no question with one open-ended question to assess the relationship between factors and whether they belong to the right stage. The open question gave interviewees the opportunity to explain their opinions regarding factor relationships. The questions in this section were developed by the researcher and reviewed by the supervisor.

Questions in the third section related to participants' perception of the enhanced e-nudging. The section included a figure of the enhanced model then presented questions regarding the model. The first question was a multiple-choice question requiring a single answer. The participants assessed the e-nudging model then provided the reasons for their assessment. Also, the section contained three questions requiring a 'yes' or 'no' answer, and open-ended question after each to give respondents the opportunity to express their opinions of the e-nudging factors in the model, and to suggest other factors that might facilitate or influence the e-nudging model, or suggest those that should be deleted or placed in a different position. At the end of the section, three 'yes' and 'no' questions with an open-ended question for each were designed to evaluate participants' perceptions of the relationship between stages in the model. The questions in this section were developed by the researcher and reviewed by the supervisor see the process in Figure 5.2.

For the interview, the researcher worked with the supervisor to develop the questions based on the themes that needed to be investigated in order to address the research question. The interview questions in the three sections were refined then critiqued by the researcher and supervisor and refined once more before applying for ethic approval.

After the interview was developed and approved by the supervisor and co-supervisors, ethics approval was sought from the Human Research Ethics Committee of Curtin University (HREC). The interview was approved (approval No. HRE2020-0060). Then, the final version of the online interview was developed using the Qualtrics platform. Finally, the pilot study was conducted to improve validity (Kelle et al., 2019). Also, a cover letter was attached to the interview material to give a brief explanation of the research aims, purpose, instruments structures, ethics etc. The pilot study results revealed that no changes were required for the survey items or the design. The online surveys were reviewed by supervisors after the pilot study. All stages of the online interview development process are shown in below. The final copy of the interview is presented in Appendix E

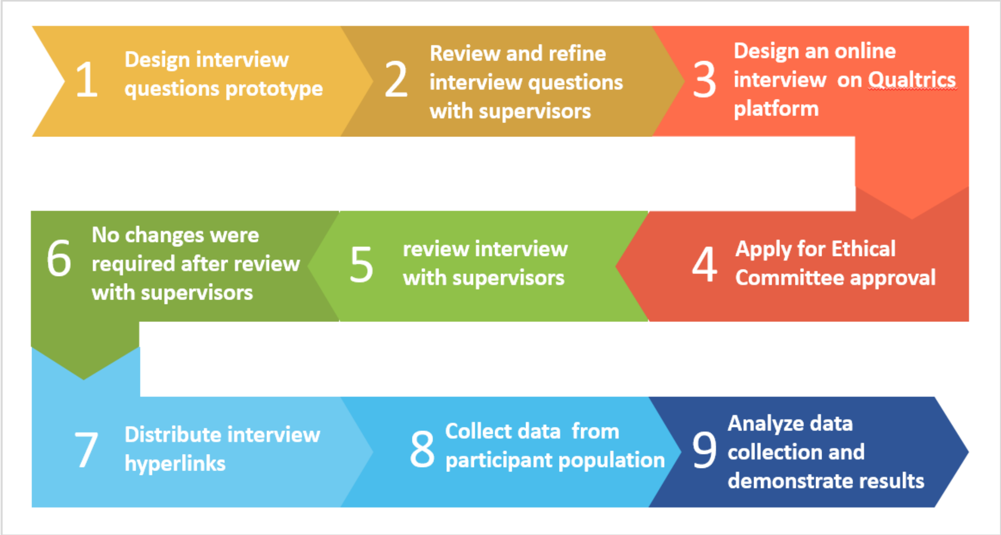


Figure 5.2: Developing the interview questions (prepared by the researcher).

5.2.3 Interview Sample

The sample population for the online interview comprised expert academics who work in public and private universities in SA and are interested in educational development or nudge theory. However, the researcher decided to stop interviews after the fifth round as theoretical saturation had been achieved According to Saunders et al. (2016, p. 1897) "saturation is achieved when new data repeat what was expressed in previous data". Some participants did not complete the interview because they were busy.

Due to the Covid-19 pandemic, the interviews had to be conducted online by developing and distributing the interview via Qualtrics platform as face-to-face interview was impossible to conduct according social-distance rules in the country and the vaccine was only for elder people and individual has vital or special medical cases. According to that the researcher attempted to conduct virtual meetings such as via Skype, but most of the interviewees preferred receiving the interview questions as a hyperlink via emails or LinkedIn profile pages to complete it at their convenience, mainly due to having other time-competing obligations.

The number of responses from the experts were 32 in total, 25 of which were valid and complete, as shown in Table 5.2. The final sample that was used for this research was obtained from several private and public SA universities.

Table 5.2: The interview target populations and response rates (prepared by the researcher).

Interview population	Number of received responses	Number of valid and completed responses
Expert academics	32	25

The completed and valid response will analyze by utilizing Thematic Analysis (TA). Participants involved in this research were coded in order to maintain their anonymity. Participants were from several universities in SA, mainly those that were the highest-ranking universities in the Arab world; two of these universities were ranked first and second in 2019. Table 5.3 illustrates the qualifications, experience, and positions of each participant. The participants' knowledge of e-nudging in higher education was revealed in their interview answers.

Table 5.3: The interviewees' qualifications, experience and positions - developed by the researcher. (prepared by the researcher)

Participants	Level of knowledge of e-nudging in higher education	Gender	Job Title	Participant's level of qualification and employment
Participant A	Medium	Male	Assistant Professor	PhD in educational instructional technology. He has been an Assistant Professor in a Saudi University and also works as consultant for the Ministry of Education, SA. He is interested in e-learning, multimedia design for learning and instructional design.
Participant B	Low	Male	Assistant Professor	PhD in information system and technology. He is vice dean of the Institute of Research and Consultancy at a Saudi University. He

				is interested in teaching and learning in higher education.
Participant C	High	Male	Assistant Professor	PhD degree in Information Systems. He has a sound knowledge of nudge in the education field. Currently, he is the dean of computer science and information technology in a university.
Participant D	Medium	Male	Assistant Professor	PhD in computer science. He is highly interested in web development and security.
Participate E	Low	Female	Assistant Professor	PhD degree in economics. She was chairperson of Scientifics committee in Economics departments. She has a strong history of working in Saudi higher education and is interested in learning strategies.
Participant F	medium	Male	Lecturer	Master's degree in digital innovation and digital transformation. His knowledge regarding digital nudge is medium. He has done some research in the education sector.
Participant G	High	Male	Assistant Professor	PhD in information systems. He has supervised many students who do research in the higher education field. He is working with his colleagues on many projects to improve learning and education environments in his university.
Participant H	Medium	Male	Assistant Professor	PhD degree in applied linguistics. He is head of the e-learning unit at his university. He has several licenses and certifications from ELC eLearning college.
Participant I	Low	Male	Assistant Professor	PhD degree in Pharmacology and Toxicology. His knowledge regarding nudge in education is low. He read many research about nudge individual to be healthy. He is interested in learning techniques for medicine students.
Participant J	Medium	Female	Professor	PhD degree in digital signals and imaging processing. She has been director of post-graduate committee in the information technology department of a Saudi university for more than five years. She is interested in education and e-learning.

Participant K	Medium	Female	Lecturer	Master degree in instructional technology. She has collaborated with Tatweer Educational Technologies, a Saudi company offering high quality education and communication digital and technology solutions. She has between 4-5 years' experience as a lecturer.
Participant L	Low	Male	Associate Professor	PhD in computer science. He is vice dean of development- Faculty of Computer and Information Technology. He has skills in e-learning, analytical skills and computer science and data analysis.
Participant M	High	Male	Associate Professor	PhD in educational instructional technology. He is interested in developing teachers' programs, cognition and learning. He is working as an international accreditor for continuing education and training (IACET)
Participant N	Low	Male	Associate Professor	PhD in computer science. He is interested in learning and knowledge analytic, web science.
Participant O	Low	Female	Associate Professor	PhD in Sociology. She is interested in the sociology of education.
Participant P	Low	Male	Lecturer	Master degree in business administration (M.B.A). He is the head of quality and academic accreditation unit in the finance and investment department. He is interested in decision systems, developing courses.
Participant Q	Medium	Female	Lecturer	Master's degree in educational instructional technology. She is interested in learning environments, course design, adopting new learning technologies.
Participant R	low	Female	Lecturer	Master degree in advanced computer science. She is currently PhD candidate. She has little knowledge of nudge, but she is interested in analysis and design of user interfaces
Participant S	High	Male	Lecturer	PhD degree in decision making, project management. Also, he was a former deputy minister for higher education in the Ministry of Education SA. He has sound knowledge of nudge in higher education,

				learning strategies and techniques, e-leaning system.
Participant T	Low	Male	Associate Professor	PhD degree in Mechanical & manufacturing engineering. He was head researcher for postgraduate studies for two years. He is interested in decision support systems and has been teaching for more than 16 years.
Participant U	Low	Male	Associate Professor	PhD degree in artificial intelligence, computer science. He is interested in AI applications in education and learning.
Participant V	Medium	Male	Associate Professor	PhD in data mining. He is interested in AI systems and machine learning. He is working on AI-based platform to automatically generate and grade assessment tasks.
Participant W	Low	Male	Professor	PhD degree in informatics. He has been working as a Professor of e-learning and computer education for more than a year. He has high experiences in e-learning and education.
Participant X	Medium	Male	Assistant Professor	PhD degree in educational instructional technology. He is head of the Instructional Technology department in a university. He is interested in learning environment and resources, designing courses, workshop and training sessions.
Participant Y	Medium	Female	Associate Professor	PhD degree in educational instructional technology. She is working as senior consultant of e-learning and distance education; she has a medium knowledge of how apply nudge in higher education. She is greatly interested in improving higher education.

5.2.4 The Interview Data Collection Channels and Timeline

As mentioned above, the online interview was designed using the Qualtrics platform. The online interview was distributed to interviewees via emails and LinkedIn. The latter channel has been used for gathering interview data and the response rate is rapid.

Furthermore, in LinkedIn, the user profile provides information regarding job position, academic level, research works and interested area. This information assisted the researcher to distribute the interview hyperlink to academics who were really interested in educational development or nudge theory.

Via LinkedIn, a direct message was sent to academics. These direct messages enabled the researcher to access potential participants for the interview. A total of 42 direct messages were sent to academics working in Saudi universities, and 15 official emails. A total of 35 responses were received.

The data collection period was around seven weeks. The collection was conducted from 22 March 2021 to 7 May 2021. The first two weeks were taken up with finding participants willing to be interviewed. First, the researcher sought potential participants via LinkedIn and universities' official websites. After that, the researcher sent the necessary information about the interview and the link to the interview and the attached cover letter briefly explaining the research aims, purpose, instruments structures, ethics etc. The distribution stages of the interviews are shown in Table 5.4. In week one, 8 responses were received, six in week two, ten in week three, five in week four, and six in week five, yielding a total of 32 interviewees. Each response was reviewed after it was received. Respondents who provided little or incomplete data were not considered for the research. This screening process resulted in 25 potential interviewees. Then, the interviewing process stopped based on theoretical saturation Saunders et al. (2016, p. 1897). In other words, the new data was repeated, and the e-nudge model's themes and criteria already have been assessed and confirmed by most of participants.

Table 5.4: The distribution stages of the interviews (prepared by the researcher).

Round	Start date	End date	No. of Messages	No. of received interviews	No. of completed interviews
Week 1	3/04/2021	9/4/2021	15	8	6
Week 2	10/4/2021	16/4/2021	15	7	6
Week 3	17/4/2021	23/4/2021	12	10	9
Week 4	24/4/2021	30/4/2021	10	3	2
Week 5	1/5/2021	7/5/2021	5	4	2

5.2.5 Interview Validity

The interviews were designed to ensure that the data derived from them was valid and trustworthy. The following points summarize the process that was utilized to ensure the interviews were valid and trustworthy:

- Interviews were semi-structured with open-ended questions.
- The interview questions were designed based on the survey outcomes.
- A pilot study was conducted to increase validity.
- The participants were carefully selected to ensure their appropriateness for the research.
- The data transcript of each interview was reviewed repeatedly to check for new data and determine whether new coding was required.
- The researcher made an effort to provide rich data by ensuring data saturation (the point at which no new information continues to emerge), and providing accurate findings by reviewing, with PhD supervisors, all analysis processes and decisions.
- To differentiate between researcher words and the participants' words, the participants' comments are presented in italic.

5.3 Interview Analysis Method and Tools

Descriptive Statistics and Thematic Analysis (TA) was conducted to analyse data from the online interviews and examine the factors derived from the quantitative phase (i.e., online survey). The collected data was analysed using Microsoft Excel 2016, SPSS software version 26 and NVivo 1.0. The following subsection explains the analysis method applied to the interview data.

5.3.1 Descriptive statistics for interview

As mentioned in chapter 3 sub-section 3.7.1, descriptive statistics are used to present basic information about variables in the dataset and explore patterns and relationships between the variables. It is an effective method used to give a better understanding of research results obtained from the data, and enables the data to be presented in graphs and tables.

5.3.2 Qualitative Thematic Analysis

The purpose of collecting qualitative data is to provide in-depth knowledge enabling a detailed interpretation of the research topic. Thematic analysis (TA) is a common qualitative analysis approach utilized to analyse textual data and explain themes (Vaismoradi et al., 2016; Xu & Zammit, 2020). It is a flexible and accessible method. Thematic analysis is a systematic process that involves coding, examination of meaning and theme creation from interesting data; subsequently, these themes are used to answer the research problem (Maguire & Delahunt, 2017; Vaismoradi et al., 2016).

Two procedures can be used to apply thematic analysis to interpret raw data: deductive and inductive. In deductive analysis, the initial themes are derived from theory and prior research frameworks (Fereday & Muir-Cochrane, 2006; Nowell, Norris, White, & Moules, 2017). This method is useful when the themes have already emerged and are used to cluster the raw data. Conversely, the inductive thematic analysis is used to derive themes from raw data. It is a process of coding the data without trying to fit it into an existing coding framework or analytical preconceptions of the researcher (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006; Nowell et al., 2017).

In this research, the combined technique of inductive and deductive thematic analysis (i.e. hybrid approach to thematic analysis) was applied to interpret interview transcripts via NVivo 1.0 (Fereday & Muir-Cochrane, 2006). The deductive analysis was selected to enhance the e-nudging model based on the quantitative data, and simplify the interpretation of the interview data and define themes. The inductive analysis was also utilized to seek or explore new themes.

The six-phase framework proposed by Braun and Clarke (2006) is very useful for conducting thematic analysis. This framework was adopted for the qualitative phase of this research. Each of the six phases is described in more detail below.

- **Become familiar with the data**

  The first step involves reading and re-reading the transcript. Then, it is useful to make notes and write down initial thoughts and opinions. Highlighting and making notes help the researcher to start thinking about the meaning of data. This research yielded a total 275 pages of transcription obtained from 25 interviews. The transcripts were read repeatedly to ensure that the researcher was very familiar with the data.

- **Generate initial codes**

  The coding step reduces a large amount of data by coding each data segment that captures something interesting or potentially relevant to the research question (Maguire & Delahunt, 2017). It is important to write a clear code name and mark the text after interesting data has been extracted and identified. The coding process ends when the data are fully coded and the data relevant under each generated code has collected and organized in appropriate way (Braun & Clarke, 2012). The coding process can be conducted on hard-copy or computer software. In this research, NVivo 1.0 was used to generate the codes.

- **Search for themes**

  A theme is a pattern that captures something interesting or significant in relation to the research question (Braun & Clarke, 2006). The step comprises reviewing the initial codes to identify how relevant codes could be collated into a theme (Braun & Clarke, 2012; Maguire & Delahunt, 2017; Xu & Zammit, 2020). A theme is formed by clustering codes that seem to share some similar features and reflect meaningful patterns in the data (Braun & Clarke, 2012). As mentioned previously, the hybrid approach to thematic analysis was adopted in this research. Some themes were already identified from the quantitative phase. Additionally, several themes emerged from interview transcripts. The "miscellaneous" theme is used to collect all the codes that seem to not fit under other themes. Then this theme might end up being a new theme or being deleted (Braun & Clarke, 2012; Xu & Zammit, 2020). Finally, the enhanced e-nudge model can be further refined or modified if any new themes emerge from the analysis.

- **Review themes**

  Firstly, the data associated with each theme should be checked to ensure that it really supports and forms coherent theme. In this step, some codes might be discarded or relocated under another theme. Then, the candidate themes should be checked to see whether they accurately represent the meanings of entire dataset (Braun & Clarke, 2012; Maguire & Delahunt, 2017; Xu & Zammit, 2020). When the themes do not reflect data relevant to the research question, further reviewing is necessary to ensured that an adequate amount of data is captured. The review step includes: generating new themes, and tweaking or deleting existing themes (Braun & Clarke, 2012).

- **Define and name themes**
  This phase contains two steps. First, the essence of each theme is defined (Braun & Clarke, 2006) to show how themes relate to each other but do not overlap. The next step is giving each theme a name. The label should be informative, succinct, attractive and easy to understand (Braun & Clarke, 2012).
- **Writing up**
  In this step, the analysis results are reported. The writing-up involves explaining the interview design, the target population, and data collection process. Moreover, the reason for conducting the thematic analysis to generate themes should be explained. In the end, there should be an explanation how the analysis outcome has answered the research question.

5.4 Interview analysis results

This section presents the results of the analysis of data collected from experts academics (interviewees). In total, *n=25* valid and completed responses were obtained and transcribed. Descriptive statistics were applied to the demographics information section, while Thematic Analysis (TA) were applied to e-nudging model factors, and the perception of e-nudging in higher education. The following sub-sections will present in detail the results of data analysis.

5.4.1 Interviewees' demographic profiles

The items in the demographic section collected participant information in regard to academic qualifications, years of experience in their current job, and level of knowledge about e-nudging techniques.

The total sample size *(n=25)* comprised expert academics who work in Saudi Arabian universities. The majority of participants were experts with job titles as follows: Assistant Professor (36%), Associate Professor (36%) followed by Lecturer (20%), and Full Professor (8 %), illustrated in Figure 5.3.

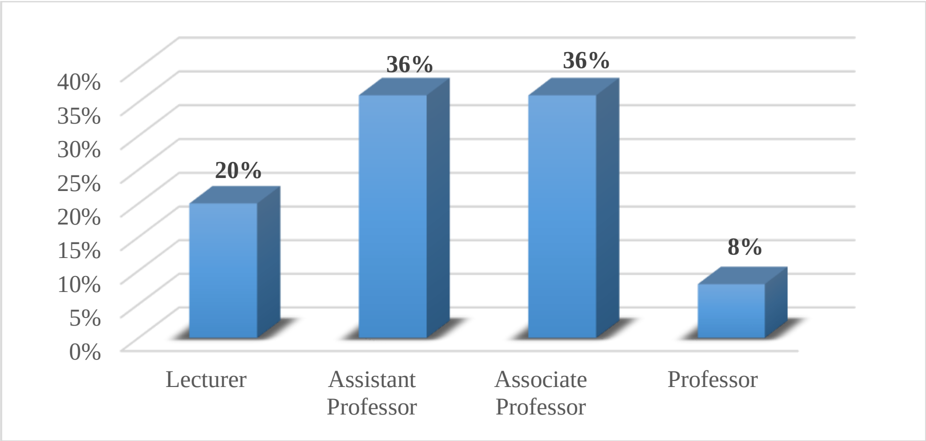


Figure 5.3: Interviewees' education level (prepared by the researcher).

In terms of participants' length of time in their current job, only 16% had held the position for 1 year or more than 5 years; 36% for between 1 and 3 years; and 32% for between 4 and 5 years. These statistics are depicted in Figure 5.4.

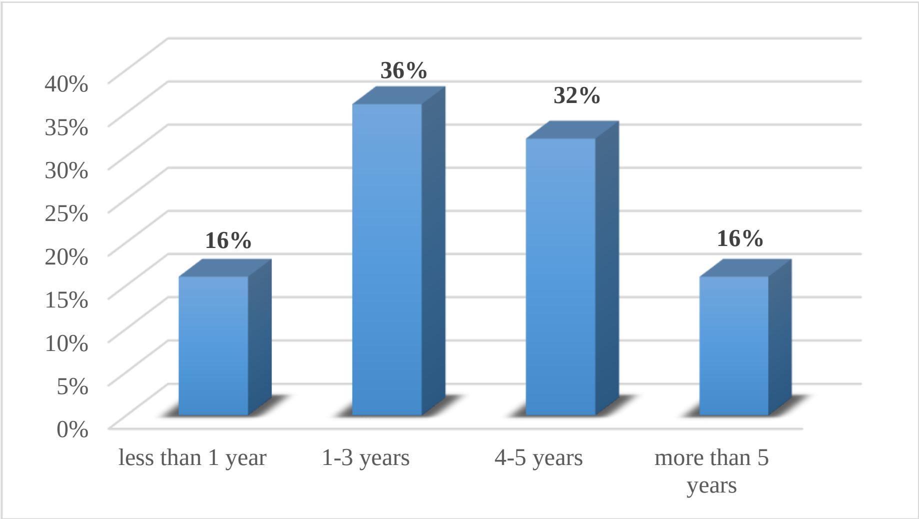


Figure 5.4: Interviewees' number of years in current job (prepared by the researcher).

Figure 5.5 illustrates participants' level of knowledge in regard to e-nudge techniques. These results indicate the extent to which participants are familiar with e-nudge, and their ability to evaluate model factors. Forty-four percent of the respondents had limited knowledge of e-nudge techniques, 40% respondents had medium knowledge, and only 16% had a sound knowledge of e-nudge techniques.

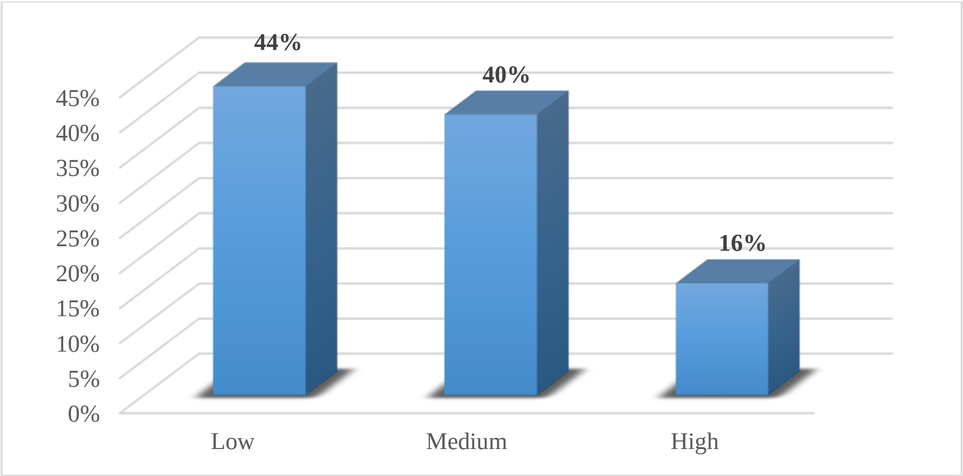


Figure 5.5: Interviewees' level of knowledge of e-nudge techniques (prepared by the researcher).

The interviewees’ demographic information is summarized in Table 5.5

Table 5.5: Response rate and proportions for the interviewees’ demographic features (prepared by the researcher).

Demographic Feature	Respondents’ options	Response rate	Proportion
Education Level	Lecturer	5	20%
	Assistant Professor	9	36%
	Associate Professor	9	36%
	Professor	2	8%
The number of years has been in the current job	less than 1 year	4	16%
	1-3 years	9	36%
	4-5 years	8	32%
	more than 5 years	4	16%
Level of knowledge in regard to e-nudge techniques	High	11	44%
	Medium	10	40%
	Low	4	16%
Total		25	100%

5.4.2 Suggested factors from based on their experiences

This section contained only two open-ended items (nos. 4 & 5) intended to seek information about the interviewees' knowledge of and experience with e-nudging in SA higher education. The items were:

- Please share with us your general knowledge and experience of e-nudging in higher education.
- From your experience, what are the important factors that should be considered prior to introducing e-nudging into a learning management system such as Blackboard at Saudi universities?

These questions were utilized to encourage the participants to give their feedback, thoughts and opinions about the important factors that should be considered in order to introduce e-nudging successfully based on their experiences and knowledge. This question also helped to prepare the participants for the next part of interview (i.e., assessing the enhanced e-nudging factors) as the question had prompted them to form an initial vision about the factors.

The interviewees revealed similar opinions regarding the application of e-nudge techniques in SA higher education. The results revealed that they all agreed that e-nudging could improve the students' academic achievements and stir student's behaviour to make better education decisions. They provide positive comments about using the e-nudging techniques specially now during the online and virtual classes. They believed the e-nudge can stir student behaviours to make better decisions during the Covid-19 pandemic. In addition, some participants believed that e-nudge would help to achieve the Saudi Vision 2030.

> *Minor change in educational environment to make efficient outcomes.* **Participant A**

> *Understand education system in SA, adopt the Saudi 2030 vision and rules. Design nudge that meets students' needs, easy to use, meet educations objectives in university.* ***Participant E***

> *The nudge is new concept that used to improve individual decision, in education field, this concept can be used to help student to be more responsible, control, engage.* **Participant F**

> *It is good idea to use nudge in education sector. During the covid-19 pandemic, their education was affected and student need motivation to continue online*. **Participant K**

> *I think the nudge can provide benefits for Saudi student and help them to achieve their goals.* **Participant V**

Given their knowledge and experiences of e-nudging in higher education, interviewees believed that the introduction of e-nudging in SA universities would be welcomed and supported by government education policy, faculty members and students in higher education. This related to the third research question on how e-nudging model could meet the requirements of students.

The second question (no. 5) focused on the important factors that should be considered prior to introducing e-nudging into a learning management system. This question aims to provide better understanding of the phenomenon as the researcher can compare the respondents' suggested factors with the factors of the enhanced e-nudging model derived from the survey responses. This question is related to the research question regarding the specific factors that must be considered when developing an e-nudging model for higher education in SA. Some participants mentioned factors that were already in the model such as nudge goal, constraints, usability, and HCI. Test nudge impact. However, some responses revealed new factors such as ethics and freedom of choice, and understanding students' challenges, need for privacy, and culture. Table 5.6 show the list of factors, and response rate of interviewees.

> *Easy to use and privacy, understand decision, design suitable nudge interventions, test nudge*. **Participant A**

> *Determine student need, define the problem, design an appropriate nudge that deal with problem (there are different types of nudges) test nudge*

impact, ethics, consider usability, HCI as the nudge apply in LMS. **Participant C**

Understand the environment, set nudge goal, design effective nudge. **Participant L**

Define the goal, check organization constraints and polices, design nudge, test and evaluation. **Participant M**

Table 5.6: The response rate for interview question 5 (prepared by the researcher).

Factors already in the enhanced e-nudging model	
Factor	**No. of interviewees who mention it**
e-nudging goals	9
e-nudge constraints	3
Mapping the decision process	6
e-nudging techniques	3
optimal e-nudging moment	1
Human Computer Interaction (HCI)	8
Usability	16
e-nudging prototype	15
Implementing e-nudging	2
Test nudging	13
Environmental influence	6
Training instructors and students	1
Support instructors and students	1
Evaluation	4
Awareness	1
New factors derived from responses to question 5	
Factor	No. of interviewees who mention it
Determine or understand student barriers	9
Ethics	6

5.4.3 Analysis Results for e-Nudging factors Assessed by Interviewees

The interview items were designed to assess the enhanced e-nudging model factors and identify the specific factors that must be considered when implementing an e-nudging model for the higher education sector in SA. An e-nudging model comprises six stages with each stage containing specific factors that must be incorporated to generate a significant e-nudge model that meets higher education needs and improves students' educational decisions in order to improve their academic performance.

The enhanced e-nudging model comprises six main stages: planning, analysis, design, implementation, testing, training and support stage and evaluation stages. Also, the enhanced e-nudging model contained a new factor that was derived from survey, called 'awareness'.

Thematic analysis (TA) methods were utilized to assess, confirm, and explore new factors in each of the e-nudging model stages.

Each stage comprised three questions, apart from the evaluation and awareness factors in the first two questions only. The first item used a five-point Likert scale on which participants rated the importance of each factor for the final design of an e-nudging model for the Saudi Arabian higher education sector. The scale was anchored by 'extremely important', 'very important', 'moderately important', 'slightly important', and 'unimportant', with values ranging from 5 to 1 respectively. This was followed by one open-ended question asking participants to explain their previous rating. At the end of the section, there was a question requiring a 'yes' or 'no' in addition to one open-ended question asking interviewees to assess the relationship between factors and whether they were positioned in the right stage. The following sub-section presented the results of thematic analysis for each stage in the enhanced e-nudging model.

5.4.3.1 Analysis Results for Planning Stage

The planning stage consisted of three factors: e-nudging goals, e-nudging constraints and mapping the decision process. The thematic analysis resulted in 64 codes under four themes and in one main stage. Three of these factors were already in the enhanced model, and one was added as illustrated in Figure 5.6.

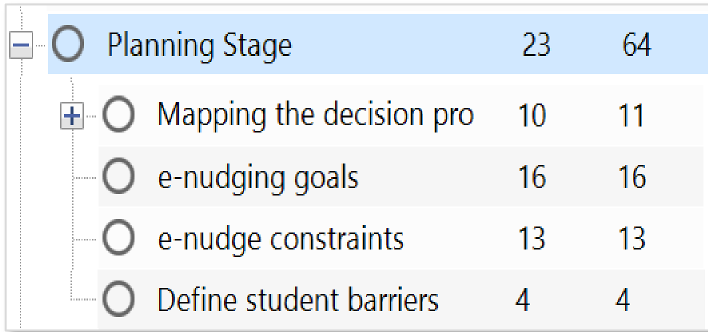


Figure 5.6: NVivo coding results for planning stage (prepared by the researcher).

The interviewees were asked to rate the importance of each factor in the planning stage. The majority of interviewees believed the three existing factors were very important or extremely important. Only two participants saw the e-nudge constraint factors as moderately important and four participants thought that mapping the decision process was moderately important as well. The Figure 5.7 below illustrates the interviewees' responses regarding the importance of three factors in the planning stage.

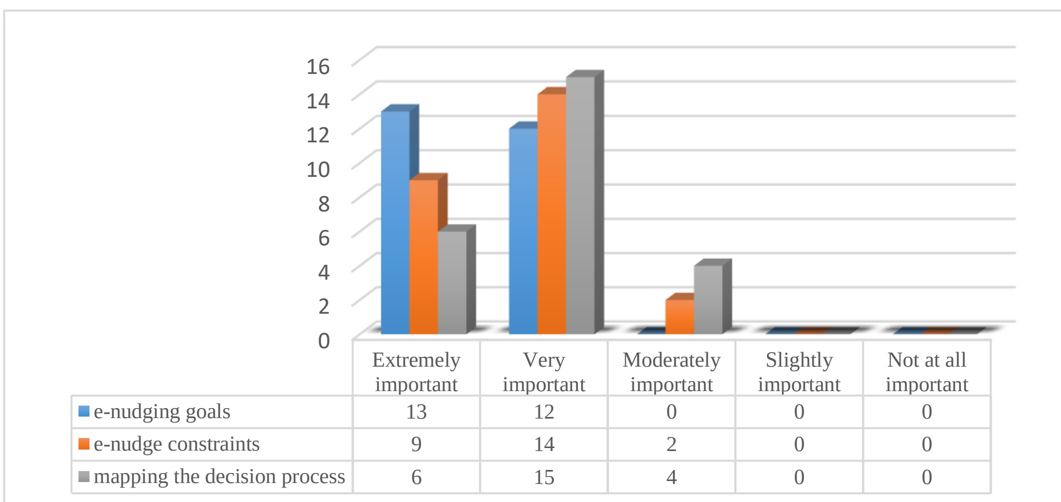


Figure 5.7: Interviewees' responses regarding the importance of three factors in planning stage (prepared by the researcher).

The next question asked interviewees to give their reasons for this rating. Some of the interviewees' responses are given below.

Planning affects the successful execution. The poor plan that has no enough information and consideration, the execution will be full of mistakes and waste resources. **Participant A**

It is guide development's team through other phases. When the team set a clear goal, know constraints, understand the decision process, this highly reduce mistake and develop effective nudge for student. **Participant B**

The planning shows the start and end point for nudge development. **Participant D**

When you design e-nudge innervations the plane stage clarifies all aspects of your project. **Participant F**

It is most vital part for reducing risk and failure rates. Proper planning allows teams to ensure that risks can be manageable. **Participant K**

- **e-nudging goals**

The thematic analysis resulted in 16 codes. It is clear that all the interviewees agreed that e-nudge goals were important and should be included in the e-nudge model for SA higher education (see Figure 5.7). Some interviewees' comments are given below.

Setting clear goals for e-nudging would help deciding on the choices of e-nudging. **Participant P**

Define nudge goal draw the path for other steps. **Participant R**

Define goals and the constraints are important step because they help guides your focus and reach your targets. **Participant S**

Setting goals and knowing the constraints is an essential step because they identify your destination and provide a road map for getting there. **Participant T**

- **e-nudging constraints**

  Thirteen codes were generated by the thematic analysis. Fourteen interviewees believed that e-nudging constraints was a very important factor, while 9 thought that it was an extremely important factor. Only two interviewees thought it was moderately important as illustrated in Figure 5.7. Below are some of the interviewees' comments on this factor.

  > *The constraints show you what can or not can do*. **Participant R**

  > *Define goals and the constraints are important step because they help guides your focus and reach your targets.* **Participant S**

  > *It provides all the work details and consideration to reduce the errors rate and manage risk.* **Participant X**

- **Mapping the decision process**

  Eleven codes were generated by the thematic analysis. Fifteen participants believed that e-nudging constraints was a very important factor, and six participants thought it was an extremely important factor (Figure 5.7). Only four interviewees thought that it was moderately important. The following comments indicate their views:

  > *The mapping step is good. It shows how the students make decision, and how can be nudge the student.* **Participant C**

  > *They define how to solve the problem or improve the system.* **Participant E**

  > *The most important factor is mapping decision that provide the main outline to the next step.* **Participant Q**

  > *You need understand and break down decision process to outline the critical actions the impact Saudi students and influence them to make bad or wrong decisions*. **Participant U**

Only three interviewees commented on the name of the factor. These interviewees suggested that the factor be renamed to clarify its purpose. Their comments are given below.

> *I suggest renaming the factor to make it more clear what do you mean.* **Participant C**

> *The Factor (mapping the decision process) is better to rename it like define student decision process*. **Participant D**

> *I recommend rewriting the name of the (mapping decision process) to avoid the confusing between stakeholder decision and the students or user decision.* **Participant M**

Four interviewees suggested a new factor for the planning stage called "determine students' barriers" before mapping the decision process factor. As explained in section 4.7, the mapping decision process is used to understand how and when students make decisions, as well as their circumstances such as how information related to the decision is gathered and presented, and whether students' emotions influence their decision. The factor "understand students' barriers" was included in the initial e-nudging model. However, the results of the survey of academics and IT staff showed that respondents had different opinions about this factor. Thus, it was discarded from the enhanced model. However, the interview results indicated that this is considered to be a factor and should be included in the e-nudge model for higher education. This is shown in the comments below.

> *I recommend you add a new factor called understand student behaviour or understand student obstacles in university. Because you need to determine what the students struggling with to design effective e-nudge*. **Participant F**

> *If the "mapping decision process" covered the "define students' barriers" this great. If no I think this factor is very important*. **Participant- G**

> *I think "determine Students Mental issues" is important factor in order to target and solve the problem to design successful nudge.* **Participant- H**

> *The mapping is factor is also important, but I think there is important factor should be added before it which is (determine the heuristics and biases the influence decision) and focus on the education context.* **Participant- S**

The next question (no. 8) sought interviewee's opinions about the relationships between factors and whether they belong to the right stage. All the interviewees agreed that all the factors seem to be related to each other and have a logical relationship, and all of them belong to the planning stage as showed in Figure 5.8.

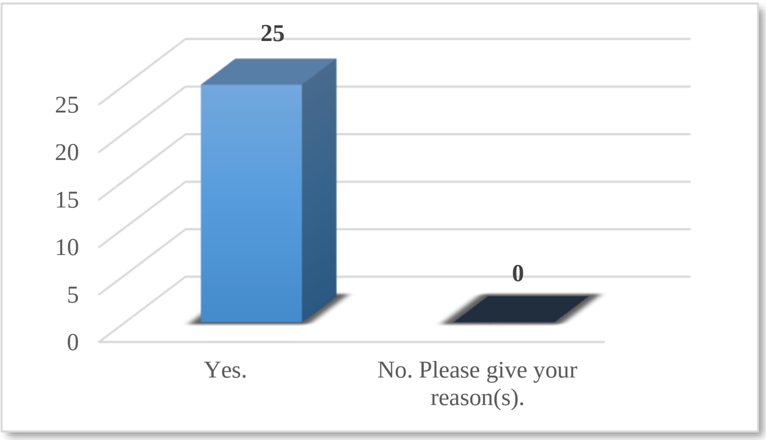


Figure 5.8: The interviewees' assessment of relationships between factors in the planning stage (prepared by the researcher).

Hence, most of the interviewees agree on the importance of including e-nudge goal, e-nudge constraints and mapping decision process factors in the e-nudging model. The name of the factor related to the mapping decision process was changed by adding the word 'student' to clarify the purpose and functionality for the factor. The new factor "define student barriers" was added as many interviewees believed this factor plays an important role in ensuring a successful nudge in LMS. Also, this factor was included in the initial model derived from the literature review. The result of this stage is demonstrated in Figure 5.9 below.

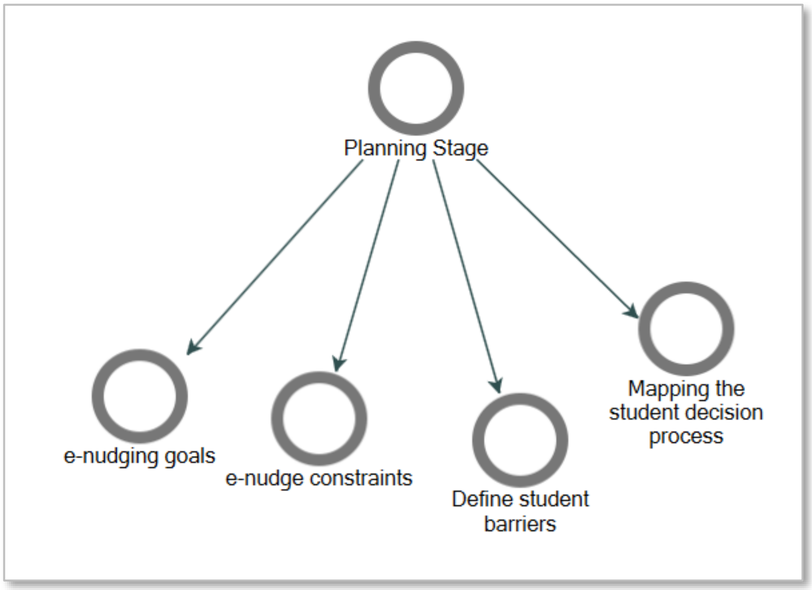


Figure 5.9: Coding tree for the planning stage using NVivo (prepared by the researcher).

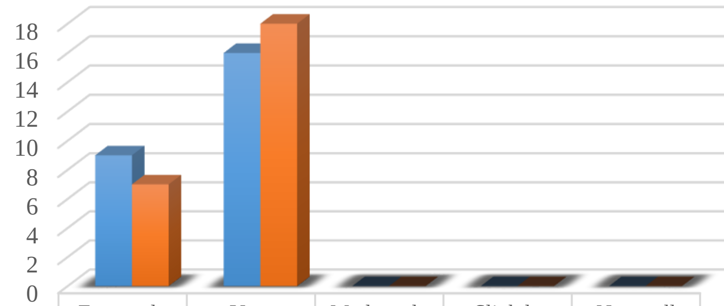
5.4.3.2 Results for Analysis Stage

Two factors are involved in analysis stage: e-nudging techniques and optimal e-nudging moment. The thematic analysis yielded 50 codes under two themes and one main stage as illustrated in Figure 5.10.

Analysis Stage	25	50
optimal e-nudging mo	9	9
e-nudging techniques	18	19

Figure 5.10: NVivo coding results for analysis stage (prepared by the researcher).

Interviewees were asked to rate the importance of each factor in analysis stage. The results showed that all interviewees believed these two factors were very important or extremely important. Figure 5.11 below shows the interviewees' responses regarding the importance of two factors in the analysis stage.



	Extremely important	Very important	Moderately important	Slightly important	Not at all important
e-nudging techniques	9	16	0	0	0
optimal e-nudging moment	7	18	0	0	0

Figure 5.11: Interviewees' responses regarding the importance of two factors in analysis stage (prepared by the researcher).

The next question asked interviewees to give reasons for their rating. Some of their comments are quoted below.

> *The stage helps to explore any error or gaps in early time before design. This help save time and money. Also help do overcome these problems before execution.* **Participant H**

> *Provide a better understand to the development team about what required to achieve, when and how to conduct the nudge to motivate students*. **Participant U**

> *It is analysing and measuring all the e nudge techniques and select which meet the needs and constraints. The stage helps to make early decision to continue or stop process without losing time and money.* **Participant X**

To decrease the risks, time, money, effort and provide final requirements for the applying e-nudge. **Participant Y**

- **e-nudge techniques**

  The thematic analysis resulted in 19 codes and confirmed the importance of e-nudge techniques. It is noteworthy that all the interviewees agreed that e-nudge techniques were extremely important or very important, and should be included in the e-nudge model (Figure 5.11). Some interviewees' comments are shown below:

> *Define all e-nudge techniques that appropriate to solve the student's problem*. **Participant B**

> *The output is all alternative e-nudge interventions that could be a suitable solution to change student behaviours*. **Participant D**

> *In this stage, the team can discuss all possible solution and evaluate them to make a list of best e-nudge in order to choose the correct technique*. **Participant E**

> *Determine which nudge interventions achieve the goal and can be implemented and meet constraints.* **Participant K**

- **Optimal e-nudge moment**
  The thematic analysis resulted in 9 codes and indicated the importance of having an optimal e-nudge moment. All the interviewees considered this factor to be either extremely important or very important, and should be included in the e-nudge model (see Figure 5.11). Some interviewees' comments quoted below:

> *Determine what the effective time to nudge the student in LMS interface*. **Participant B**

> *The (optimal e-nudge moments) is extremely important, it is clarified what the perfect time to nudge student in LMS*. **Participant H**

> *The time is crucial. There is no benefit to nudge student in wrong time or late to make the decision*. **Participant S**

The next question (no. 11) required the interviewees to assess the relationship between factors and determine whether they belonged to the right stage. All interviewees agreed that all the factors seemed to related to each other and had logical relationship, and all of them belonged to the analysis stage as shown in Figure 5.12.

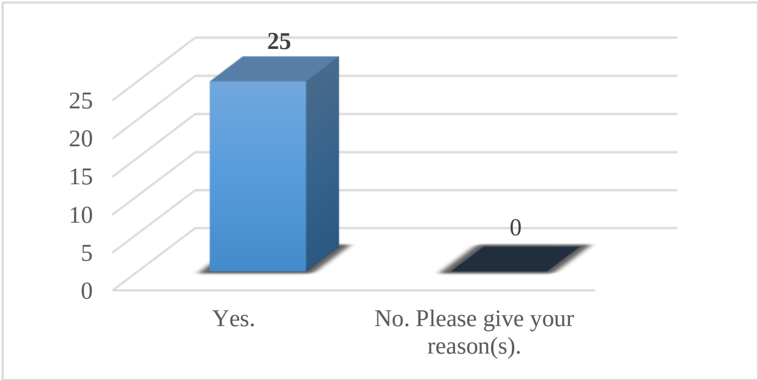


Figure 5.12: Interviewees' assessment of relationships between factors at analysis stage (prepared by the researcher).

All of the interviewees agreed that e-nudge techniques and optimal e-nudge moment were important factors that should be included in the final e-nudging model. The results for this stage are given in Figure 5.13 below.

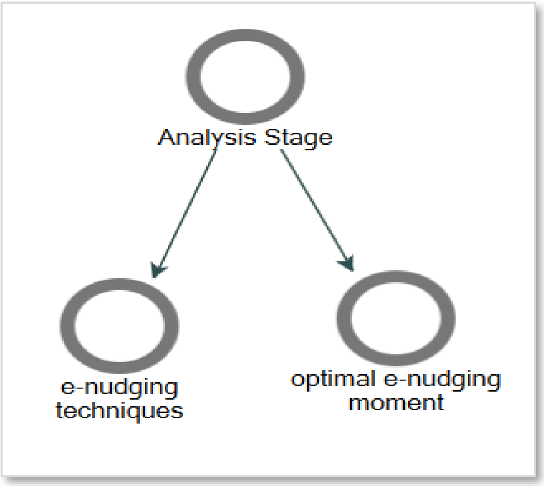


Figure 5.13: Coding tree for the analysis stage using NVivo (prepared by the researcher).

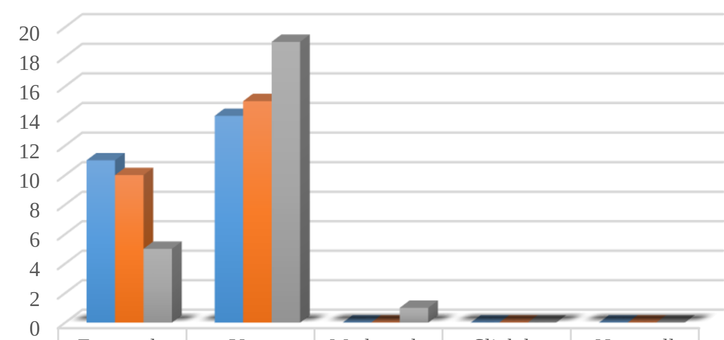
5.4.3.3 Analysis Results for Design Stage

The design stage comprised three factors: usability, human computer interaction (HCI) and e-nudge prototype. The thematic analysis resulted in 43 codes under three themes and one main stage as illustrated in Figure 5.14.

Design Stage	23	43
Usability	12	12
HCI	12	12
e-nudging prototype	7	7

Figure 5.14: NVivo coding results for design stage (prepared by the researcher).

Interviewees were asked to rate the importance of each factor in the design stage. The results showed that more than half interviewees believed these three factors were very important, and the others thought the three factors were extremely important. Only one participant thought the e-nudge prototype factor was moderately important. Figure 5.15 presents the interviewees' responses regarding the importance of three factors in the design stage



	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Usability	11	14	0	0	0
Human computer interaction (HCI)	10	15	0	0	0
e-nudging prototype	5	19	1	0	0

Figure 5.15: The interviewees' responses regarding the importance of three factors in design stage (prepared by the researcher).

The next question asked interviewees to give reasons for their rating. The interviewees' comments are given below.

> *It is essential stage; it is show you who the nudge will appear in the system and when and how the innervations show to the student in LMS*. **Participant H**

> *All factors are important. It provides overview about the final design and decided which elements can be changed or removed*. **Participant J**

> *The design gives the outline about final nudge.* **Participant L**

It is important when design the system interfaces, they affect how the nudge appear among other elements. **Participant M**

- **Usability**
  The thematic analysis yielded 12 codes that reflected the importance of usability in the e-nudge model. All the interviewees agreed that usability was extremely important or very important and should be included in the e-nudge model for SA higher education. The results are given in Figure 5.15. Some interviewees' comments are quoted below.

  > *HCI and usability are very important to design effective, efficient nudge to improve students' decision*. **Participant C**

  > *Nudge should be simple effective to use it*. **Participant D**

  > *Usability and user interface of the program is very important. If the program is not usable then no one will use it and leave it. The design needs to be simple and clear*. **Participant Q**

  > *They are good new factors, I believe the usability and HCI important factor if we design nudge in digital environments, they are used to design effective efficient easy user interface and improve user experience.* **Participant S**

- **Human computer interaction (HCI**
  The thematic analysis resulted in 12 codes indicating the importance of HCI in the e-nudge model. Interviewees' evaluation of the HCI was similar to that for usability. All the interviewees rather HCI as either extremely important or very important, and should be included in the e-nudge model for SA higher education

as the nudge will applied via LMS which is a digital environment. Figure 5.15 illustrates the interviewees' ratings. Some of the interviewees' comments are given below.

> *Usability and HCI are the foundation of design effective UI. The nudge to be effective they need to focus on the design and how deliver it to students in LMS, should be easy to use, see, learn*. **Participant R**

> *It is significant to consider the usability and HCI factors in order to meet students' needs and improve the feeling, and motivation, when students are interacting with the system.* **Participant T**

> *Usability and HCI are important to design effective nudge in the LMS interface and increase usage for LMS*. **Participant V**

- **e-nudge prototype**

  The thematic analysis resulted in 7 codes indicating the importance of the e-nudge prototype in the e-nudge model. Of the 25 interviewees, 19 believed that an e-nudge prototype is very important, and five believed it is extremely important and should be included in the e-nudge model. One participant saw this factor as moderately important. The results are shown in Figure 5.15. Some of the interviewees' comments are presented below:

> *It is showing how the nudge design and who student will receive the nudge.* **Participant A**

> *The prototype helps to choose which technique can be implemented*. **Participant F**

> *It is show you who the nudge will appear in the system and when and how the innervations show to the student in LMS.* **Participant H**

> *A prototype might be important to engage with first impressions*. **Participant O**

The next question (no.14) asked interviewees to assess the relationship between factors and determine whether they belonged to the right stage. All interviewees with one exception agreed that all the factors seem to be related to each other and have a logical relationship and should be included in the design stage. One interviewee disagreed as shown in Figure 5.16.

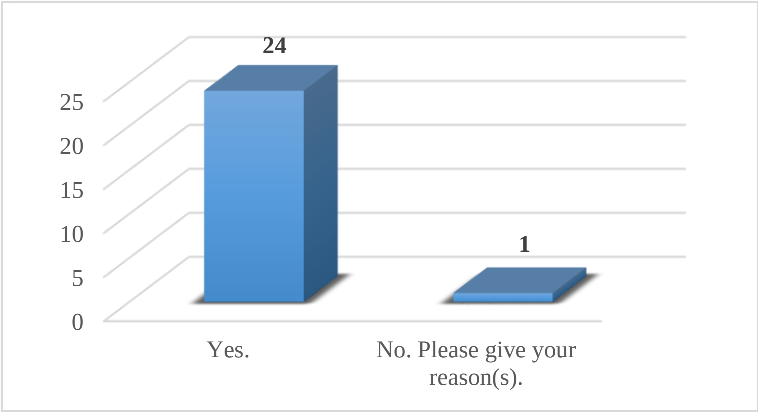


Figure 5.16: The interviewees' assessment of the relationship between factors in the design stage (prepared by the researcher).

This interviewee suggested renaming the design stage as ‘modelling stage’, as seen in this comment:

Modelling stage be a better name. **Participant W**

In fact, the design is more general term than modelling. The design defines how the system should work, what features should be included, and how the system looks and feels. However, modelling concerns how each item looks, and provides abstract language or pictures to express the new system (Suzuki & Yamamoto, 1999; Weilkiens, 2006). The nudge should be designed so as to influence students to make better decisions. The design of a nudge for the digital environment should consider the design elements of the LMS interface and the barriers that have a negative influence on students’ academic performance. When designing the nudging prototype, it is important to consider and implement the HCI and usability design principles in order to meet students’ needs. Thus, the researcher and her supervisors did not implement this participant’s suggestion, given the results of the literature review.

Hence, all of the interviewees strongly support the importance of usability, HCI and e-nudge prototype for the final e-nudging model. The results for this stage are given in Figure 5.17 below.

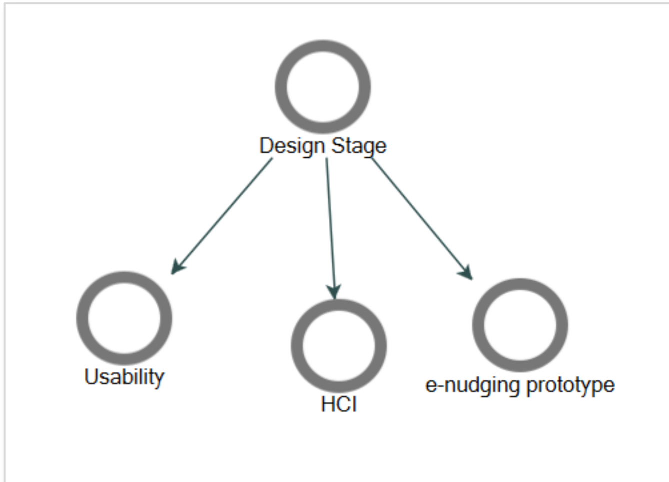


Figure 5.17: Coding tree for the design stage using NVivo (prepared by the researcher).

5.4.3.4 Analysis Results for Implementation Stage

The implementation stage contained one factor: implementing the e-nudging. The thematic analysis produced 20 codes under theme and in one main stage as illustrated in Figure 5.18

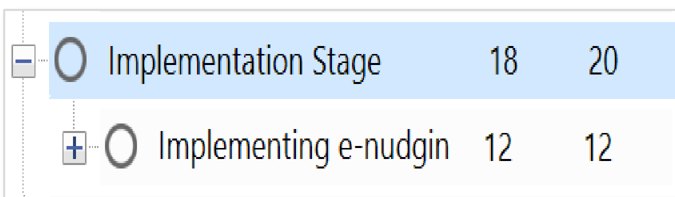


Figure 5.18: NVivo coding results for implementation stage (prepared by the researcher).

Interviewees were asked to rate the importance of implementing the e-nudging factor in the implementation stage. The results showed that most of interviewees considered implementing e-nudging factor is very important, and two interviewees considered the factor to be extremely important, whereas two believed that the factor is moderately important. Figure 5.19 showed the interviewees' responses regarding the importance of implementing the e-nudging factor in the implementation stage.

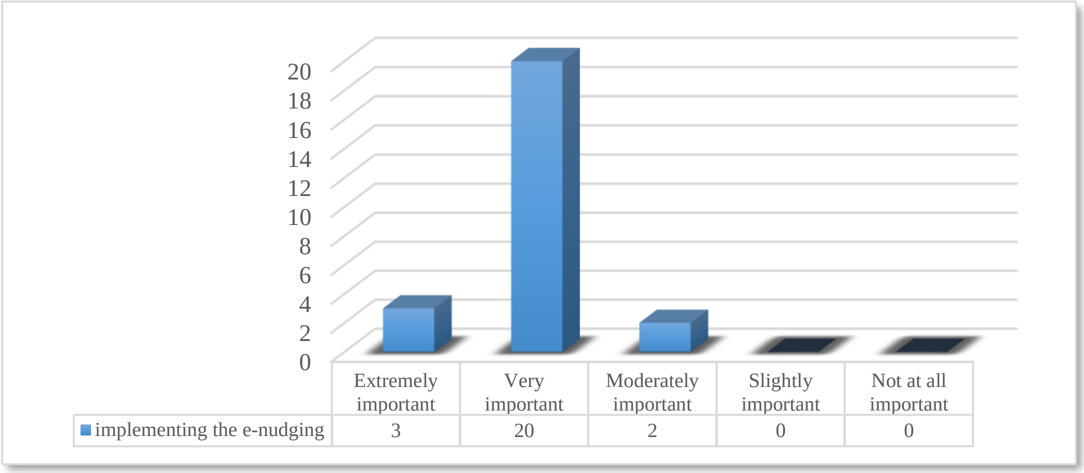


Figure 5.19: Interviewees' responses regarding the importance of two factors in the implementation stage (prepared by the researcher).

The next question asked interviewees to explain their rating. Some of the interviewees' comments are:

> *The nudge is released at the end of this stage and used to meet students' requirements*. **Participant B**

> *The stage is very important. It is the step to transform the plan to action and achieve main goal. Without implementation the is no achievement*. **Participant D**

> *Without implementation, there is no nudge to use*. **Participant E**

> *The implementation is very important. it is the stage to develop the LMS and execute the nudge*. **Participant K**

> *Implementation can show the success or failure of the e-nudging.* **Participant P**

- **implementing e-nudging**

  The thematic analysis generated 12 codes for the importance of implementing e-nudging. Most of the interviewees' comments indicated that the factor is very important. Some interviewees' comments are given below:

> *The nudge design should be implemented to harness the benefit*. **Participant G**
>
> *It is very important to accomplish the work and enable nudge interventions in the LMS*. **Participant H**
>
> *You need to implement what you have designed*. **Participant R**
>
> *It is the core of the model. the nudge will be implemented and lunched in this step*. **Participant W**

Three interviewees recommended merging this stage with the design stage, as shown in the following comments.

> *Some researchers merge this step with design to make the cycle easier*. **Participant N**
>
> *I believe design nudge includes the implementation step*. **Participant Q**
>
> *Design and implementation in many references have the same meaning*. **Participant V**

Only one interviewee explained why it is better to merge these two stages (implementation and design). The interviewee claimed that it would simplify the model cycle. This suggestion was not accepted by the researcher as these two stages are very important according to the literature review and the survey and interview results. The majority of the interviewees believed these stages are very important for the final e-nudging model.

The next question (no.17) asked interviewees to assess whether the implementing e-nudging factor is adequate and belongs to the right stage. All the interviewees agreed that the implementing e-nudging factor is adequate and belongs to the implementation stage as illustrated in Figure 5.20.

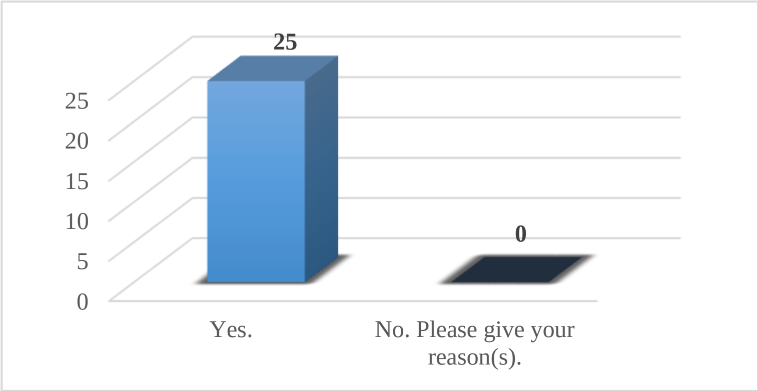


Figure 5.20: Interviewees' assessment regarding is the factor adequate for the implementation stage and can be included in this stage (prepared by the researcher).

All of the interviewees strongly agree that it is important for the implementing e-nudge factor be included in the final e-nudging model. The result of this stage is shown in Figure 5.21 below.

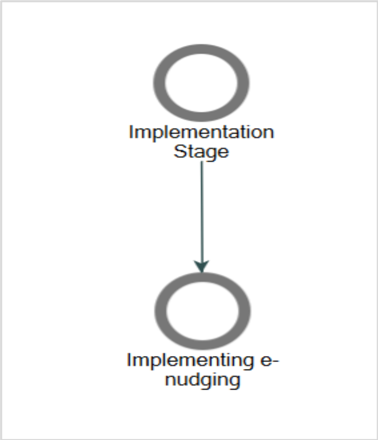


Figure 5.21: Coding tree for the implementation stage using NVivo (prepared by the researcher).

5.4.3.5 Analysis Results for Test Stage

The test stage comprised two factors: test e-nudge and environmental influence. The thematic analysis produced 30 codes under two themes and with one main stage as illustrated in Figure 5.22.

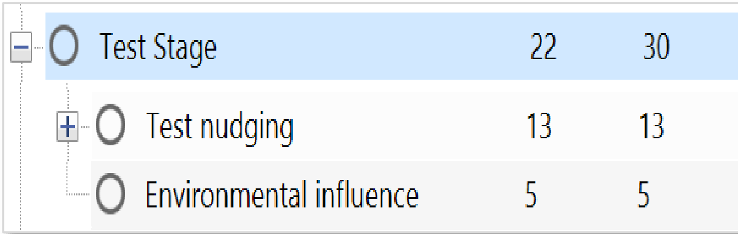


Figure 5.22: NVivo coding results for test stage (prepared by the researcher).

Interviewees were asked to rate the importance of each factor in the test stage. The majority of interviewees believed these two factors were very important, while two saw them as extremely important. Only two interviewees thought the environmental influence factor was moderately important. The interviewees' responses regarding the importance of two factors in the test stage are shown in Figure 5.23.

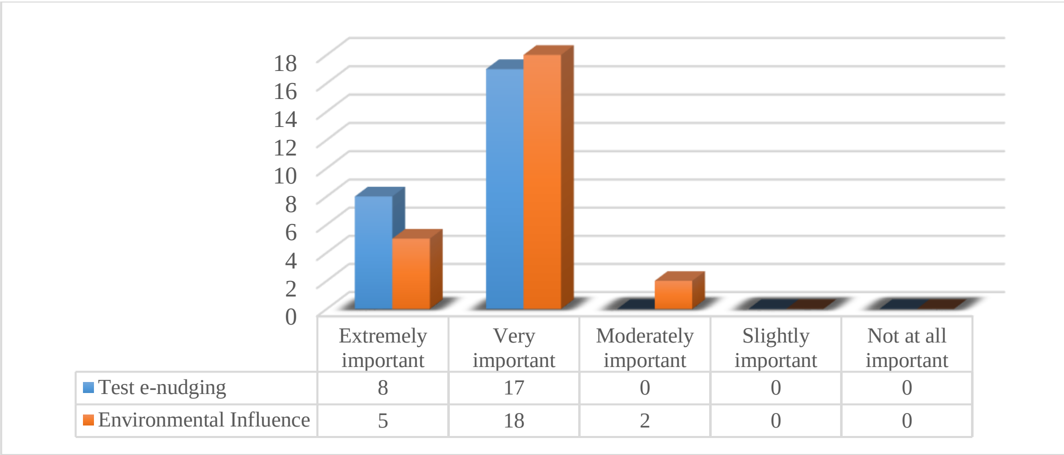


Figure 5.23: Interviewees' responses regarding the importance of two factors in test stage (prepared by the researcher).

The next question asked interviewees to give reasons for their rating. The interviewees' comments on the test stage are:

> *Test stage is important to discover the problems in the implementation before users use the system. In the nudge is critical step because this effect student future if the nudge goes wrong*. **Participant J**

> *Testing is important. To find error or update the LMS to work effectively with the new technologies.* **Participant K**

> *The test before final release is critical step to reduce error or make nudge more effective and efficient*. **Participant R**

> *Test stage is important to check for error and correct mistake early*. **Participant U**

- **Test e-nudge**

  The thematic analysis generated 13 codes for the importance of testing the e-nudge. All the interviewees agree on the importance of testing the test e-nudge. Eight believed it is extremely important, and 17 considered it very important and should be included in the e-nudge model (Figure 5.23). Some of the interviewees' comments are shown below:

> *Test nudge is important to assess nudge if effective and achieve goal or not.* **Participant B**

> *To check the effectiveness of nudge and solve problems before finial launch*. **Participant G**

> *Test nudge is very important to decide if the current design is proper or need change to improve student achievements.* **Participant O**

> *Test nudge is the key to build an effective nudge because you can assess the appearance of nudge around other elements, the excellent design lead to excellent nudge.* **Participant Q**

- **Environmental influence**

  The thematic analysis yielded five codes that reflected the importance of the environmental influence factor in the e-nudge model. Eighteen interviewees believed the environmental influence is very important, and five interviewees believed it is extremely important and should be included in the e-nudge model for SA higher education. Two participants considered this factor to be moderately important. The results are given in Figure 5.23. Interviewees offered these comments:

Environmental influence enhances the nudge if any change in the student requirements or environments. **Participant A**

To find error or update the LMS to work effectively with the new technologies. **Participant K**

Also it is important for university to be update to the environment changing. **Participant M**

Testing and environmental influences can help predict any issues that may emerge later. **Participant P**

The next question (no. 20) asked interviewees to assess the relationship between factors and determine whether they are in the right stage. The result demonstrated almost of the interviewees agreed that all the factors seem related to each other and have a logical relationship, and all of them relate to the test stage. Only one interviewee disagreed as shown in Figure 5.24.

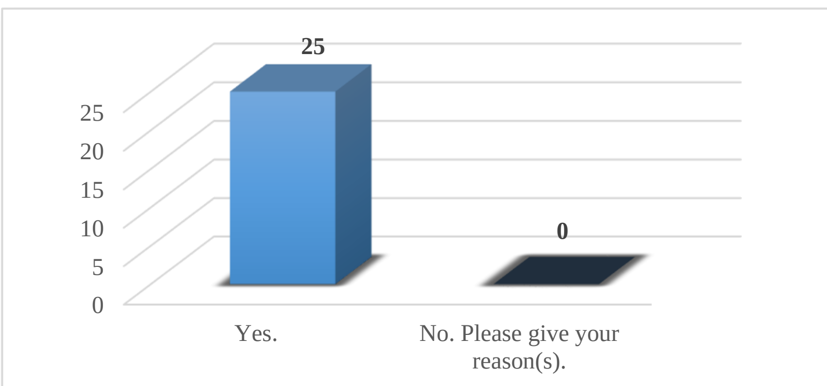


Figure 5.24: Interviewees' assessment of relationships between factors in the test stage (prepared by the researcher).

Hence, all but one interviewee strongly agree on the importance of including test nudge and environmental influence factors in the final e-nudging model for SA universities. The results for this stage are shown in Figure 5.25 below.

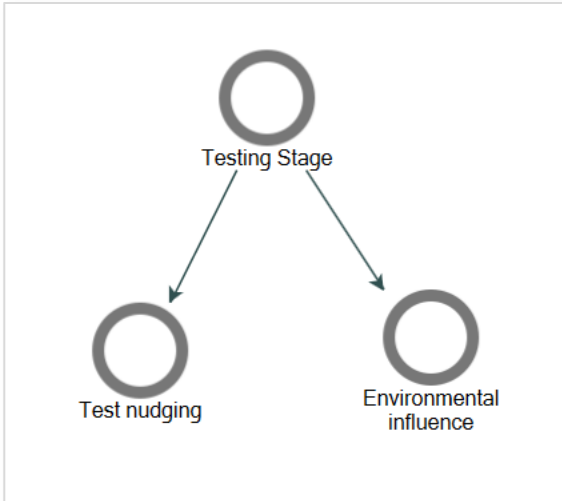
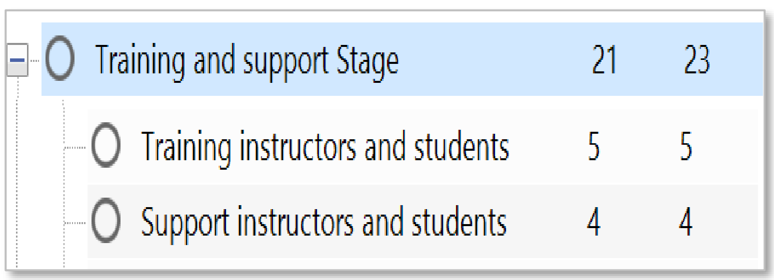


Figure 5.25: Coding tree for the test stage using NVivo (prepared by the researcher).

5.4.3.6 Analysis Results Training and Support Stage

The training and support stage comprised two factors: training instructors and students, and support instructors and students. The thematic analysis resulted in 23 codes, two themes and one main stage as shown in Figure 5.26.



Training and support Stage	21	23
Training instructors and students	5	5
Support instructors and students	4	4

Figure 5.26: NVivo coding results for training and support stage (prepared by the researcher).

Interviewees were asked to rate the importance of each factor in the training and support stage. The majority of interviewees believed that these two factors are very important and the rest of them saw the two factor as moderately important. The interviewees' responses regarding the importance of the two factors in the training and support stage are shown in Figure 5.27.

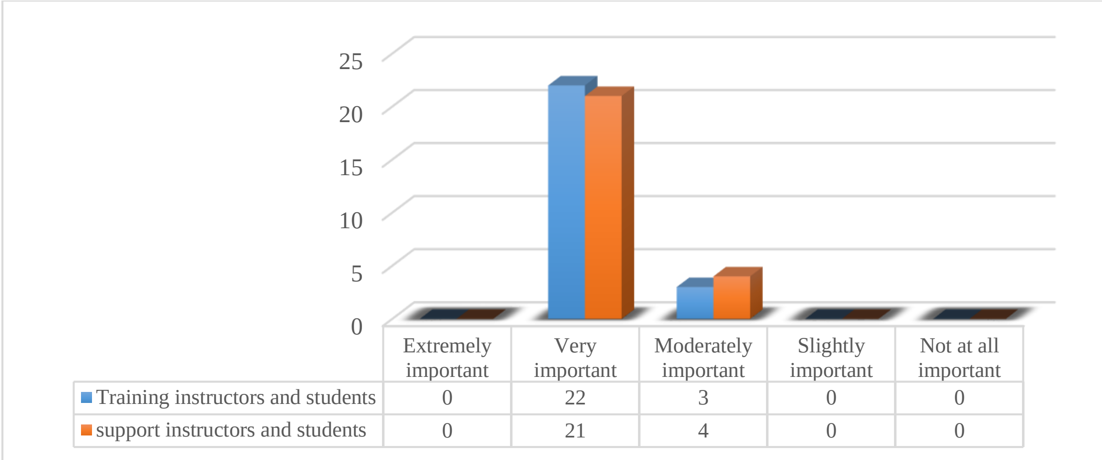


Figure 5.27: Interviewees' responses regarding the importance of two factors in the training and support stage (prepared by the researcher).

The next question was regarding the reasons for this rating. Some of the interviewees' comments on the test stage rating are:

> *It is important to reduce resistant and adopt nudge easily for both students and faculty members.* **Participant A**

> *It is useless if you implement system, the user cannot use it correctly or it is complex for them. This waste time and money and resources*. **Participant C**

> *To help user to be familiar with the new nudge and easy to use*. **Participant F**

> *Training and support is important. They help to adopt nudge and LMS faster and be familiar with it.* **Participant S**

> *If user struggle with using LMS, the nudge via LMS will be useless.* **Participant W**

- **Training instructors and students**
  The thematic analysis generated five codes for the importance of training instructors and students. The majority of the interviewees (22) agreed the training of instructors and students in the use of nudge is very important and should be

included in the e-nudge model for SA higher education. Only three participants thought the factor is moderately important. The interviewees' results are shown in Figure 5.27. Some of the interviewees' comments are:

> *The user needs to be trained to reduce errors and help them how the nudge works.* **Participant G**

> *It is important to train all the instructors and students in LMS after apply nudge to improve their skills, confident and reducer mistake.* **Participant H**

> *Training is essential that the e-nudging successfully adopted in Saudi universities.* **Participant P**

> *Training is important. It assists users and increase acceptance to use nudge you and rename the phase support, it is easier and more general.* **Participant U**

- **Support instructors and students**

  The thematic analysis generated four codes for the importance of support for instructors and students. Twenty-one participants agreed that it is important to support instructors and students regarding nudge, and this factor should be included in the e-nudge model. Only four participants thought the factor is moderately important. The interview results for this factor are shown in Figure 5.27. Some interviewees' comments are:

> *Support is important to use the LMS easy, fast and do not affect their works or homework.* **Participant J**

> *It makes it easier for instructors and students to use LMS after develop nudge. Many instructors and student don't have technical background how to use the system.* **Participant R**

> *They need the IT for their assistance.* **Participant Y**

The next question (no. 23) aimed to assess the relationship between factors and whether they are in the right stage. Almost all of the interviewees agreed that all the factors seem related to each other and have logical relationship, and all of them related to the test stage. Only one interviewee disagreed as shown in Figure 5.28.

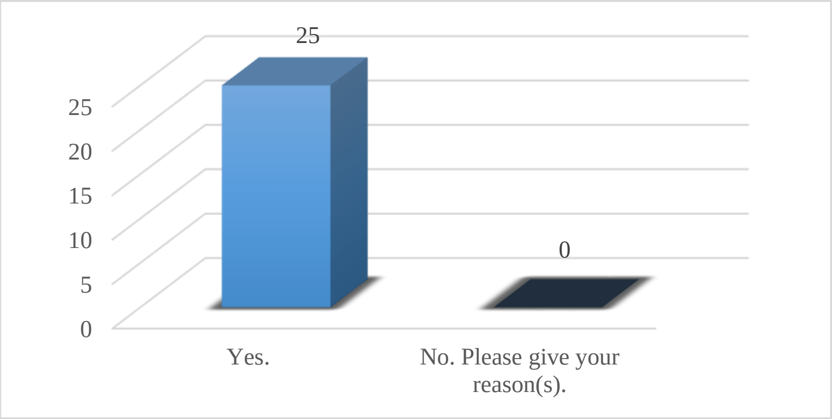


Figure 5.28: Interviewees' assessment of the relationship between factors in the training and support stage (prepared by the researcher).

Two interviewees suggested renaming the stage as ‘support’ stage as it is easier and more general and could refer to both training and support. The two comments are:

> *You can rename this stage to be supporting stage instead of Training and Support stage. Because I think supporting could be refer to any support including the practical support which means training*. **Participant T**

> *Training is important. It assists users and increase acceptance to use nudge you and rename the phase support, it is easier and more general.* **Participant U**

In academic research, preciseness and accuracy are significant criteria that should be applied, particularly to the results. Thus, the researcher needs to prove that the conducted research is reliable, valid, and generalizable. As mentioned in section 4.7, training helps instructors and student to understand and adopt changes after the integration of e-nudge in the LMS. It is important that support and training be offered to instructors and students from the outset, as this will help to avoid future problems. The support can help to meet the users’ needs. Hence, the interviewees’ suggestions were not followed.

Hence, the majority of interviewees strongly support the importance of training instructors and students, and believed that the factor 'support instructors and students' should be included in the final e-nudging model. The results for this stage are shown in Figure 5.29 below.

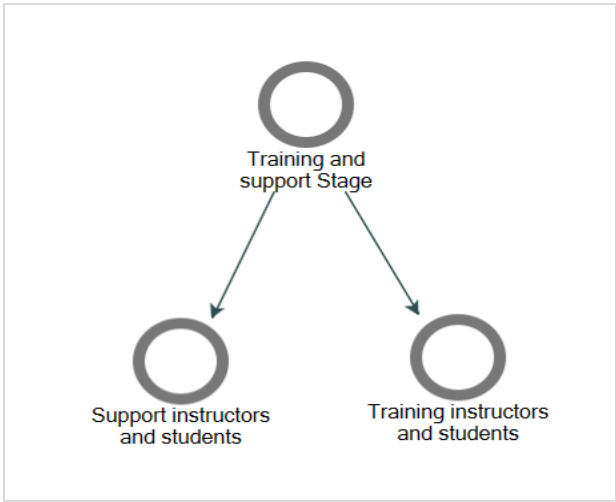


Figure 5.29: Coding tree for the training and support stage using NVivo (prepared by the researcher).

5.4.3.7 Analysis Results for Evaluation Factor

The thematic analysis generated 22 codes under one theme as illustrated in Figure 5.30.

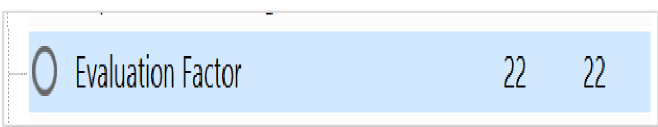


Figure 5.30: NVivo coding results for evaluation factor (prepared by the researcher).

Interviewees were asked to rate the importance of the evaluation factor in the enhanced e-nudging model. Fifteen interviewees considered the evaluation factor to be extremely important, and 10 rated it as very important. Figure 5.31 shows the interviewees' responses regarding the importance of the evaluation factor.

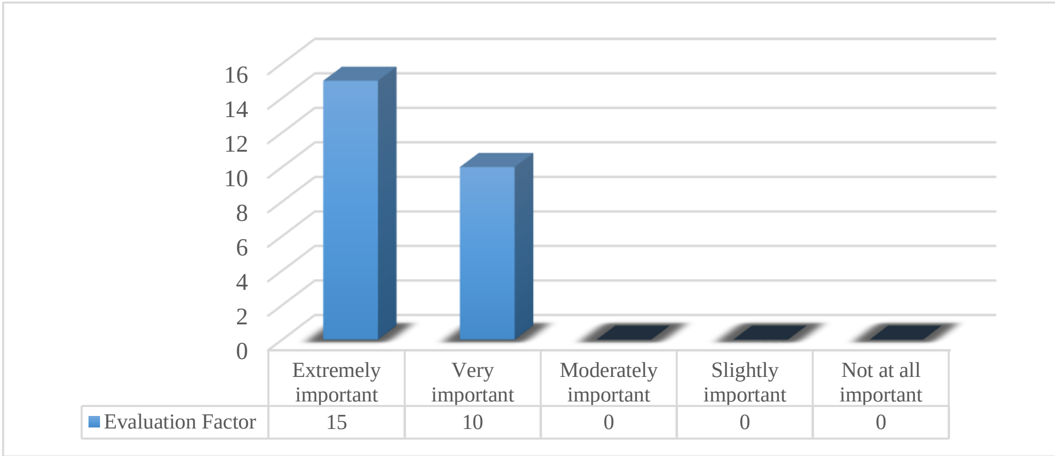


Figure 5.31: The interviewees' responses for the importance of two factors in the evaluation stage (prepared by the researcher).

The next question asked respondents for the reasons for their rating. Some of the reasons are given below:

> *It helps to review, reflect, assess, feedback before moving to second step.* **Participant F**

> *It is important to assess or evaluate each stage outcome before moving to next one. This assessment gives the chance to improve the quality and reduce error rate while design the e nudge*. **Participant H**

> *To measure the impact of the LMS after apply nudge and check if the nudge technique is suitable*. **Participant J**

> *It is critical factor. The evaluation never end process even after development nudge, to check for updates or need changing*. **Participant O**

> *It is a procedure done at the end of each part to ensure the goal is achieved and the nudge is actionable*. **Participant R**

> *Evaluation is very important step in improving any new technology. The designer needs to evaluate every step during the development cycle and prior releasing the e-nudging to the student to ensure that the e-nudging meets the student's requirements.* **Participant T**

Hence, all of the interviewees strongly supported the importance of the evaluation factor and its inclusion in the final e-nudging model. The results for this stage are shown below in Figure 5.32.

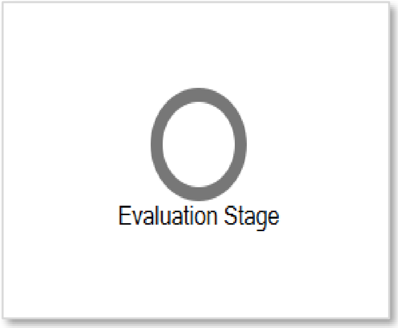


Figure 5.32: Coding tree for evaluation stage by NVivo (prepared by the researcher).

5.4.3.8 Analysis Results for Awareness Factor

The thematic analysis generated 22 codes with one organizing theme as illustrated Figure 5.33

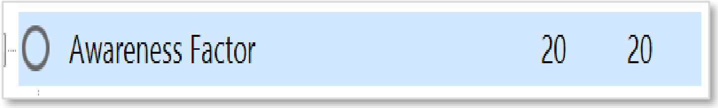


Figure 5.33: NVivo coding results for awareness factor (prepared by the researcher).

Interviewees were asked to rate the importance of the awareness factor in the enhanced e-nudging model. There was no consensus of opinion regarding this factor. Almost half of the interviewees think the evaluation factor is very important, 8 thought it was moderately important. Three of the interviewees believe this factor is slightly important, whereas two consider it unimportant. Figure 5.34 shows the interviewees' responses for the importance of the awareness factor.

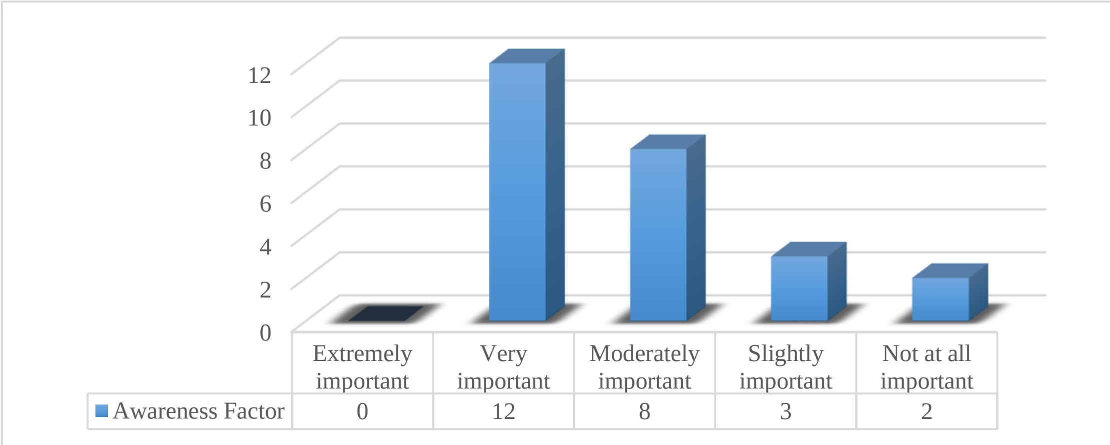


Figure 5.34: Interviewees' responses regarding the importance of two factors in awareness factor (prepared by the researcher).

The interviewees had different opinions about the importance of the awareness factor. There 11 positive comments show why the factor is important and should be included in the final e-nudge model. Only one interviewee (participant C) had a high level of knowledge about e-nudge in higher education, seven had medium knowledge (participants: A, H, K, Q, V, X and Y) and three had little knowledge (participants: P, R, W). Below are some of the interviewees' comments:

> *It is good to increase society awareness about the new theory and how to utilize it*. **Participant A**

> *It is important to be aware about the advantage of nudge. **Participant C***

> *It is very important factor; it is encouraging the decision maker in the organization to apply more nudge*. **Participant H**

> *It is help to create more interventions not just for student, for instructors and academic as well.* **Participant V**

> *The nudge would increase its effect after awareness.* **Participant W**

> *It helps to increase the acceptance of nudge and adopt it correctly.* **Participant Y**

Three interviewees believed that the awareness factor is slightly important. Only one had a high level of knowledge about e-nudge in higher education (participant S), and two had a low level of knowledge about the research domain (participants I and T). Some of the interviewees' comments are shown below:

> *I don't have much knowledge about the awareness in nudge*. **Participant I**

> *Some cases the awareness reduces nudging effectiveness/ it is better to remove it from students' side. The instructors may need to be aware about the benefit of the nudge for students and how use it*. **Participant S**

> *Students might refuse the nudge and avoid it in LMS*. **Participant T**

The comment made by Participant S suggests that he believes that the instructor needs to be aware of the nudge in order to encourage students to use it effectively. Additionally, he stated that there are some cases where the awareness reduces the effectiveness of nudge, although he was not referring to the education sector in particular.

Of the interviewees who believe that the awareness factor is not important enough to include in the final e-nudge model, one of them has a high level of knowledge about e-nudge in higher education (Participant G) and the other has medium knowledge (Participant J). Their comments were:

> *Increase user resistant to except nudge.* **Participant G**

> *Increase the undesired behaviour when person tend to be rebelling.* **Participant J**

As mentioned in section 4.7, the awareness factor emerged from the results of the survey analysis. This factor is considered as new factor as no previously proposed models included it. Furthermore, in the quantitative phase (i.e., survey) both students and academics provide positive comments about the e-nudge and they believe that it will improve their academic performance. Also, the majority of survey participants (i.e. academics, IT staff and students) understand that the purpose of e-nudging is to encourage and motivate students to improve their academic performance.

Indeed, in both phases of the research, many participants' comments reveal that e-nudging is an excellent idea that will help them to make better decisions that will help them improve their academic performance. Thus, the awareness factor will increase the effectiveness of nudge as both students and academic welcomed the idea of applying nudge in LMS.

Because over half of the interviewees believed that the awareness factor was important, it was retained for the final model. Moreover, the survey results confirmed that this factor is necessary for e-nudge to successful in the higher education sector. The result of this stage is shown below in Figure 5.35.

Figure 5.35: Coding tree for awareness factor (prepared by the researcher).

5.4.5 Analysis Results for Interviewees' perception of the Enhanced e-Nudging Model

This section contained 7 questions. The purpose of this section was to discover the interviewees' opinions about the enhanced e-nudging model. The interviewees were asked to evaluate the enhanced e-nudging model as a whole. The model was presented to the interviewees at the beginning of this section. After that, they were asked to give their suggestions about factors to add, delete, merge, or reposition, and to give their reasons for these changes. The last 3 questions assess the three e-nudging model phases: *Analysing user behaviour, nudging user behaviour, assessing nudging impact.*

At the beginning, the interviewees were asked to evaluate the enhanced e-nudging model. The majority of the interviewees (20) believed the presented model (i.e., enhanced e-nudging model) would be effective, while five thought it would be moderately effective.

Figure 5.36 illustrates the interviewees' evaluation. The following comments indicate their views:

> *I think the model included all the key factor to implement effective nudging in SA or any country, well done and good effort*. **Participant A**

> *The model clear and the color is nice and helps to distinguish BTW the stages, phases and factors*. **Participant B**

> *It includes the important factors to conduct the e-nudge successfully in SA universities.* **Participant E**

> *It provides all important elements that can be used as a blueprint for stakeholders to implement the e-nudging in Saudi Arabia*. **Participant T**

> *I think this is an extremely important step towards promoting positivity in learning process by influencing students to do tasks in a good way.* **Participant W**

> *The model is clear and comprehensive, understandable, easy to use and can be generalized in other sectors.* **Participant Y**

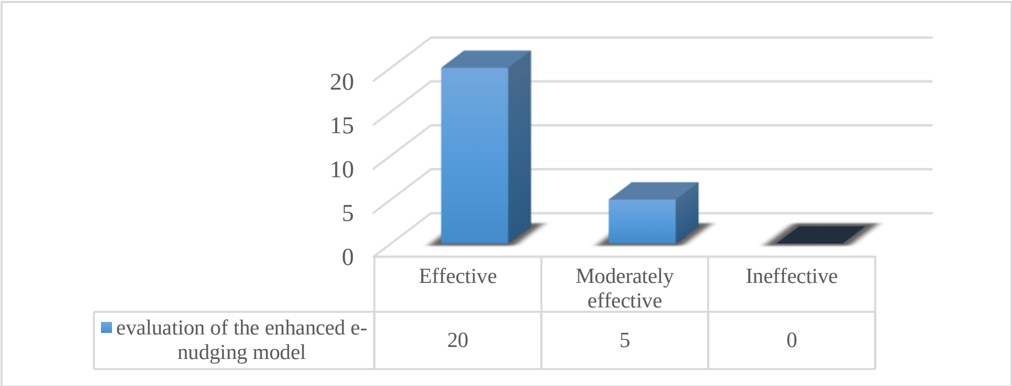


Figure 5.36: Interviewees' responses to evaluate the effectiveness of enhanced e-nudging model (prepared by the researcher).

Five participants (interviewees: F, G, H, L and S) assessed the model to be moderately effective, and four of these (L excluded) recommended adding the new factor 'define student barriers' to the planning stage see sub-section 5.4.3.1. This factor is included to the final e-nudge model.

Moreover, four interviewees recommended the addition of a new factor, ethics, as indicated in the comments below.

> *I recommend considering ethics*. **Participant F**

> *I recommend considering the following factors define behaviours, cognitive problems, ethics.* **Participant G**

> *You might consider nudge ethics in the design stage.* **Participant J**

> *Overall, the model is designed in a good way I suggest to add freedom.* **Participant V**

Participants J and V believed the enhanced model is effective, although ethics should be considered for the final model. The ethics factor was included in the initial e-nudging model; however, the analysis of the academic online survey showed different opinions about this factor. Thus, it was discarded from the enhanced model but re-emerged in the interviews. The interviewees' comments were considered, and the ethics factor was added to the final e-nudging model.

Two interviewees commented on the position of the evaluation factor in the enhanced model:

> *I suggest if add evaluation stage after each stage to be more effective and reduce errors.* **Participant I**

> *The model flow and relation are logical and easy to understand I suggest evaluating the outcome from each stage before move to another stage.* **Participant R**

The researcher took these two comments into consideration when designing the final model.

The next questions asks participants to offer suggestions about factors to add, delete, merge or reposition in the enhanced e-nudge model which they were asked to consider.

- **Add new factor**

  Nineteen interviewees thought there was no need to add new factors, while six interviewees suggested adding new factors. Actually, these factors were mentioned previously in interviewees' comments when answering questions. The interviewees' responses are shown in Figure 5.37.

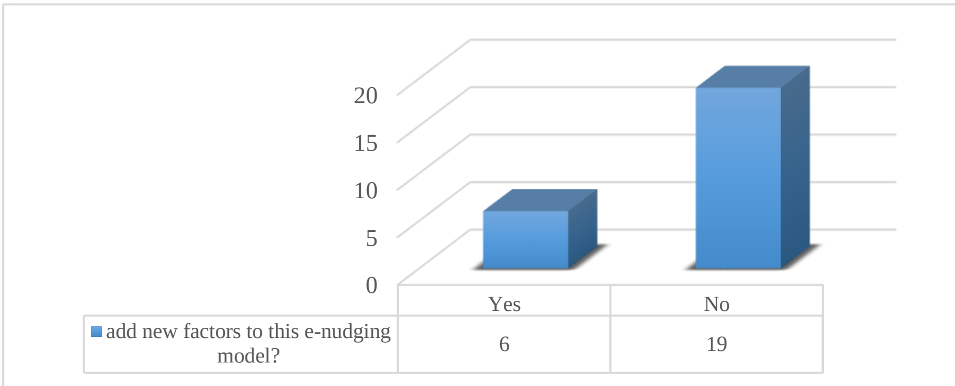


Figure 5.37: Interviewees' responses to adding new factors to the enhanced e-nudging model (prepared by the researcher).

The interviewees recommended to add the factors 'define students' barriers' and 'ethics' which had been mentioned by Participants F, G, H, J, S). Table 5.7 illustrates the interviewees' suggestions and the actions taken by the researcher.

Table 5.7: Interviewees' suggestions to adding new factors and the actions taken (prepared by the researcher).

Participant	Suggestions (add new factor)	Action	Reason
C, F, G, J	Ethics	This factor had already been taken into consideration	These factors were included in the initial e-nudge model according to the literature reviews. Of the interviewees who recommended these factors, three had a high level of knowledge (Participants C, G, S) about e-nudge in higher education and three had moderate knowledge (Participants F, J, H). The interviewees' comments aligned with the literature review. Results showed these factors to be important.
C, F, H, S	Define students' barriers	This factor had already been taken into consideration	

- **Delete or merge factors**

  Twenty-two interviewees thought that there was no need to delete or merge any factors in the enhanced model. Only three interviewees suggested deleting or merging factors. Actually, these factors had been mentioned in previous answers to interview questions. The interviewees' responses are depicted in Figure 5.38.

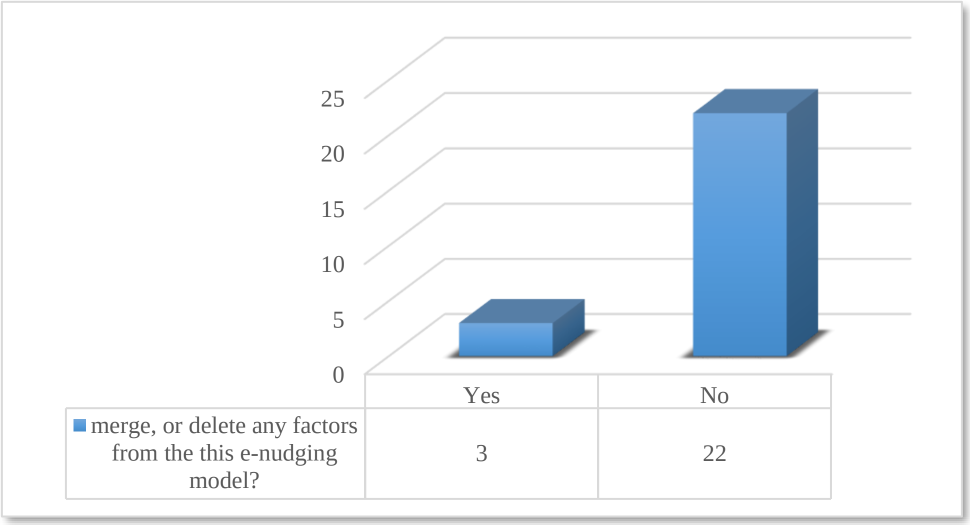


Figure 5.38: Interviewees' responses to deleting or merging factors in the enhanced e-nudging model (prepared by the researcher).

Two interviewees recommended deleting the awareness factor and one interviewee suggested merging the training and support stage and renaming it 'support stage'. Comments along these lines had been made by mostly the same interviewees. The interviewees' suggestions and the researcher's actions are shown in Table 5.8.

Table 5.8: Interviewees' suggestions to deleting or merging factors and the actions taken (prepared by the researcher).

Participant	Suggestions (delete or merge)	Action	Reason
G, O	Delete awareness	The suggestion was not implemented.	The quantitative results generated this new factor. Also, the academics and students believe the e-nudge will improve academic performance, and welcomed the idea of applying nudge in LMS. In the qualitative phase, half of the interviewees believed the factor was very important.
T	Merge the training and support factors	The suggestion was not implemented.	The majority of interviewees agreed on the importance of each of these factors being included separately in the final e-nudge model.

- **Change position of factor**

  Twenty-one interviewees thought there was no need to change the position of any factor in the enhanced model, where only four interviewees suggested to change position of factors. These factors had been mentioned in previous answers to interview questions. The interviewees' responses are shown in Figure 5.39.

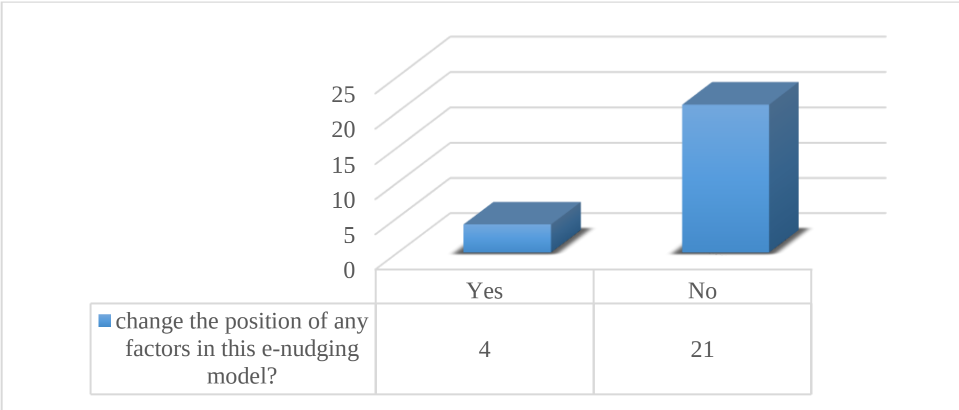


Figure 5.39: Interviewees' opinions to changing the position of factors in the enhanced e-nudging model (prepared by the researcher).

The two interviewees recommended changing the position of the evaluation factor, and two suggested changing the position of the awareness factor. The same interviewees made these comments in other responses to interview questions. The interviewees' suggestions and the action taken are shown in Table 5.9.

Table 5.9: Interviewees' suggestions to changing position of factors, and actions taken (prepared by the researcher).

Participant	Suggestions (change position)	Action	Reason
I, N	Include an evaluation step after each stage	There was no need to follow this suggestion.	This step was already in the enhanced model.
M, O	Change awareness position so that it is only for instructors.	The suggestion was not followed.	The quantitative results indicated that both academics and students believe the e-nudge will improve students' academic performance and they welcomed the idea of applying nudge in LMS. In the qualitative phase, half of the interviewees believed the factor is very important for both students and instructors.

- **Three phases for e-nudging model**

  The last three questions (nos. 36 37, 38) asked participants to assess the relationship between stages and determine whether they belonged to the right phase. There were three phases: analyzing user behavior phase, nudging user behavior phase and assessing nudging impact. All the interviewees agreed that the three stages were interrelated and had a logical relationship, and all of them related to the right phase as shown in Figure 5.40.

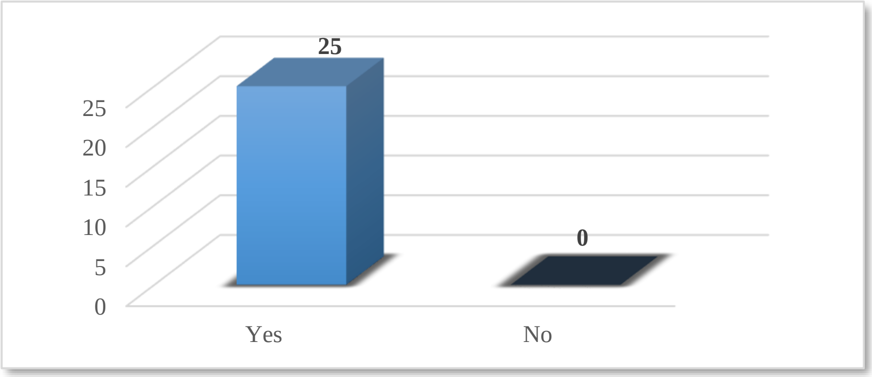


Figure 5.40: Interviewees' assessment of the relationship between stages and whether they belong to the right phase (prepared by the researcher).

5.5 Summary of Interview Findings

The online interview analysis was used to assess the effectiveness of the enhanced e-nudging model for higher education in SA. The analysis results indicated the factors that should be included in the final e-nudging model. Moreover, the online interviews were intended to collect the opinions of academics regarding the appropriateness of the enhanced e-nudging model for SA's higher education sector, and to determine whether the e-nudging model will meet the requirements of university students.

The interview data was analysed using descriptive statistical and thematic analysis (TA) methods. With descriptive statistical, interviewees' responses were evaluated to determine the weighting of these factors based on their influence by using a five-point scale ranging from 1=Not at all important to 5=Extremely important.

The factors in the enhanced e-nudging model were analysed via TA. After analysis, some factors in the enhanced e-nudging model were changed. Figure 5.41 shows the final results, which are explained below:

- The planning stage contains three factors named "e-nudging goals", "e-nudge constraints", and "mapping student decision process" with, respectively, 90.4%, 85.6%, and 81.6% of the participants agreeing these factors are important for the final e-nudge model.

- The second stage was the analysis stage. This stage contained two factors: "e-nudging techniques" and "optimal e-nudging moment" with, respectively, 87.2% and 85.6% participants, agreeing that these factors are important for the final e-nudge model.
- The third stage was the design stage. This stage comprised three generated factors called "usability", "HCI" and "e-nudging prototype" with, respectively, 88.8%, 88%, and 83.8%, of the participants agreeing these factors are important for the final e-nudge model.
- The implementation is the fourth stage with one factor called: "implementing e-nudging" with 80.8% agreeing that this factor is important for the final e-nudge model.
- The fifth stage is testing stage. The first factor is called "test e-nudge". The second factor is labelled "environmental influence" with, respectively, 86.4% and 82.4% of the participants agreeing these factors are important for the final e-nudge model.
- The sixth stage is training and support. This stage included two factors: "training the instructors and student", and "support the instructors and student" with, respectively, 77.6% and 76.8% respectively, agreed these factors are important for the final e-nudge model.
- The last stage is evaluation with 92% of participants agreeing that this factor is important for the final e-nudge model.
- The awareness factor with 64% agreed this factor important to influence the final e-nudge model.

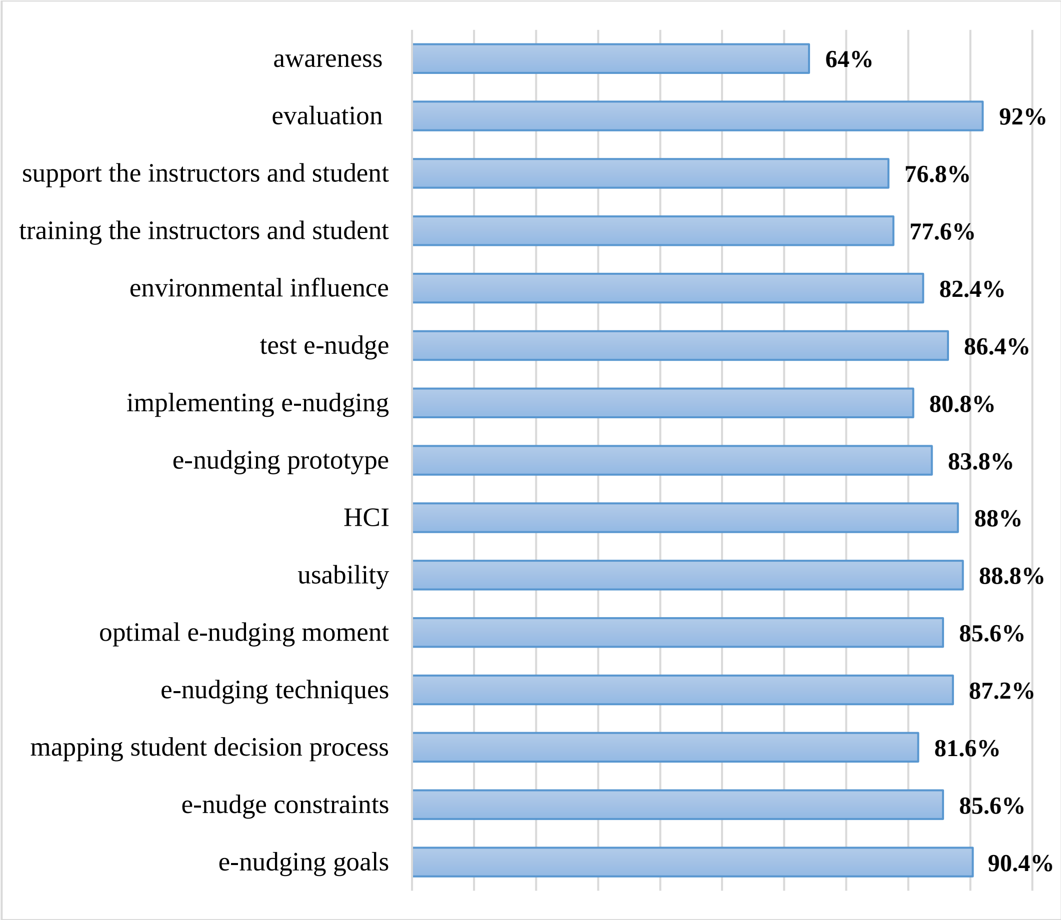


Figure 5.41: Rating of overall factors in the enhanced e-nudging model (prepared by the researcher).

In addition, two new factors emerged from the interview data: “define students’ barriers: behaviour, cognitive and environmental” and “ethics of e-nudge”. The position of the evaluation stage was changed in order to make the purpose and functionality of this stage evident to the readers. The factor “mapping the decision process” was renamed as “mapping the student decision process”. The coding tree generated from the TA using NVivo (1.0) showing the themes and the relationships is depicted in Figure 5.42

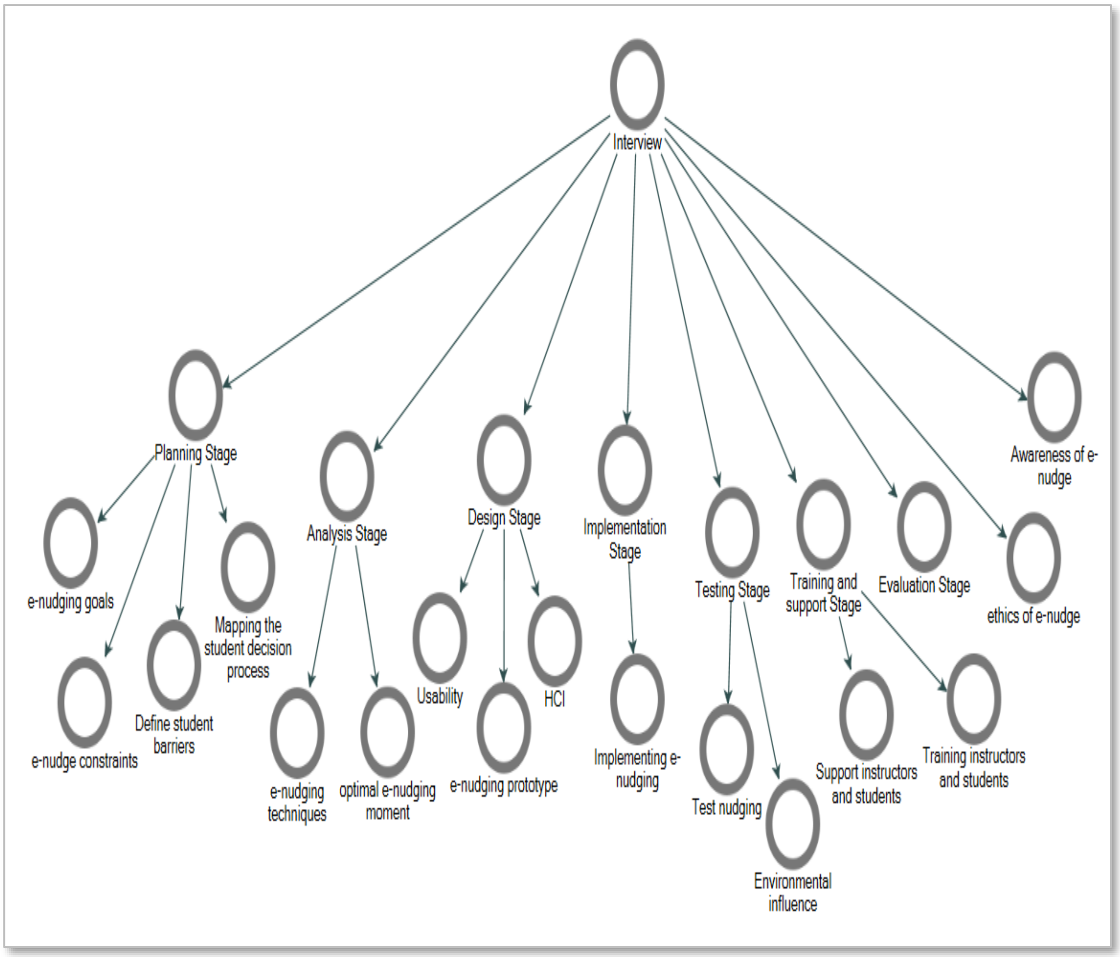


Figure 5.42: Interview data coding tree (prepared by the researcher).

Table 5.10 shows the changes made to the enhanced e-nudging model based on the analysis of the interview data. The new factors generated by TA are shown in red.

Table 5.10: Summary of results of thematic analysis of interview data (prepared by the researcher).

Stage	Enhanced e-nudging model for higher education in SA (After factor analysis)	Final e-nudging model for higher education in SA (After thematic analysis)
Planning Stage	e-nudging goals	e-nudging goals
	e-nudging constraints	e-nudging constraints
		Define students' barriers: behaviour, cognitive and environmental
	Mapping the decision process.	Map the student' decision process.
Analysis Stage	e-nudging techniques	e-nudging techniques
	optimal e-nudging moment	optimal e-nudging moment
Design Stage	HCI	HCI
	Usability	Usability
	Design e-nudging prototype	Design e-nudging prototype
Implementation Stage		Implement e-nudge
Test Stage	Test e-nudging	Test e-nudging
	Environmental influence	Environmental influence
Training and support Stage	Training instructors and students	Training of instructors and students
	Support instructors and students	Support instructors and students
Evaluation Stage		Evaluation of outcomes of each stage
Awareness	Awareness of e-nudge	Awareness of e-nudge
Ethics		Ethics of e-nudge

The final e-nudging model was modified in order to accommodate the new findings; changes were confirmed by the interviewees. Hence, the final model is highly likely to meet the requirements of students in the higher education sector for several reasons. The majority of participants (i.e., academics, IT staff and students) in both research phases understand the purpose of e-nudging, and their comments endorse the value of e-nudging;

they believe that it is an excellent idea that will help students to improve their academic performance by steering their behaviours towards better decision-making.

5.6 The Refined E-nudge Model Based on Interview Data

The aim of this phase was to assess factors included in the enhanced e-nudging model derived from the quantitative phase. Thematic analysis was applied to analyse the interview data. The results indicated the factors that should be retained and the new ones that should be added to the enhanced e-nudging model.

The final e-nudging model is depicted in Figure 5.43. The TA led to the improvement of two factors and the addition of two new factors based on interviewees' recommendations.

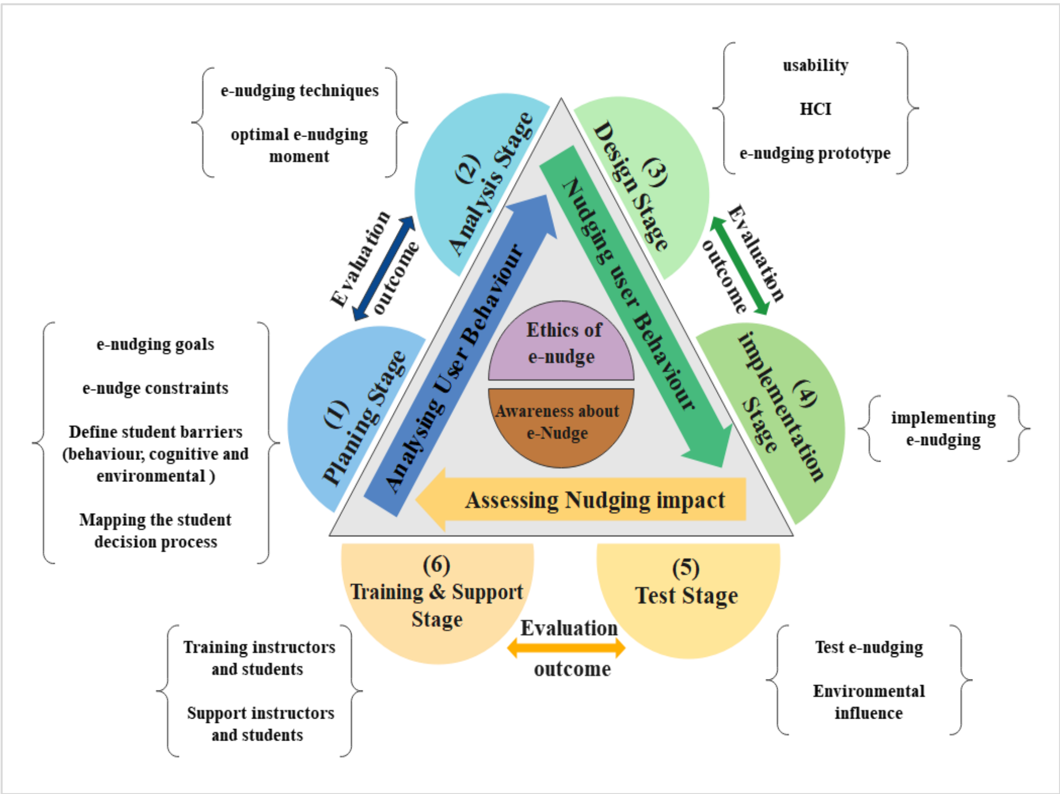


Figure 5.43: The final e-nudge model derived from interview data (prepared by the researcher).

Two new factors emerged from the interview data analysis: "define students' barriers: behaviour, cognitive and environmental" and "ethics of e-nudge". The position of the evaluation stage was changed to clarify the purpose and functionality of this stage. The factor “mapping the decision process” was renamed as “mapping the student decision process” to make the name reflect the purpose of the factor.

5.7 Chapter 5 Summary

This chapter presented the main changes that were made to the enhanced e-nudge model based on the analysis of the qualitative data obtained from the interviews. The chapter explained the interview design and the development of the interview questions, and described the target population and how and where data was distributed and collected. The results from the thematic analysis of the interview data were presented, leading to the improvement of the enhanced e-nudging model. The main changes made to the enhanced e-nudging model were explained, and reasons were given for the retention or deletion of certain factors, and the inclusion of new factors. The interviewees confirmed all the key factors derived from the quantitative data, and recommended the addition of two new factors.

The results from this phase were utilized to further refine the previously-enhanced e-nudging model that was considered by the interviewees. The final model consists of a comprehensive set of key factors that that will encourage the adoption of digital nudge techniques in higher education, and ensure their success. The research findings and the final e-nudging model are discussed in detail in the next chapter.

Chapter 6. Conclusion

6.1 Introduction

In the previous chapter, the qualitative data collected from the interview was analysed using thematic analysis. The key factors were validated via thematic analysis to confirm the final e-nudging model for the higher education sector in SA.

This chapter presents the final e-nudge model and provides a comprehensive explanation of each component in the model. The findings from the data analysis confirmed the importance of each factor and yielded some additional factors which were incorporated into the final model presented in section 6.3.

Moreover, answer to both the primary and secondary research questions are presented in section 6.4. Then, the research limitations and recommendations are discussed in section 6.5 and section 6.6 respectively. Finally, future research opportunities in this field are presented in section 6.7. This chapter is summarized in section 6.8.

6.2 Research Summary

This section presents a summary of the research. The summary shows the purpose, methodology processes, and outcome of the research.

Despite the importance of universities and their benefits, many students perform poorly or decide to drop out of university. In fact, the dropout rate from universities and colleges in SA is 30%. This high rate is attributed to several factors such as lack of student interest, poor attendance, and a social structure that has made the younger generation more immature and more dependent on family and society (Sulphey & Alkahtani, 2018).

Nudging interventions have received much attention in education research. The influences of nudging can go beyond psychological barriers by maximizing student welfare as encouraging them to make better decisions. Nudging techniques can provide low-cost support and timely solutions for all students during a semester, and the university can alleviate the pressure placed on students by their having to make choices and decisions without assistance.

The purpose of this study was to develop an e-nudge model for the higher education sector in SA, utilizing a mixed-methods research approach. This model will provide a foundation for stakeholders enabling them to effectively establish and implement the e-nudging model in the Saudi education system. It is anticipated that the study's findings will encourage further research in this area which has great potential to benefit both research and society.

The main phases of this research are: the literature review, online survey and interviews. This sequence was adopted as the application of e-nudge in the education domain is a relatively new notion requiring a comprehensive investigation. The qualitative data obtained from the interviews was used to confirm the statistical results derived from the survey stage, provide richer information, and contribute to the final model (Ivankova et al., 2006).

Chapter 2 presented a comprehensive literature review ultimately leading to the identification of a research gap (section 2.8). First, the background of SA's higher education sector was explained. Many recent studies related to nudging and digital nudging were reviewed. The behavioral, cognitive and environment barriers in the context of educational decisions were discussed. The main outcome of the review was the initial e-nudging model as shown in Figure 2.13 with full details regarding the factors..

Two online surveys comprised the first phase in the mixed method as presented in Chapter 4 section 4.2. The surveys were conducted to assess the factors in the initial model and confirm the factors that should be retained. Also, the online surveys were intended to gather the opinions of university students, academics, and IT staff regarding the implementation of e-nudging in SA's higher education sector and to determine whether the e-nudging model would meet the requirements of university students. The questions designed for the online surveys were translated into Arabic by a qualified third-party translator. Then the survey questionnaires were developed via the Qualtrics platform, and a survey hyperlink was distributed to potential participants. The total number of valid responses of academics and IT staff were 375 and 408 from students. The data collected from both surveys (i.e., academics and IT staff, and students) was analysed using descriptive statistical and Exploratory Factor Analyses (EFA) methods. The software was

Microsoft Excel 2016, SPSS software version 26. The enhanced e-nudging model is depicted in Figure 4.43.with full details regarding the factors.

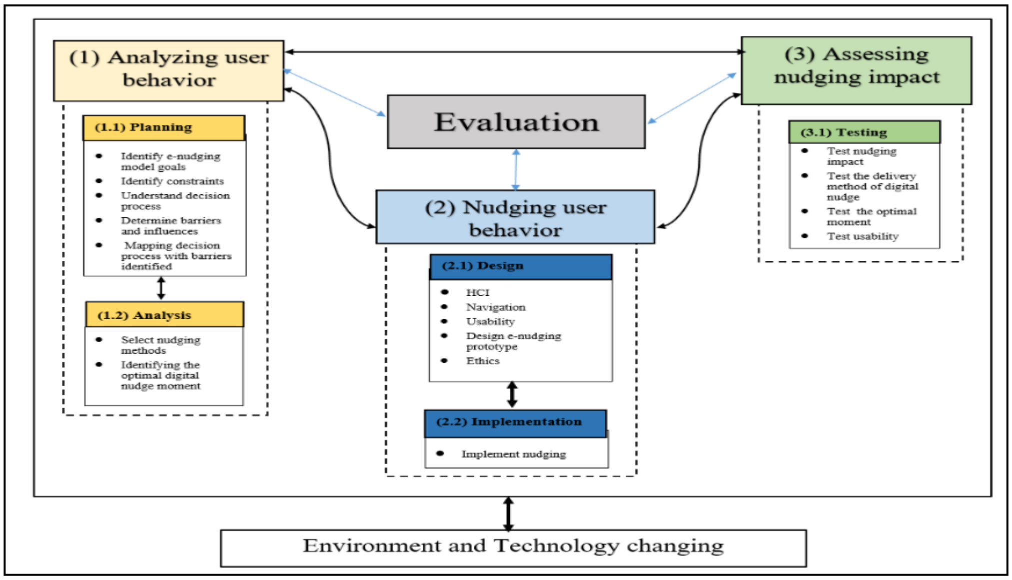
The second phase in the mixed method was the qualitative phase where interviewees were asked to evaluate the enhanced model resulting from the quantitative phase. Also, the interviews collected the opinions of expert academics regarding the factors that should be included in an e-nudging model for SA's higher education sector. The Qualtrics platform was used to develop the interview questions and a hyperlink was distributed to potential participants. Twenty-five respondents agreed to be interviewed. The collected data was analysed using descriptive statistical and thematic analysis methods. The software was NVivo version 1.0. The final e-nudging model is illustrated in Figure 5.43 with full details regarding the factors.

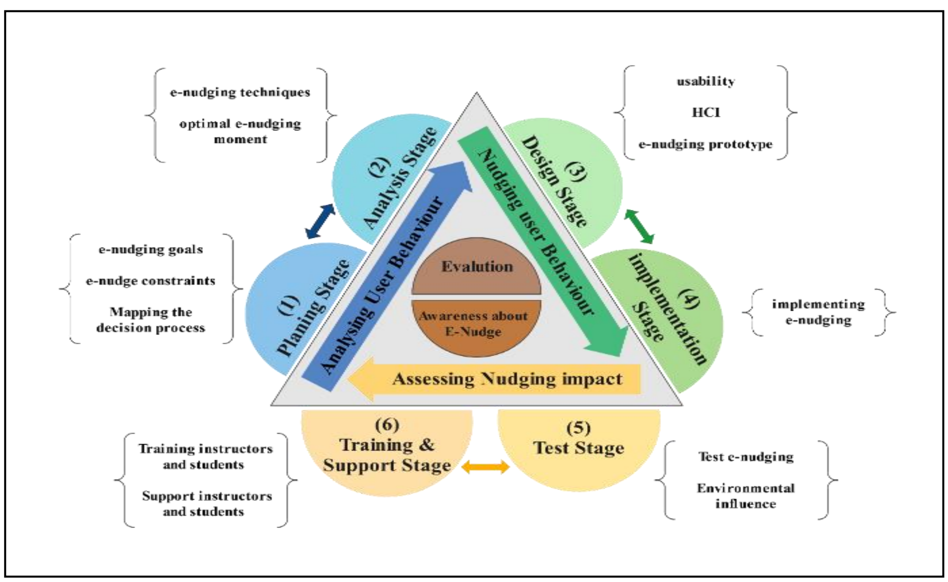
The outcome of this research is an e-nudging model for higher education in SA. The research findings will assist stakeholders such as universities, education departments and governments to make more informed decisions about applying digital nudging successfully in the education system and harness the benefits of this emerging concept. This model will assist stakeholders to establish an effective e-nudging model in the education system of SA and other developing nations such as the Gulf Cooperation Council (GCC) countries. Also, the proposed model with some amendments, could be adopted by organizations in other sectors such as health.

6.3 The e-Nudging Model for SA's Higher Education Sector

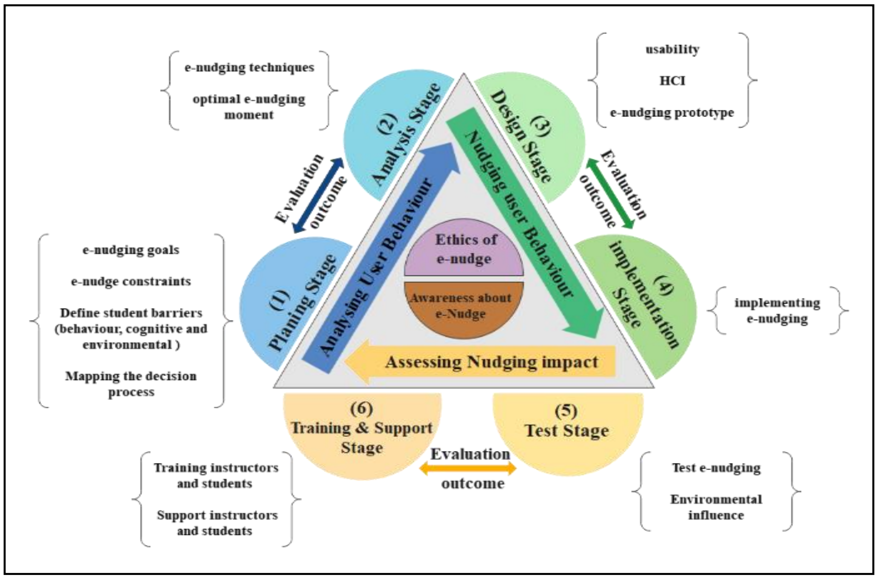
This section summarizes the major findings from the data analysis phase. As mentioned before, this research utilized the mixed-methods sequential explanatory design that involved online surveys followed by interviews to assess the initial and then enhanced models in order to generate the final model. After each step, some modifications were made according to the analysis result obtained from each phase as shown in Table 6.1. This section briefly explains the final model, including the main phases, stages and factors.

Table 6.1: Development of the e-nudging model for SA’s higher education sector (prepared by the researcher).

<table>
<tr><th>Version 1</th></tr>
<tr><td>Initial model generated from literature review Figure 2.13</td></tr>
<tr><td>


</td></tr>
<tr><th>Version 2</th></tr>
<tr><td>Enhanced model based on the online survey data analysis Figure 4.43</td></tr>
<tr><td>


</td></tr>
<tr><th>Version 3 (Final Version)</th></tr>
<tr><td>Final Model based on the interview analysis Figure 5.43.</td></tr>
</table>



The final e-nudging model in Figure 6.1 comprises the three phases of the development of a digital nudging model for the digital environment. All three phases include a feedback loop to enhance the development process. The first phase involves "*analysing user behaviour"* which consists of two stages: planning and analysis. The second phase "*nudge user behaviour"* which also consists of two stages: design and implementation. The last phase is "*assessing nudge impact*" and includes the testing stage and training and support stage. The aim behind creating these three main phases is to simplify the main points for designing digital nudge.

The e-nudging model architecture, which is illustrated in Figure 6.1, is inspired by the system development life cycle (the number of stages and flow or loop). Hence, designers can easily update the current system to adopt and implement the digital nudge by applying the following stages.

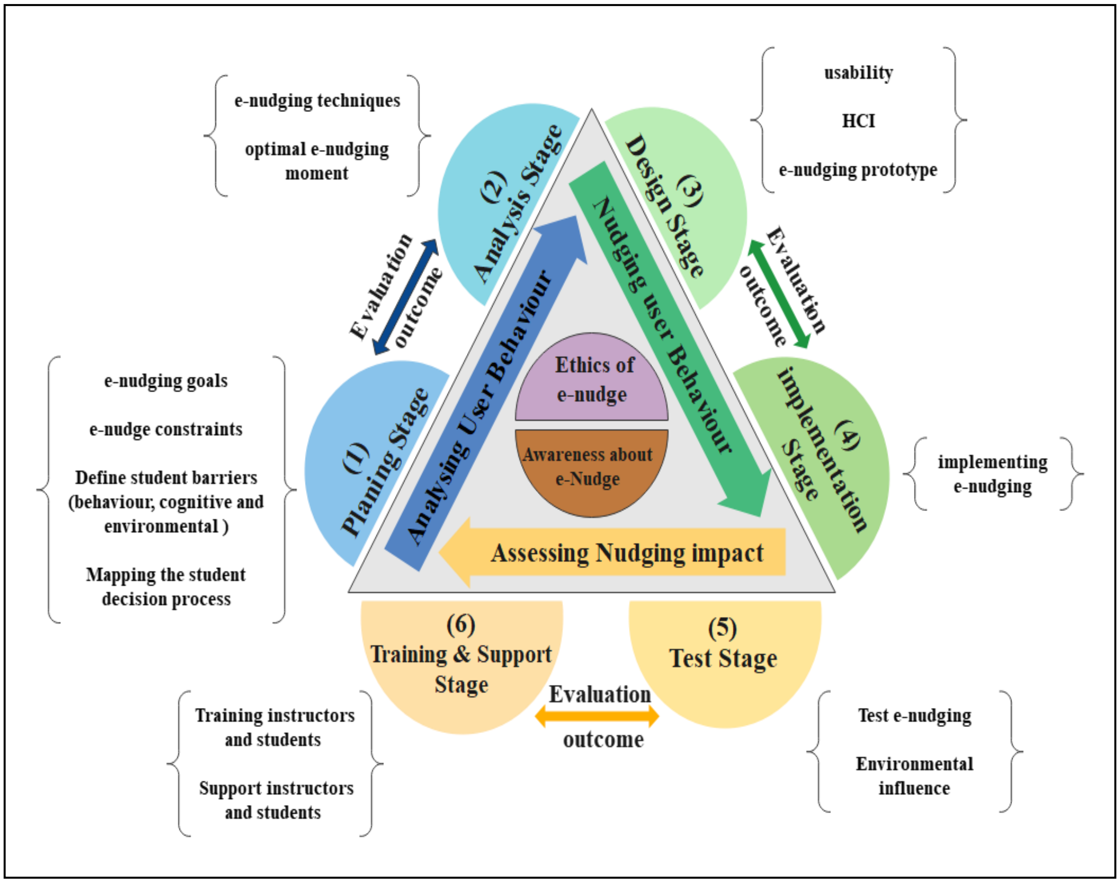


Figure 6.1: Final e-nudge model for this research (prepared by the researcher).

6.3.1 Planning Stage

The aim of this stage is to define the boundaries and understand the outcome. The decision to implement the digital nudge is made in this stage. The planning stage guides the design team through other stages. This stage defines the goal, timeline, cost, and resources. Moreover, it is important to confirm that an organization’s goals and constraints do not conflict with the nudging goals. The planning stage will influence the other stages in the e-nudging model.

The stage contains four factors: “e-nudging goals”, “e-nudge constraints”, “define students’ barriers: behaviour, cognitive and environmental”, and “mapping the student decision process”. Each factor is explained below in detail.

- **E-nudging goals:** the first step in the whole cycle is to define the purpose/goal of the nudge. This must be clarified because every goal will determine the design elements in the user interface (Schneider et al., 2018). Moreover, by understanding the e-nudge goals, the designer can understand which educational decisions and barriers should be considered in order to achieve the e-nudge goals.
- **E-nudge constraints:** this is the second factor. Identifying e-nudge constraints such as cost and resource availability to develop digital nudge is an important step. Also, it is important to consider other constraint such as culture, ethics, and government polices before developing an e-nudging system. The constraints define whether, and how, the nudge should be implemented.
- **define students' barriers: behaviour, cognitive and environmental:** a general understanding of the target population (i.e., students) will lead to better design and reduce development cost, dissatisfaction and errors that may influence the users (Bertheim, 2018). To design an effective digital nudge, it is essential to know the problem(s) that influence a student's decision. It is crucial to match the nudge goal with the defined barrier. For example, if the behavior barrier is limited attention, then the digital nudging goal will be to increase student attention to improve their learning outcomes. In this research, the education barriers that affect students' decisions were placed under three categories: behaviours: cognitive and environmental. It is important to determine what these barriers are, whether a digital nudge can address them, and whether these barriers influence students' education-related decisions. Therefore, it important to understand the behavioural, cognitive, environmental factors that influence the user's decisions, and to ensure that digital nudging is properly conducted and does not occur at random.
- **Mapping the decision process:** this is the last factor in this stage. In order to design an effective e-nudge, it is important to understand how, when, and why students make education-related decisions, and their particular circumstances when they make these decisions. For example, a university student may aspire to securing a 'dream job' eventually, so the notion of a dream job could nudge the student to improve his/her academic performance (digital nudge goal) and

undertake the required action (i.e., complete and submit assignment on time). Also, some desired outcomes may require a number of smaller decisions. So, a nudge can encourage a student to be self-regulated and do work on time, check, complete, and then submit the assignment via the learning system. Another issue relates to emotions, as many students do to think they have the ability to perform well (Azmat et al., 2019). Thus, it is important to outline all critical actions involved in education-related decisions so as to understand when and how to nudge students effectively.

6.3.2 Analysis Stage

The purpose of this stage is to define what is required in order to achieve e-nudge goal. After the e-nudge goal and student barriers have been determined, the most suitable nudge intervention or technique is selected to influence student decisions when using LMS. Also, in this stage, all other possible nudge techniques are examined. In this stage, it is important to analyze the current user interface to check whether it needs any changes or whether these are required in subsequent stages. This stage comprises two factors:

- **E-nudging technique:** This relates to an e-nudging system that can significantly overcome barriers (behavioral, cognitive, and environmental) to improve students' educational decisions and, ultimately, their academic success. Schneider et al. (2018) established three steps for selecting a suitable nudge technique, and gave several examples. In the education context, the first step is to identify the choices to include in the learning system environment. The second step is used to define the education barriers. Then, based on these two steps a suitable nudge can be selected that can best influence students' decisions. Finally, choosing and prioritizing the best nudging technique that meets the system requirements and can influence students' decisions is the final step in this phase and will be the input for the design stage.
- **optimal e-nudging moment**: The time of the nudging must be considered, and is essential in the e-nudging model as explained by (Purohit & Holzer, 2019). Purohit and Holzer (2019) state that the nudging time can be set to occur before, during or

after the semester. For example, if a student needs to work on a project and submit it within two weeks, it is more effective to remind (i.e., nudge) student about the submission date for the project one week before the deadline, than to remind him day before. Finally, it is important to consider the form of digital nudge (text, sound, vibration ...etc.) when setting the time for the nudge.

6.3.3 Design Stage

This stage is intended to define exactly how the digital nudge will be designed and work, and also considers the elements in the interface design that will be most appropriate for the chosen digital nudge technique (i.e., output from analysis stage). During the design of the digital nudging prototype, it is important to consider and implement the Human-Computer Interaction (HCI) and usability design principles in order to meet students' requirements. As mentioned previously, user interfaces are likely to influence students' decision-making in an online environment (Issa & Isaias, 2015; Schneider et al., 2018; Weinmann et al., 2016). With the nudge, there is a subtle change in the 'choice architecture' to steer people's behaviors in predictable ways (Caraban et al., 2019; Konstantinou et al., 2019). This stage contains three factors:

- **Usability**

  Usability is a critical aspect of Human-Computer Interaction (HCI). Usability defines as users can effectively use system to complete a task easily with satisfaction. (Thuseethan et al., 2014). Usability means that the system is effective, efficient, safe to use, easy to use and evaluate, enjoyable, and satisfying (Isaa and Isaias, 2015). In the education context, usability can improve students' learning experiences and academic performance (Thuseethan et al., 2014). A poorly-designed nudge is useless as students will avoid using the system if it is difficult. Hence, usability is an important factor to be considered when designing e-nudge for higher education in SA.

- **Human computer interaction (HCI)**

  The aim of following the principles of Human-Computer Interaction (HCI) is to design a system that meet users' needs and requirements (Issa & Isaias, 2015). As mentioned above, there is no general way to design choices due to the changes in the environment and the ways in which humans intract with technologies (Mirsch et al., 2017; Weinmann et al., 2016). Because digital nudge is implemented via the user interface to alter people's behavior in digital choice environments (Weinmann et al., 2016), it is an element in the user interface. Thus, HCI is an imporant factor in the e-nudge model to ensure that it meets students' requirements and improves their educational decisions.

- **e-nudging prototype**

  Here, a simple model of the user interface is drawn to show how e-nudging will appear among other elements on the students' interface in the learning system. One or more designs can be proposed to achieve the desired e-nudging goals. In this step, it is important to test the choice option, usability and HCI of the user interface after adding the e-nudging technique before moving to the next stage (i.e., implementation stage). It is important to consider the design elements and the way that the nudging appears on the interface.

6.3.4 Implementation Stage

The chosen e-nudging prototype will be implemented at the end of this stage. This stage has one factor named "implementing the e-nudging". In this stage, the digital nudge and the rest of the user interface are actually built.

- **Implementing e-nudging**

  The best digital nudging technique chosen from candidates in the design stage, is implemented together with the rest of the user interface,

6.3.5 Test Stage

The stage aims to test the e-nudging impact on student decisions, and how e-nudging appears in the system among other interface elements. Testing e- nudge is a significate step as the digital nudge might work differently based on context, goals and target groups

(Schneider et al., 2018). The test stage also aims to test the usability and HCI principles for the interface and nudge. The stage comprises two factors:

- **Test e-nudging**
  This factor relates to the measurement of the effectiveness of the nudging and how the nudges appear in the system among other interface elements. The delivery method of the nudging (i.e., notification, sound, vibration, or message) and the timing of nudging must be measured to ascertain their influence on student behavior and produce the desired outcome. It is important to test the timing of nudging to ensure the nudge occurs so that a timely decision can be made. The digital nudges can be tested by conducting online experiments using A/B testing and split testing (Schneider et al., 2018). As timing is an important factor in the final e-nudge model, this test is conducted to find the nudge that works best for a given context and users. Bertheim (2018, p. 49) stated that "split tests can investigate how many are using your nudge, and also track how they are using it."
- **Environmental influence**
  This factor relates to the changing nature of the environment and technology that should be considered when developing effective e-nudging that meets the students' requirements. Also, it is important for digital nudge be adopted in alignment with the rapid changes caused be technology and environment. Technological change may create or facilitate social activities. On other hand, the environmental policy interventions develop new constraints or incentives in order to control the impact of technological change (Jaffe et al., 2003).

6.3.6 Training and Supporting Stage

The training and support stage follows the digital nudge implementation. In this stage, students and instructors learn how to use the learning system, and how to manage the changes in the learning system resulting from the implementation of the digital nudge. The analyst team establishes a support plan for the system. This plan usually includes a formal or informal post-implementation review as well as a systematic way for identifying major and minor changes needed for the system. This stage has two factors:

- **Training instructors and student**
  Training helps users to adapt to changes in a learning system and changes in their roles after the implementation of e-nudge, as training can improve computer skills and user confidence when using an e-nudging in learning system.
- **Supporting instructors and student**
  Support provided from the very beginning will help users to avoid mistakes and associated nudge issues. Support can help users to complete their work efficiently and effectively.

6.3.7 Evaluation stage

In the evaluation stage, the outcomes of each of the e-nudging model stages are examined and assessed. In this stage, a final assessment is given prior to the final e-nudging intervention. In fact, none of the previously proposed models has an evaluation step after each phase; all the models assess the effectiveness of the digital nudging at the end of the entire process in the test phase. Evaluation is a critical step in the development of new technology. The designer needs to plan each evaluation step during the development cycle and before releasing the technology to the user in order to ensure that the new technology meets the user's requirements (Issa & Isaias, 2015).

- **Evaluation step after planning stage**: The final step in the planning stage reviews the nudge goals and constraints, and evaluates the barrier impacts and students' decision process, since the planning stage is a significant and critical stage in the e-nudging model.
- **Evaluation step after analysis stage**: the best nudging method that meets the system requirements and can influence student's decision effectively is the final step in this phase and will be the input for the design stage.
- **Evaluation step after design stage:** in the final step, the digital nudging prototype is evaluated according to two criteria: efficiency and full freedom of choice. This step improves the nudging design by reworking and testing it until the nudging prototype meets the requirements and ethics before the implementation stage.

- **Evaluation step after implementation stage:** in this stage, the digital nudge is implemented and examined to see whether the choices on the interface need to be re-designed. It is important to ensure that the learning system works consistently and to find whether there is a need to change "the e-nudge technique or design another choice option" on the interface user. Also, operational costs associated with implementation must be considered.
- **Evaluation step after test stage:** after the effectiveness of digital nudge and the usability and HCI for the learning system interface have been tested, the learning system is ready for the training and support stage.
- **Evaluation step after training and support stage:** after the training stage, the evaluation stage continues to evaluate the effectiveness of the learning system after the integration of e-nudge, and determine whether it needs to be improved.

6.3.8 Ethics of e-Nudge

Ethics must be taken into account when designing a digital nudge. The concept of nudging originates from economics and is intended to safeguard liberty and not limit or preclude any choice. It is unethical to nudge people towards decisions that could harm them or compromise their welfare (Hortal, 2020). Sunstein (2015) stated that if nudges are designed to ensure freedom of choice, individuals can choose what they like and not be constrained to follow nudges. Also, it is important to not use individuals' behavioral characteristics such as inertia or inattention against them (Sunstein, 2016). Nudging should be non-irresistible and transparent. Individuals should be aware of any kind of intervention that is intended to restructure the choice environment in order to direct their behavior (Hortal, 2020). Many researchers claim that transparency is an important requirement in the design of nudging in order to maintain the individual's autonomy and to forestall any ethical complaints (Grüne-Yanoff & Hertwig, 2016; Hortal, 2020). Finally, ethics should be considered throughout the whole process to ensure that the design does not harm anyone (Bertheim, 2018).

6.3.9 Awareness of e-Nudge

This factor is new factor that emerged from the analysis of the survey data. This factor is new and controversial. If people resist e-nudging or prefer not to be monitored, they will resist the e-nudge even though it is tailored to their preferences. In these cases, awareness of the nudge is likely to reduce its effect. On other hand, when the person appreciates the effort that has gone into developing the nudge, this awareness might increase the influence of the nudge so that students can make better decisions (Cutler, 2016). Thus, the factor was included in the model as all participants welcome the idea of digital nudge and believe it will improve academic outcomes.

6.4 Answering the Study Research Questions

In this research, the surveys and interview were conducted to determine the e-nudging model factors, participants' perceptions, education barriers, and e-nudge techniques.

As indicated in section 3.3, the main research question is:

- *What are the specific factors that must be considered when designing an e-nudging Model for higher education in Saudi Arabia?*

The surveys and interview determined the factors of e-nudge as shown in Table 6.2. Also, the changes in factors included in the e-nudging model after each analysis phase is illustrated in Figure 6.2. However, the implementation and evaluation stages were assessed only in the interview phase as these stages had few variables. Moreover, the researcher was concerned that the survey items might cause survey participants to misunderstand or confuse the design and implementation of e-nudging. Hence, these two stages (i.e., implementation and evaluation) were evaluated by the interviewees. For the training and support stage, and awareness factor was generated from the survey analysis results and later assessed by the interviewees.

Table 6.2: Mapping table for first research question (prepared by the researcher).

Themes	Survey			Interview	Research Objective			Research Question		
	Academics	IT Staff	Student	Academics	RO1	RO2	RO3	RQ1	RQ2	RQ3
Factors for e-Nudging Model										
Planning Stage	√	√		√	√			√		
Analysis Stage	√	√		√	√			√		
Design Stage	√	√		√	√			√		
Implementation Stage				√	√			√		
Testing Stage	√	√		√	√			√		
Training and support Stage				√	√			√		
Evaluation Stage				√	√			√		
Awareness Factor				√	√			√		

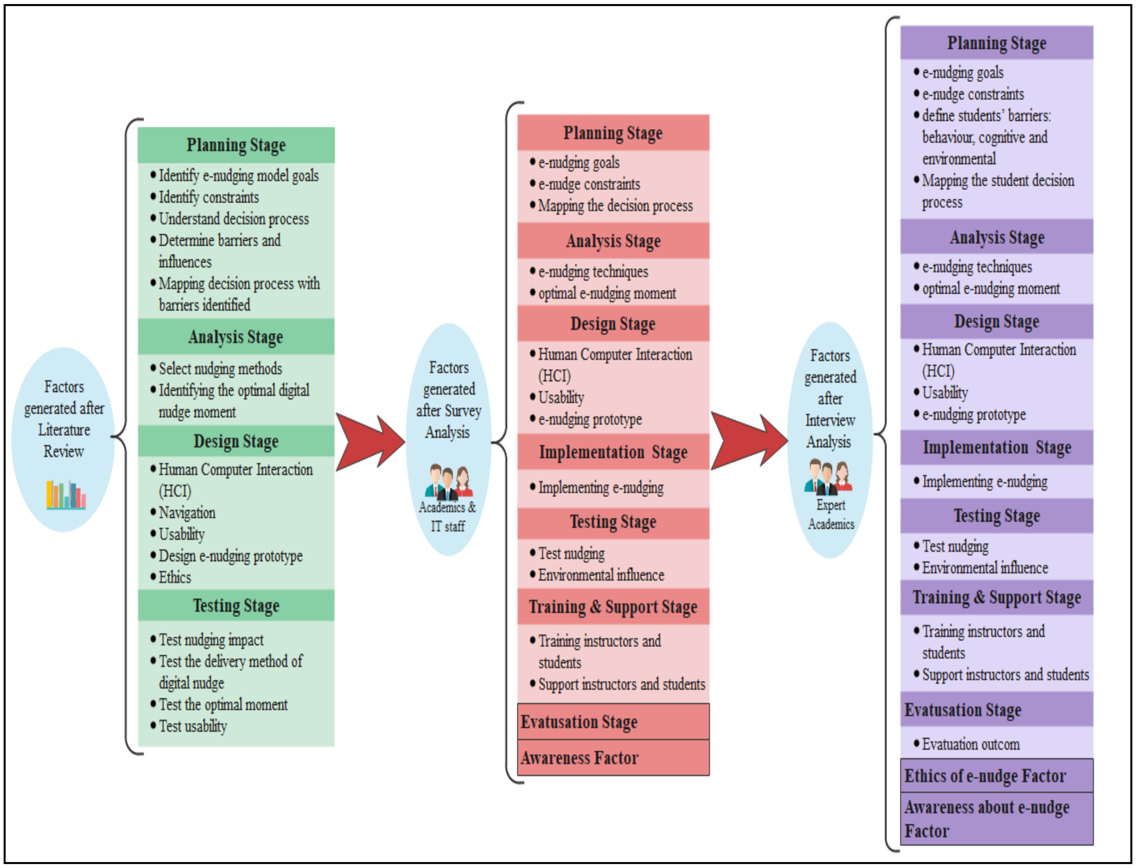


Figure 6.2: The changes in factors of the e-nudging model after each analysis phase (prepared by the researcher).

As illustrated in Figure 6.1, the final version of the e-nudging model contains three main phases each phase has two stages, and each stage has one to four factors. There is one stage called "*evaluation*", and two factors, "ethics" and "awareness about e-nudge", should be considered throughout the entire process, not just in one stage.

- First phase: analysing user behaviour. This phase contained two stages. The first stage is the planning stage. It has four factors: "e-nudging goals", "e-nudge constraints", "define students' barriers: behaviour, cognitive and environmental" and "mapping student decision process". The second stage is the analysis stage. This stage comprised two factors: "e-nudging techniques" and "optimal e-nudging moment.
- Second phase: nudge user behavior. This phase contained two stages. The first stage is the design. This stage comprised three factors: "usability", "HCI" and "e-

nudging prototype". The second stage is the implementation stage with one factor: "implementing e-nudging"

- Third phase: assessing nudge impact. This phase involves two stages. The first stage is the testing stage. The stage has two factors: "test e-nudge" and "environmental influence". The next stage is training and support. This stage included two factors: "training the instructors and student" and "support the instructors and student".

The evaluation stage, the awareness factor and ethic factor are undertaken throughout the entire process to influence the final e-nudge model.

The second research question for this research is:

- *What are the perceptions of university expert academics regarding the e-nudging model for Saudi Arabia higher education?*

The interview covered the following themes: participants' perception regarding the enhanced e-nudge model after survey analysis results as shown in Table 6.3.

Table 6.3: Mapping table for second research question (prepared by the researcher).

Themes	**Survey**			**Interview**	**Research Objective**			**Research Question**		
	Academics	**IT Staff**	**Student**	**Academics**	**RO1**	**RO2**	**RO3**	**RQ1**	**RQ2**	**RQ3**
Perception of:										
▪ Factors of the enhanced e-nudging model for higher education in SA				√		√			√	

As discussed in section 5.4, all of the interviewees provided feedback regarding the enhanced model which was based on the results obtained from the academics and IT staff survey. Overall, expert academics who were interviewed were satisfied with the final e-nudging model, although some amendments were required. Two new factors emerged from the interview data. The position of one stage has changed and a factor label was slightly modified in order to make the purpose and functionality of this stage evident to the readers.

The third research question for this research is:

- *How can an e-nudging model meet the requirements of students?*

The survey covered the following themes: participants' attitude to the implementation of the e-nudge model, the e-nudge interface, education barriers, and e-nudging techniques as shown in Table 6.4.

Table 6.4: Mapping table for third research question (prepared by the researcher).

Themes	Survey			Interview	Research Objective			Research Question		
	Academics	IT Staff	Student	Academics	RO1	RO2	RO3	RQ1	RQ2	RQ3
▪ Implementation of e-nudging in SA's higher education	√	√	√				√			√
▪ Students' e-nudging interface	√	√	√				√			√
Education barriers										
Behavioral barriers			√				√			√
▪ Self-regulation			√				√			√
▪ Bounded Rationality			√				√			√
Cognitive barriers			√				√			√
▪ Attention			√				√			√
▪ Memory			√				√			√
▪ Self-confidence			√				√			√
Environmental barrier			√				√			√
▪ LMS interface Complexity			√				√			√

e-nudging Techniques										
▪ Feedback	√	√	√				√			√
▪ Reminder	√	√	√				√			√
▪ Peer comparison	√	√	√				√			√
▪ Reduced distance	√	√	√				√			√

As discussed in section 4.5, the students' online survey results showed that behavioural, cognitive and environmental factors present a significant challenge to tertiary students and can negatively influence their decisions. However, the integration of e-nudging in the LMS can address these challenges. Therefore, when designing an e-nudge, developers must take into account all of these challenges in order for the nudging to be an effective means of improving students' academic performance and meeting their needs.

Moreover, as shown in sub-section 4.4.3 and sub-section 4.5.3, the majority of respondents (academics, IT staff and students) understand that e-nudging is intended to encourage and motivate students to improve their academic outcomes. The academics and IT staff indicate that usability and HCI features are important for students' e-nudging interface, and should meet students' requirements.

The majority of students indicated that e-nudging is an excellent idea, the nudge should be easy to use, and HCI and usability features should be taken into account and integrated in the design e-nudging.

6.5 Research Limitations

This research offers significant contributions in terms of digital nudge in education filed from both theoretical and practical perspectives; however, it has several limitations.

To begin with, the Covid-19 pandemic affected the research in various ways. First, during the data collection stages, it was crucial to balance health risks against the research needs. A few days after the survey stage began, the Saudi governments announced on 12 March 2020 the closure of all schools and universities; teaching would be conducted online with virtual classes. As a result, the response rate remained unchanged for two weeks, so the researcher decided to use social media such LinkedIn and Twitter, and utilize the snowball technique to speed up the process. It became apparent that the interviews could not take place face-to-face due to social distancing regulations and the availability of vaccines only for the elderly or those with a medical condition. Hence, the interviews would have to be conducted online. The researcher developed the interview questions and distributed them via the Qualtrics platform.

Second, during this time (i.e., the Covid-19 pandemic) the researcher was in Saudi for data collection, the national borders were closed, and the researcher was compelled to continue this study in SA and to have virtual meetings with her supervisor. Additionally, the time zone difference between Australia and SA was also a limitation, as it was challenging to arrange virtual meeting times that were convenient for both parties. Despite that, the supervisor put in extra effort and time to support this research during the pandemic which posed an additional challenge as it created a climate of uncertainty.

Furthermore, there is a lack of previous studies in the research area. To date, only six digital nudging models have been proposed. This limitation should encourage researchers to conduct more studies in this area and contribute to the current body of knowledge about the nudge and its applications.

Finally, apart from the data collection having been done during Covid-19, a large number of returned responses were incomplete (both surveys and interviews). Regarding the surveys, 434 incomplete responses were returned by academic and IT staff, and 681 by students. In the interview phase, there were seven incomplete responses from expert academics. The reasons could be a lack of knowledge about some of the concepts involved in the research as nudge is a relatively new concept, or possibly a lack of motivation to take part in or complete voluntary surveys.

Ultimately, the research presents a useful perspective regarding the factors that should be included in the final e-nudging model for higher education in SA, despite all the acknowledged limitations. These findings could be utilized by higher education providers who are considering the implementation of nudging.

6.6 Research Recommendations

As aforementioned, nudge interventions have been widely applied in offline contexts (Thaler & Sunstein, 2008). The concept of digital nudge has received much attention over the last ten years, as indicated by the literature review. There are several recommendations that should be considered in order to design an effective nudge for students in SA's higher education. Figure 6.3 summarizes the recommendations, each of which is explained below in more detail.

- **Understand the students' needs**
  It is important to examine the current situation of the student to identify their various challenges and understand how they make their educational decisions. It is critical to understand the students properly as the success of the digital nudge techniques (i.e. interventions) depends on the user (Bertheim, 2018; Goepel, Svanhall, & Rahme, 2015).
- **Usability and HCI Factors**
  Usability and HCI are significant factors. The research findings indicate that all participants have a strong interest in using digital nudge in education. They suggested that a learning system that integrates e-nudge should be effective, easy to use, and easy to learn, and have a user-friendly interface to improve academic performance, and deliver an enjoyable experience to end users.
- **Ethics Factor**
  Ethics is a significant factor in designing digital nudge. Sunstein (2015) stated that if nudges are designed to ensure freedom of choice, individuals should be able to choose what they like and not be constrained to follow nudges. Thus, it is important for instructors not to penalize or threaten students who are being nudged to submit assignments on time. The purpose of using nudge is to assist students to overcome challenges by helping them make better decisions throughout their studies.
- **Transparency**

Another important recommendation is transparency. Students should be aware of any kind of intervention that is intended to restructure the choice environment in order to direct their behavior (Hortal, 2020). Many researchers claim that transparency is an important requirement for design nudging in order to maintain the individual's autonomy and to forestall any ethical complaints (Grüne-Yanoff & Hertwig, 2016; Hortal, 2020). If the design of the digital nudge offers transparency, there are less likely to be ethical complaints or objections. In addition, a transparent e-nudge design gives the student freedom to choose whether or not to follow the nudge. However, Weijers et al. (2020) claimed that no research has been conducted to examine the effect of nudge transparency in education. There is a need to conduct more research to investigate the extent to which different levels of transparency influence the effectiveness of a nudge (Weijers et al., 2020).

- **Technology Infrastructure**

  The implementation of the digital nudge in the learning systems requires improvement in infrastructures and facilities to harness the benefit of learning systems effectively. It is important to have well-equipped offices and labs with PCs hardware, and software in universities, especially in villages and rural areas. For example, the PC should have at least enough memory and good resolution screen. Moreover, it is important that universities have a high-speed Internet and a good bandwidth to provide seamless access to the learning system.
- **Training and Support**

  Training and support are significantly important after implementing digital nudge. If an excellent learning system is implemented but without a support team, the system will not work. Universities should conduct training sessions for instructors and students, especially those who are unfamiliar with computers and learning technology, enabling them to use the learning system effectively. Furthermore, it is essential to select a skilled support team that has been trained on LMS administration. The universities should have various channels that can offer support such as online help or virtual references.

- **Monitoring and Tracking**

  It is critical to monitor and track the influence of the e-nudge on students' behaviour. It is important to evaluate the effectiveness of the digital nudging to ensure that it is properly conducted and systematic. Also, this gives an opportunity for potential improvements to the nudge intervention or learning system to enable students to derive the maximum benefit from the learning experience.

SA aims to meet global technical standards and to this end has established the Saudi Vision 2030. Therefore, it is recommended that universities allocate sufficient financial resources to upgrade the requisite technology such as hardware, software, and Internet connections, especially in rural areas. Also, if e-nudging is to be integrated in the learning system, it is essential to establish a plan for training and supporting end users (i.e., instructors and students) so that the LMS can be used effectively. Moreover, it is important that IT and administrative departments in universities consult with academic staff as they will be the end users of the technology that will be purchased, and its benefits must be maximized.

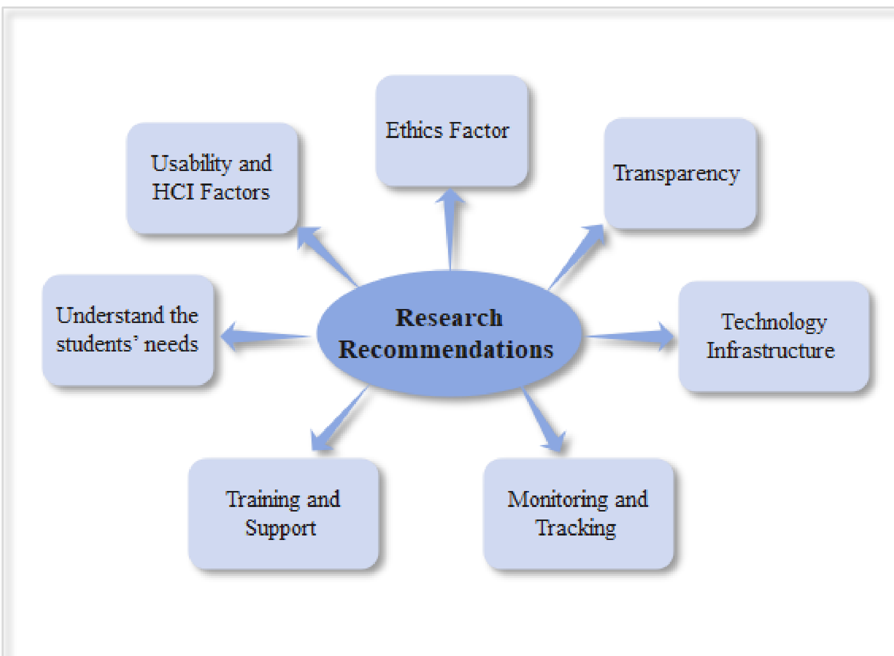


Figure 6.3: Research recommendations (prepared by the researcher).

6.7 Significance and Future Research

The main significance of this research is that a model was proposed which provides a foundation and guidelines for stakeholders who wish to implement an e-nudging model in the Saudi education system. To the best of the researcher's knowledge, this study is the first to define the key factors that must be taken into consideration when designing an e-nudge for students in Saudi universities.

The results of this study revealed that SA is in a situation to reap the benefits of digital nudging and that end users in the sample agreed and supported the critical factors involving model for implementation of digital nudging in higher education. However, study provide several avenues for future research. The future research has summarized in Figure 6.4

- **Experiments to assess e-nudge model in learning system**
  First, this research created and assessed a model for the implementation of digital nudging in higher education. A useful research avenue could involve experiments to implement digital nudge in learning systems in SA universities following the proposed model. The aim of the experiments would be to assess the model to determine whether it is comprehensive or whether it needs to include other factors.
- **Experiments to examine the influence of informational digital nudge**
  The research proposed four types of information digital nudges that can help overcome education barriers: behavioural (i.e., self-regulation and bounded rationality), cognitive (i.e., attention, overconfidence), and environmental (i.e., learning management system functionality, HCI, navigation and usability). The informational digital nudge include: feedback from instructors, peer comparison, reminders, and reduced distance. The reducing of distance is a new type of informational nudge proposed in this research. It is used when students struggle or fail to engage in self-improvement activities when the outcomes will become apparent only in the distant future. In future, studies could be conducted to

examine the influence of these informational digital nudges on the aforementioned educational challenges.

- **Study awareness factor**

  Second, factor "awareness" is a new factor that emerged from the surveys. However, the interview participants had different opinions regarding this factor. To date, no research has been conducted to determine the influence of this factor on nudge intervention. According to Cutler (2016), when the person appreciates the effort that has gone into developing the nudge, this awareness might increase the influence of the nudge so that students can make better decisions. All participants (academic, IT staff, and students) welcomed the idea of e-nudge and agree that e-nudging is an excellent idea that will help them to make better decisions that will help them improve their academic performance. Further research is needed to confirm this novel finding.

- **Re-conducted research in other developing countries**

  Third, this study can be re-conducted in other developing countries, especially Gulf Cooperation Council (GCC) countries, as they share many common characteristics such as culture, religion, social, languages, and economic and financial systems.

- **Replicate this research in different context**

  Also, future studies could replicate this study in different contexts. For instance, it can be used in the areas of donations, health, security, shopping, and consumption (i.e., water and electricity). The various nudging techniques have received more attention and several studies have found that nudging can produce significant results.

- **Test and compare influences of different digital nudge techniques**

  In addition, the research aims to provide valuable knowledge about important behavioral, cognitive and environmental factors in the education field, facilitating the design of successful digital nudging in learning systems. Also, future research could examine other digital nudging designs and compare the results. It would be interesting to conduct research to examine how different digital nudge interventions in LMSs can steer user behaviours compared to systems that do not provide a digital nudge.

- **Explore culture dimensions**

  Another future avenue is explore the impact of culture factor on applying e-nudging in higher education in SA. There are several models can be used to study the culture dimensions. A common model called Hofstede model. The model contains six dimensions of national cultures: Power Distance, Uncertainty Avoidance, Collectivism, Masculinity, Long Term Orientation, and Indulgence (Hofstede, 2011). For instance, Al-Gahtani, Hubona, and Wang (2007) claimed that SA ranks much higher than the US in uncertainty avoidance and power distance in regard IT acceptance. This mean the Saudi society preference for avoiding uncertainty and ambiguity with computer. Additionally, power distance refers that the Saudi society accept the hierarchical order where everyone has a place without further justification. Thus, the community might show deference to authority and conform to the expectations of others who play the superior or important roles. As mentioned, the digital nudge is new concept, so it is important to explore the relationship between culture and digital nudge and evaluate the acceptance of Saudi students in higher education in order to design and implement the nudge successfully in LMS.

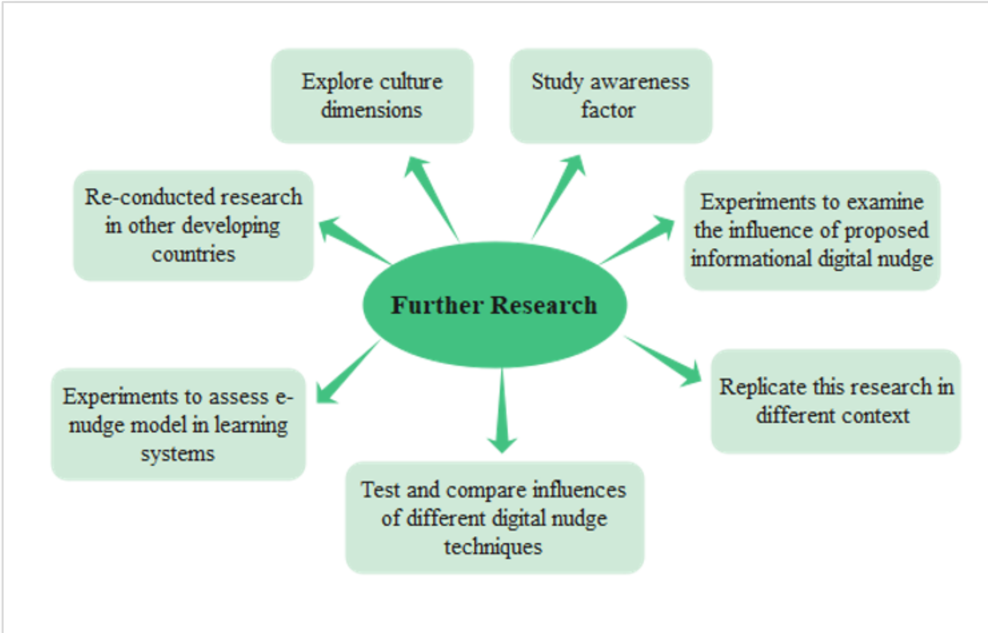


Figure 6.4: Future research (prepared by the researcher).

At the end, the nudge is a relatively new concept that provides many avenues for future research in SA and other GCC countries in the education domain and other areas as well. In fact, with certain modifications, the e-nudging model could be adapted for other organizations and universities in other countries. This research provides the foundation for stakeholders to effectively establish and implement digital nudging in education systems in particular and in other areas in general.

Information systems offer unique opportunities for harnessing the power of nudging. For example, web technologies allow not only real-time tracking and analysis of user behavior but also the personalization of user interfaces, and both can help test and optimize the effectiveness of digital nudges.

6.8 Chapter 6 Summary

The overall findings of this research are presented in this chapter. The chapter begins with a list of the key factors that were included in the final e-nudge model for the higher education sector in SA. These factors were confirmed and accepted after the quantitative and qualitative data were analysed. The final model is illustrated in Figure 6.1 with a brief description of each stage, including all factors. Then, both the primary research question and the secondary research questions are answered. The research limitations are acknowledged, the significance of this research is explained, and recommendations for future research directions are offered. It can be concluded that the power of nudge can be harnessed by IS technologies, making them a useful tool for steering users, particularly students, towards better and wiser choices.

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Appendices

Appendix A: Email Survey Letter

SA **Salihah Farhan T Alotaibi**
11/04/2020 6:16 PM

To:

Dear

I am currently undertaking a PhD research entitled as "Initiating and Assessing an e-Nudging Model for Higher Education in Saudi Arabia" at Curtin University, Australia.

Please share with us your opinion about applying e-nudge for higher education in Saudi Arabia. Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2020-0060).

Academic and technology staff survey

https://curtin.au1.qualtrics.com/jfe/form/SV_4MWWJfTtafcPny5

Regards,
Salihah

Appendix B: Surveys Target universities

Table: Surveys Target universities.

University	Classification	Location	No of academics	No of students	Arab world ranking 2019
University A	Government	Western province (Jeddah)	7,382	163,979	1st
University B	Government	Eastern province (Dhahran)	1,095	12,324	6th
University C	Government	Western province (Mecca)	5,008	107,432	17th
University D	Government	Central Province (Riyadh)	4,009	117,077	36
University E	Private	Central Province (Riyadh)	186	2,971	52
University F	Private	Central Province (Riyadh)	444	4,905	85
Total			**13,116**	**301,256**	
Research Sample size			373	384	
Valid and completed responses			375	408	

Appendix C: Pilot Study Checklist

Curtin University

Pilot study checklist for students' survey

Overall, the instructions contained in the consent were clear	☐ Yes	☐ No
The Language of the questionnaire is simple and easy to understand	☐ Yes	☐ No
The format of the questionnaire is easy to read	☐ Yes	☐ No
The questionnaire font size is easy to read	☐ Yes	☐ No
The number of questions on each page in the questionnaire was appropriate	☐ Yes	☐ No
The time it took to complete the questionnaire is appropriate	☐ Yes	☐ No
The questions are ordered in a logical manner that is easy to follow	☐ Yes	☐ No
Are there questions you feel are unimportant, irrelevant, or redundant and could be eliminated from the questionnaire without jeopardizing completeness of the study results?	☐ Yes	☐ No
Are there any questions NOT included in this questionnaire that you feel would be important to include to better understand how teams function	☐ Yes	☐ No

Do you have any comments on questionnaire that might improve responds rate ?

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Curtin University

Pilot study checklist for Academics and technology staff survey

Overall, the instructions contained in the consent were clear	☐ **Yes**	☐ **No**
The Language of the questionnaire is simple and easy to understand	☐ **Yes**	☐ **No**
The format of the questionnaire is easy to read	☐ **Yes**	☐ **No**
The questionnaire font size is easy to read	☐ **Yes**	☐ **No**
The number of questions on each page in the questionnaire was appropriate	☐ **Yes**	☐ **No**
The time it took to complete the questionnaire is appropriate	☐ **Yes**	☐ **No**
The questions are ordered in a logical manner that is easy to follow	☐ **Yes**	☐ **No**
Are there questions you feel are unimportant, irrelevant, or redundant and could be eliminated from the questionnaire without jeopardizing completeness of the study results?	☐ **Yes**	☐ **No**

Are there any questions NOT included in this questionnaire that you feel would be important to include to better understand how teams function ☐ **Yes** ☐ **No**

Do you have any comments on questionnaire that might improve responds rate ?

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Appendix D: Survey Questions

Participant Information Sheet

Teachers & Technology staff Survey

I am currently undertaking a PhD research entitled as “Initiating and Assessing an e-Nudging Model for Higher Education in Saudi Arabia” at Curtin University, Australia and is funded by my sponsor. The research work on the initiation and assessment of an e-nudging model for the higher education sector in SA. The survey will examine the current factors that influence the effectiveness of the e-nudging model. The nudge is defined as being a soft intervention that steers a person’s behavior in a predictable way without restricting people’s options, while encouraging them to make better decisions.

The purpose of this research is to understand the concept of digital nudging in terms of its application in universities to encourage better education decision-making for students in a digital environment (i.e. learning system) in SA.

This survey is conducted exclusively for PhD research purposes. It should take approximately 20 minutes to complete. This survey contains four sections. Please read each statement and then circle the number or tick the box that best describes your attitude or belief. Please, feel free to disregard to answer any particular question that you do not wish to answer for any reason.

We greatly appreciate your participation because your responses may help us learn more about how to successfully implement an e-nudging model in the higher education sector in SA. This research will help to improve the quality of higher education in SA. Your assistance in this research is greatly appreciated and is critical for the success of its findings.

Your Participation in this research is completely voluntary and your responses will be treated as being anonymous. Participants have the right to refuse or withdraw at any time without penalty or negative consequences and do not need to provide a reason. By completing this survey, you are consenting to participate and allow me to use your data in this research.

The data collected through the survey will be held as strictly confidential. The data collected for this study will be available in R Drive (in accordance with Curtin Data Management policy) at Curtin University, and only the researcher and PhD committee will have the authority to access it. The data will be used for the research purpose only and will not be revealed to or shared with others. Finally, the researchers will ensure that published material does not contain any information that can identify the participants.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **HRE2020-0060**). 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 hrec@curtin.edu.au

Thank you for your involvement in this study. Your participation is highly appreciated. If you need any additional information, please feel free to contact the researcher.

Thank you in advance.

Yours faithfully,

Salihah Alotaibi

Participant consent statement:

◯ I have received information regarding this research and have had the opportunity to ask questions. I believe I understand the purpose, extent and possible risks associated with my involvement in this project and I voluntarily consent to take part

Dear Sir/Madam

Please click on the link below to watch the video about the study aims and how the digital nudge will help students to make a better decision before answering the online survey questions

https://drive.google.com/file/d/1y4FQzIQZb-mKKrT-3jsWNtB3RfxgthEZ/view?usp=drivesdk

SECTION A: DEMOGRAPHIC DATA

Q1. Gender

◯ Male

◯ Female

Q2: What is your age?

◯ 24-28

◯ 29-33

◯ 34-38

◯ 39- 44

◯ 45-50

◯ 51 and above

Q3: Please tick your highest education level

◯ Professional Certificate

◯ Diploma

◯ Advanced/Higher/Graduate Diploma

◯ Bachelor's Degree

◯ Post Graduate Diploma

◯ Master's Degree

◯ Doctorate Degree

Q4: What is your Job Title?

◯ Lecture

◯ Assistant Professor

◯ Associate Professor

- ○ Information Technology department's staff
- ○ Other- please specify [ ]

Q5: Please tick the type of your university .

- ○ Government
- ○ Private
- ○ Other

Q6: Please tick your main field(s) of work

- ○ Accounting
- ○ Business Law
- ○ Economics and Finance
- ○ Information Systems
- ○ Information Technology
- ○ Computer Science
- ○ Management
- ○ Marketing
- ○ Health Sciences
- ○ Humanities
- ○ Science and Engineering
- ○ Art and Design
- ○ Other – Please specify [ ]

Q7: Please tick the type of learning management system used in your university.

- ○ Blackboard
- ○ Moodle
- ○ Other – Please specify ☐

Q8: Please tick your level of computer experience.

- ○ Beginner
- ○ Intermediate
- ○ Advanced
- ○ Expert

Q9: Please tick your usage of education-related technology in your professional activities.

- ○ High
- ○ Medium
- ○ Low

Q10: Please tick your level of knowledge in regard to e-nudging techniques.

- ○ High
- ○ Medium
- ○ Low

SECTION B: In this section, the researcher will identify the specific factors that must be considered when implementing an e-nudging model for the higher education sector in SA.

In order to develop and successfully implement an e-nudging model in the higher education sector in SA, several factors need to be taken into consideration at each stage of development.

An e-nudging model comprises five stages with each stage containing specific factors that must be implemented in order to meet model requirements. The stages are detailed below.

To what extent do you agree with the following statements?	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
Planning stage contains the following factors					
(1) Define e-nudging model goals: stakeholders/developers need to understand the goal behind e-nudging (i.e. improve students' academic outcomes). **The goals of the e-nudging model must be defined in order to:**					
Understand what the e-nudging is trying to achieve.	○	○	○	○	○
Understand students' educational decisions in relation to the e-nudging goals.	○	○	○	○	○
Understand how the students' interface in a learning management system (LMS) should be designed.	○	○	○	○	○
Ensure that the right team is responsible for the development of an e-nudging model.	○	○	○	○	○
Monitor the developmental stages of an e-nudging model.	○	○	○	○	○
Make effective decisions during the development of the e-nudging model.	○	○	○	○	○

Achieve an e-nudging goal by encouraging teamwork.	◯	◯	◯	◯	◯
(2) Identify constraints: things that restrict e-nudging model and influence how the development process can be managed. **The aim of identifying constraints in e-nudging goals is to:**					
Influence the quality of an e-nudging model's outcome.	◯	◯	◯	◯	◯
Continue to develop and refine an e-nudging model.	◯	◯	◯	◯	◯
Determine the resources that are required for the development of an e-nudging model.	◯	◯	◯	◯	◯
Understand the time constraint influencing the development of an e-nudging model.	◯	◯	◯	◯	◯
Understand the government constraints influencing the development of an e-nudging model.	◯	◯	◯	◯	◯
Understand the cultural constraints influencing the development of an e-nudging model.	◯	◯	◯	◯	◯
Understand the ethical constraints influencing the development of an e-nudging model.	◯	◯	◯	◯	◯
(3) Understand the decision-making process: student' educational decision): what are the actions and decisions that need to be completed to achieve task successfully. **In terms of decision-making, it is important to:**					
Understand how students make their educational decisions via a learning management system (LMS).	◯	◯	◯	◯	◯
Determine the main steps involved in the decision to complete an education task via a learning management system (LMS).	◯	◯	◯	◯	◯
Understand the barriers that prevent students from completing an education task via a learning management system (LMS).	◯	◯	◯	◯	◯
Understand the type of e-nudging technique that could encourage students to complete education tasks via a learning management system (LMS).	◯	◯	◯	◯	◯

Understand where e-nudging could be located to encourage student to complete education task via a learning management system (LMS).	○	○	○	○	○
(4) Determine barriers and influences heuristics and behavioral, cognitive and environment biases that influence students' educational decisions. **The purpose of determining the barriers and influences is to:**					
Identify the barriers that influence students' educational decision in a learning management system (LMS).	○	○	○	○	○
Identify the education-related barriers that prevent student from complete education task via a learning management system (LMS).	○	○	○	○	○
Understand how to nudge students to complete an education task via a learning management system (LMS).	○	○	○	○	○
Understand the type of e-nudging that could be used to reduce the barriers' influence in a learning management system (LMS).	○	○	○	○	○
Understand where e-nudging could be located to reduce the barriers' influence in a learning management system (LMS).	○	○	○	○	○
Assist the designer to focus on students' needs in terms of using a learning management system (LMS).	○	○	○	○	○
(5) Mapping the decision process with barriers identified aims to					
Provide a complete visual overview showing how education's barriers influence students' educational decision-making in a learning management system (LMS).	○	○	○	○	○
Understand education's barriers in LMS.	○	○	○	○	○
To communicate easily how e-nudging should be designed in a learning management system (LMS).	○	○	○	○	○
Identify students' critical educational decisions in regard to completing an education task via a learning management system (LMS).	○	○	○	○	○

Determine the e-nudging actions that students need in order to complete an education task via a learning management system (LMS).	◯	◯	◯	◯	◯
Determine when e-nudging could influence students to complete an education task via a learning management system (LMS).	◯	◯	◯	◯	◯
Ensure that students are helped at each stage of the educational decision based on the choices via a learning management system (LMS).	◯	◯	◯	◯	◯
Discover new factors related to the education's barriers.	◯	◯	◯	◯	◯
Analysis stage contains the following factors: find e-nudging method according to the pre-defined goals, education barriers, decision process					
(1) The selection of an e-nudging methods aims to:					
Identify the choices in the students' interface that should be influenced by e-nudging in a learning management system (LMS).	◯	◯	◯	◯	◯
Identify e-nudging techniques that can effectively reduce the influence of identified education barriers on students' decisions in an LMS.	◯	◯	◯	◯	◯
Identify e-nudging techniques that work with choices offered in the students' interface in a learning management system (LMS).	◯	◯	◯	◯	◯
Evaluate e-nudging techniques according to their location in decision mapping (i.e. nudging a student to recognize the importance of an education task is much important than nudging the student to submit an assignment on time).	◯	◯	◯	◯	◯
Select all suitable e-nudging techniques that meet constraints.	◯	◯	◯	◯	◯
(2) Identifying the optimal e-nudging moment aims to:					
Identify the suitable time to nudge students to complete an education task via a learning management system (LMS).	◯	◯	◯	◯	◯

Provide enough time to complete an education task via a learning management system (LMS) after e-nudging occurred.	◯	◯	◯	◯	◯
Identify how often a student needs to be nudged to complete each education task via a learning management system (LMS).	◯	◯	◯	◯	◯
Identify the nudge moment that should occur before action.	◯	◯	◯	◯	◯
Identify the nudge moment that should occur during action.	◯	◯	◯	◯	◯
Identify the nudge moment that should occur after action.	◯	◯	◯	◯	◯
The design stage contains the following factors:					
(1) HCI aims to ensure that the students' interface after applying e-nudging in LMS:					
Is practical	◯	◯	◯	◯	◯
Is easy to see	◯	◯	◯	◯	◯
Satisfies students	◯	◯	◯	◯	◯
Has a suitable text style	◯	◯	◯	◯	◯
Has an appropriate font size	◯	◯	◯	◯	◯
Has suitable page layout	◯	◯	◯	◯	◯
Has appropriate graphics	◯	◯	◯	◯	◯
Has suitable colour	◯	◯	◯	◯	◯
(2) Navigation aims to ensure that the following are easy to find in students' interface after applying e-nudging in LMS:					
Elements in the site	◯	◯	◯	◯	◯

Links	◯	◯	◯	◯	◯
Hypermedia applications	◯	◯	◯	◯	◯
(3) Usability aims to ensure that the students' interface after applying e-nudging in LMS is:					
Effective	◯	◯	◯	◯	◯
Efficient	◯	◯	◯	◯	◯
Safe	◯	◯	◯	◯	◯
Useful	◯	◯	◯	◯	◯
Easy to learn	◯	◯	◯	◯	◯
Easy to use	◯	◯	◯	◯	◯
Easy to remember	◯	◯	◯	◯	◯
Easy to evaluate	◯	◯	◯	◯	◯
(4) Design e-nudging prototype aims to:					
Determine the form of an e-nudging intervention (i.e. vibration, SMS text, prompt on students' interface)	◯	◯	◯	◯	◯
Evaluate how e-nudging will appear among other elements in the students' interface in a learning management system (LMS).	◯	◯	◯	◯	◯
Access how e-nudging design is influence by the types of choices offered in the students' interface in a learning management system (LMS).	◯	◯	◯	◯	◯
Save time during the development of an e-nudging model	◯	◯	◯	◯	◯
Focus on important interface elements in a learning management system (LMS).	◯	◯	◯	◯	◯

Reduce the designer's workload during the development of an e-nudging model	◯	◯	◯	◯	◯
Provide a clear idea about the final design of the e-nudging model	◯	◯	◯	◯	◯
(5) Ethics in e-nudging aims to					
Make better decisions for students' benefit	◯	◯	◯	◯	◯
Be considered by students (student can see the nudging in a learning management system (LMS)).	◯	◯	◯	◯	◯
Provide full freedom of choice for students in a learning management system (LMS).	◯	◯	◯	◯	◯
Respect students' preferences	◯	◯	◯	◯	◯
Support general ethics (i.e. governments, universities' ethics)	◯	◯	◯	◯	◯
The e-nudging testing stage aims to					
Measure the impact of e-nudging on students' behaviour in real life	◯	◯	◯	◯	◯
Measure the e-nudging delivery method on students' behaviour in real life	◯	◯	◯	◯	◯
Determine the optimal moment for e-nudging in terms of its impact on students' behaviour in real life	◯	◯	◯	◯	◯
Meet the e-nudging goals	◯	◯	◯	◯	◯
Meet students' expectations	◯	◯	◯	◯	◯
Obtain students' feedback by using a learning management system (LMS) with e-nudging	◯	◯	◯	◯	◯
Detect any errors during the development of the e-nudging model	◯	◯	◯	◯	◯
Consider the influence of environmental changes on e-nudging development	◯	◯	◯	◯	◯
consider factors in the students' environment that may affect e-nudging' development	◯	◯	◯	◯	◯

Consider changes in smart technologies that may impact on e-nudging development	◯	◯	◯	◯	◯

Do you have any comments on other factors that might facilitate or influence the initiating e-Nudging Model for higher education in SA?

SECTION C: In this section, the researcher will assess the perceptions and attitudes of university students and academics towards the implementation of an e-nudging model in SA’s higher education sector.

The research aims to use four digital nudging interventions (i.e. feedback, reminder, social comparison, and reduced distance) to steer students’ behavior in learning systems in the KSA.

To what extent do you agree with the following statements?	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
The implementation of an e-nudging model in SA’s higher education sector is intended to:					
Improve students’ educational decisions	◯	◯	◯	◯	◯
Encourage students to remember their educational tasks	◯	◯	◯	◯	◯
Encourage students to manage their educational tasks	◯	◯	◯	◯	◯
Encourage students to complete their educational tasks on time	◯	◯	◯	◯	◯
Assess students’ achievements during the semester	◯	◯	◯	◯	◯
Assess students’ achievements privately among classmates during the semester (ex. You got 12 out of 15 in the midterm, you are higher than 10 student in your class, the average mark is 8)	◯	◯	◯	◯	◯
Improve student’s confidence to make a better educational decisions	◯	◯	◯	◯	◯
Motivate students to continue studying	◯	◯	◯	◯	◯

Motivate students to complete their course	◯	◯	◯	◯	◯
The students' e-nudging interface should be					
Practical	◯	◯	◯	◯	◯
Easy to see	◯	◯	◯	◯	◯
Satisfying for students	◯	◯	◯	◯	◯
Text style is suitable	◯	◯	◯	◯	◯
Font size is suitable	◯	◯	◯	◯	◯
Layout of the pages is suitable	◯	◯	◯	◯	◯
Graphics are appropriate	◯	◯	◯	◯	◯
Color is suitable	◯	◯	◯	◯	◯
Elements of a site are easy to find in the students' interface	◯	◯	◯	◯	◯
Links are easy to find in the students' interface	◯	◯	◯	◯	◯
Hypermedia applications are easy to find in the students' interface	◯	◯	◯	◯	◯
Effective	◯	◯	◯	◯	◯
Efficient	◯	◯	◯	◯	◯
Safe	◯	◯	◯	◯	◯
useful	◯	◯	◯	◯	◯
Easy to use	◯	◯	◯	◯	◯

Easy to learn	◯	◯	◯	◯	◯
Easy to remember	◯	◯	◯	◯	◯
Easy to evaluate	◯	◯	◯	◯	◯

Do you have any comments regarding the implementation of an e-nudging model in the higher education sector of SA?

SECTION D: Under this section, the researcher will evaluate if the e-Nudging model will meet the requirements of students

To what extent do you agree with the following statements?	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
When applying e-nudging techniques in higher education in SA:					
It is better to receive a reminder about education tasks by:					
A reminder email sent to me by the teachers	○	○	○	○	○
My teachers posting announcements in LMS	○	○	○	○	○
Receiving an electronic reminder via the students' interface in LMS	○	○	○	○	○
Receiving an SMS on my phone	○	○	○	○	○
It is better to receive a feedback about my performance in relation to classmates by:					
Email sent to me by the teacher	○	○	○	○	○
The teacher posting feedback privately in LMS	○	○	○	○	○
Getting an SMS sent to my phone	○	○	○	○	○
It is better to receive notification about the number of weeks remaining before the end of the course by:					
Email sent to me by the teacher	○	○	○	○	○
Teachers posting an announcement in LMS	○	○	○	○	○
Receiving an electronic notification via the students' interface in LMS	○	○	○	○	○
Receiving an SMS on my phone	○	○	○	○	○

Curtin University

Participant Information Sheet

Students Survey

I am currently undertaking a PhD research entitled as “Initiating and Assessing an e-Nudging Model for Higher Education in Saudi Arabia” at Curtin University, Australia and is funded by my sponsor. The research work on the initiation and assessment of an e-nudging model for the higher education sector in SA. The survey will examine the current factors that influence the effectiveness of the e-nudging model. The nudge is defined as being a soft intervention that steers a person’s behavior in a predictable way without restricting people’s options, while encouraging them to make better decisions.

The purpose of this research is to understand the concept of digital nudging in terms of its application in universities to encourage better education decision-making for students in a digital environment (i.e. learning system) in SA.

This survey is conducted exclusively for PhD research purposes. It should take approximately 20 minutes to complete. This survey contains four sections. Please read each statement and then circle the number or tick the box that best describes your attitude or belief. Please, feel free to disregard to answer any particular question that you do not wish to answer for any reason.

We greatly appreciate your participation because your responses may help us learn more about how to successfully implement an e-nudging model in the higher education sector in SA. This research will help to improve the quality of higher education in SA. Your assistance in this research is greatly appreciated and is critical for the success of its findings.

Your Participation in this research is completely voluntary and your responses will be treated as being anonymous. Participants have the right to refuse or withdraw at any time without penalty or negative consequences and do not need to provide a reason. By completing this survey, you are consenting to participate and allow me to use your data in this research.

The data collected through the survey will be held as strictly confidential. The data collected for this study will be available in R Drive (in accordance with Curtin Data Management policy) at Curtin University, and only the researcher and PhD committee will have the authority to access it. The data will be used for the research purpose only and will not be revealed to or shared with others. Finally, the researchers will ensure that published material does not contain any information that can identify the participants.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number **HRE2020-0060**). 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 hrec@curtin.edu.au

Thank you for your involvement in this study. Your participation is highly appreciated. If you need any additional information, please feel free to contact the researcher.

Thank you in advance.

Yours faithfully,

Salihah Alotaibi

Participant consent statement:

○ I have received information regarding this research and have had the opportunity to ask questions. I believe I understand the purpose, extent and possible risks associated with my involvement in this project and I voluntarily consent to take part

Dear Sir/Madam

Please click on the link below to watch the video about the study aims and how the digital nudge will help students to make a better decision before answering the online survey questions

https://drive.google.com/file/d/1y4FQzIQZb-mKKrT-3jsWNtB3RfxgthEZ/view?usp=drivesdk

SECTION A: DEMOGRAPHIC DATA

Q1. Gender

- ○ Male
- ○ Female

Q2: What is your age?

- ○ 18-23
- ○ 24-28
- ○ 29-33
- ○ 34-38
- ○ 39 and above

Q3: Please tick your year(s) of study at the University

- ○ Year 1
- ○ Year 2
- ○ Year 3
- ○ Year 4 or above

Q4: Please tick the type of your university .

- ○ Government
- ○ Private
- ○ Other

Q5: Please tick your main field(s) of study

- ○ Accounting
- ○ Business Law
- ○ Economics and Finance
- ○ Information Systems
- ○ Information Technology
- ○ Computer Science
- ○ Management
- ○ Marketing
- ○ Health Sciences
- ○ Humanities
- ○ Science and Engineering
- ○ Art and Design
- ○ Other – Please *specify* ______

Q6: Please tick the type of learning management system used in your university.

- ○ Blackboard
- ○ Moodle
- ○ Other – Please specify ______

Q7: Please tick your level of computer experience.

- ○ Beginner
- ○ Intermediate
- ○ Advanced
- ○ Expert

Q8: Please tick your usage of education-related technology in your professional activities.

- ○ High
- ○ Medium
- ○ Low

Q9: Please tick your level of knowledge in regard to e-nudging techniques.

- ○ High
- ○ Medium
- ○ Low

SECTION B: In this section, the researcher will determine whether the e-nudging model will meet the requirements of students in the higher education sector in SA:

In order to develop and successfully introduce an e-nudging model into higher education in SA, several issues that influence students' education-related decisions need to be taken into consideration.

Have you ever not completed an education task via LMS?	***Yes***	***No** **(go to the next part)***			
If yes, this is because (you can choose more than one reason):	***Always***	***Often***	***Sometimes***	***Rarely***	***Never***
The task took too long to complete	○	○	○	○	○
The purpose of the task was unclear	○	○	○	○	○
The teacher provides insufficient feedback	○	○	○	○	○
There was insufficient time to complete the task	○	○	○	○	○
I was busy with other assessment tasks	○	○	○	○	○
I don't believe that it is important to do such tasks	○	○	○	○	○
I forgot to do the task	○	○	○	○	○
I ignored the task	○	○	○	○	○
The LMS is complex for me	○	○	○	○	○

To what extent do you agree with the following statements?	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Self-regulation					
I plan out my education tasks that I want to complete by which one need to be done first. (plan)	○	○	○	○	○
I can usually estimate how much time my education task will take to complete. (plan)	○	○	○	○	○
I have trouble making plans to achieve my education goals. (plan)	○	○	○	○	○
I keep track of my education tasks. (monitor)	○	○	○	○	○
I know when I am behind on an education task. (monitor)	○	○	○	○	○
I have trouble remembering the tasks I need to accomplish. (monitor)	○	○	○	○	○
I know what my education task that need to be done on time. (control)	○	○	○	○	○
I make choices that will help me succeed. (control)	○	○	○	○	○
When I get behind in my work, I often give up. (control)	○	○	○	○	○
I think about how well I am doing on my assignments. (reflect)	○	○	○	○	○
I feel a sense of accomplishment when I get everything done on time. (reflect)	○	○	○	○	○
When I fail at something, I try to learn from my mistakes. (reflect)	○	○	○	○	○
Bounded Rationality (assignment completion)					
Doing assignments helps me understand what's going on in class.	○	○	○	○	○

Doing assignments improves my professional skills such as reading, writing, research, critical thinking, decision making, and teamwork	○	○	○	○	○
Doing assignments improves my personal skills including personal motivation, leadership, negotiation, communication, problem solving, time management, reflection, self-management and self-appraisal	○	○	○	○	○
Doing assignments helps me to obtain a good grade	○	○	○	○	○
Graded assignments contain comments (feedback) from the teacher intended to improve subsequent submissions	○	○	○	○	○
Graded assignments contain comments (feedback) from the teacher intended to help me to correct my mistakes	○	○	○	○	○
I do not complete assignments because I do not see the benefit of completing such tasks	○	○	○	○	○
I would complete homework in order to obtain further knowledge	○	○	○	○	○
Attention					
I am able to concentrate when doing boring work. (concentration ability)	○	○	○	○	○
I am able to concentrate when worried. (concentration ability)	○	○	○	○	○
I am able to concentrate if you have to switch from one task to another. (concentration ability)	○	○	○	○	○
I am able to pay attention to one specific issue for a long period of time. (concentration ability)	○	○	○	○	○
I am able to give continuous attention if the volume of information is very large. (concentration ability)	○	○	○	○	○
I am able to give my full attention to something after a short interruption. (concentration ability)	○	○	○	○	○
I am able to concentrate if I have little time to finish the task. (concentration ability)	○	○	○	○	○
I am able to concentrate on more than one thing at the same time. (concentration ability)	○	○	○	○	○
I am able to plan ahead and pay attention to fine detail. (concentration ability)	○	○	○	○	○

My ability to concentrate decreases if the subject matter is very complex. (concentration ability)	○	○	○	○	○
I am able to concentrate if level of complexity of material is very low. (concentration ability)	○	○	○	○	○
My ability to concentrate is affected:					
• when I am cold	○	○	○	○	○
• when I am hungry	○	○	○	○	○
• when I am too warm	○	○	○	○	○
Sleep deprivation affects my ability to concentrate. (arousal)	○	○	○	○	○
Background noise and distraction affect my ability to concentrate (distractibility)	○	○	○	○	○
Noise in my immediate environment disturbs my concentration. (distractibility)	○	○	○	○	○
In order to study effectively, I must have a quiet environment. (distractibility)	○	○	○	○	○
Memory					
I am confident in my ability to remember things (feeling about memory)	○	○	○	○	○
I do not get upset when I forget to do set academic tasks (feeling about memory)	○	○	○	○	○
I use a special method to help me remember the set academic tasks (like set a reminder, take notes …etc., use memory strategies)	○	○	○	○	○
I ask my friend(s) to remind me to do the set academic tasks (use memory strategies)	○	○	○	○	○
I forget to complete set tasks on time (memory mistakes)	○	○	○	○	○
I completed my assignment but forgot to submit it via LMS (memory mistakes)	○	○	○	○	○

Confidence					
I feel that I can do the work that my teachers assign me	○	○	○	○	○
I am an extremely confident person	○	○	○	○	○
I am very sure of myself before an exam	○	○	○	○	○
I remind myself about exams	○	○	○	○	○
I never expect high grades	○	○	○	○	○
I am always apprehensive about graded work	○	○	○	○	○
I feel comfortable leading academic groups	○	○	○	○	○
The grade I expect is higher than my actual grade	○	○	○	○	○
LMS interface Complexity (Assess current LMS that use in university					
I liked using the interface of the LMS system	○	○	○	○	○
I believe I could become more productive using this system	○	○	○	○	○
The system gave error messages	○	○	○	○	○
Whenever I made a mistake using the system, I could recover easily and quickly	○	○	○	○	○
I can access the learning activities at times convenient to me	○	○	○	○	○
The online material is available at locations suitable for me	○	○	○	○	○
LMS enables me to interact with other students and the tutor asynchronously	○	○	○	○	○

I use this technology confidently	○	○	○	○	○
1. **HCI**					
Practical	○	○	○	○	○
Easy to see	○	○	○	○	○
Ensures student satisfaction	○	○	○	○	○
Text style is suitable	○	○	○	○	○
Font size is appropriate	○	○	○	○	○
Layout of pages is suitable	○	○	○	○	○
Graphics are appropriate	○	○	○	○	○
Color is suitable	○	○	○	○	○
2. **Navigation**					
Elements of the site are **easy to find**	○	○	○	○	○
Links **are easy to find**	○	○	○	○	○
Hypermedia applications **are easy to find**	○	○	○	○	○
Interface is appropriate and user-friendly	○	○	○	○	○
3. **Usability**					
Effective	○	○	○	○	○
Efficient	○	○	○	○	○

Safe	◯	◯	◯	◯	◯
Useful	◯	◯	◯	◯	◯
Easy to learn	◯	◯	◯	◯	◯
Easy to use	◯	◯	◯	◯	◯
Easy to remember	◯	◯	◯	◯	◯
Easy to evaluate	◯	◯	◯	◯	◯

SECTION C: In this section, the researcher will gather data about the perceptions and attitudes of university students and academics towards the implementation of an e-nudging model in the higher education sector of SA.

The research aims to use four digital nudging interventions (i.e. feedback, reminder, social comparison, and reduced distance) to steer students' behavior in the KSA higher education sector.

To what extent do you agree with the following statements?	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
The implementation of an e-nudging model in SA's higher education sector is intended to:					
Improve students' educational decisions	○	○	○	○	○
Encourage students to remember their educational tasks	○	○	○	○	○
Encourage students to manage their educational tasks	○	○	○	○	○
Encourage students to complete their educational tasks on time	○	○	○	○	○
Assess students' achievements during the semester	○	○	○	○	○
Assess students' achievements privately among classmates during the semester (ex. You got 12 out of 15 in the midterm, you are higher than 10 student in your class, the average mark is 8)	○	○	○	○	○
Improve student's confidence to make a better educational decisions	○	○	○	○	○

Motivate students to continue studying	◯	◯	◯	◯	◯
Motivate students to complete their course	◯	◯	◯	◯	◯
The students' interface after apply e-nudging should be					
Practical	◯	◯	◯	◯	◯
Easy to see	◯	◯	◯	◯	◯
Satisfying for students	◯	◯	◯	◯	◯
Text style is suitable	◯	◯	◯	◯	◯
Font size is suitable	◯	◯	◯	◯	◯
Layout of the pages is suitable	◯	◯	◯	◯	◯
Graphics are appropriate	◯	◯	◯	◯	◯
Color is suitable	◯	◯	◯	◯	◯
Elements of a site are easy to find in the students' interface	◯	◯	◯	◯	◯
Links are easy to find in the students' interface	◯	◯	◯	◯	◯
Hypermedia applications are easy to find in the students' interface	◯	◯	◯	◯	◯

Effective	◯	◯	◯	◯	◯
Efficient	◯	◯	◯	◯	◯
Safe	◯	◯	◯	◯	◯
Useful	◯	◯	◯	◯	◯
Easy to learn	◯	◯	◯	◯	◯
Easy to remember	◯	◯	◯	◯	◯
Easy to evaluate	◯	◯	◯	◯	◯

Do you have any comments regarding the implementation of an e-nudging model in the higher education sector of SA?

SECTION D: Under this section, the researcher will evaluate if the e-Nudging model will meet the requirements of students

To what extent do you agree with the following statements?	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
When applying e-nudging techniques in higher education in SA:					
It is better to receive a reminder about education tasks by:					
A reminder email sent to me by the teachers	○	○	○	○	○
My teachers posting announcements in LMS	○	○	○	○	○
Receiving an electronic reminder via the students' interface in LMS	○	○	○	○	○
Receiving an SMS on my phone	○	○	○	○	○
It is better to receive a feedback about my performance in relation to classmates by:					
Email sent to me by the teacher	○	○	○	○	○
The teacher posting feedback privately in LMS	○	○	○	○	○
Getting an SMS sent to my phone	○	○	○	○	○
It is better to receive notification about the number of weeks remaining before the end of the course by:					
Email sent to me by the teacher	○	○	○	○	○
Teachers posting an announcement in LMS	○	○	○	○	○
Receiving an electronic notification via the students' interface in LMS	○	○	○	○	○
Receiving an SMS on my phone	○	○	○	○	○

Appendix E: Interview questions

Dear Sir/Madam

I am conducting research "Initiating and Assessing an e-Nudging Model for Higher Education in Saudi Arabia" at Curtin University, Australia. The aim of this research is to identify the major factors that influence the effectiveness of the e-nudging model in the higher education sector in encouraging students to make better education-related decisions in a digital environment (i.e. learning system) in SA.

If you feel uncomfortable in answering certain questions, please feel free to disregard them.

Participation in this research is completely voluntary and your responses will be completely anonymous. Participants may withdraw at any time without prejudice or negative consequences, and do not need to provide a reason. By completing out the interview, you are consenting to participate.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2020-0060). 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 hrec@curtin.edu.au.

Your participation is highly appreciated. If you need any additional information, please feel free to contact the researcher.

Thank you in advance

Yours faithfully,

Salihah Alotaibi

Participant consent statement

○ I have received information regarding this research and have had the opportunity to ask questions. I believe I understand the purpose, extent and possible risks associated with my involvement in this project and I voluntarily consent to take part

Q1. Please tick your highest education level:

- ◯ Lecturer
- ◯ Assistant Professor
- ◯ Associate Professor
- ◯ Professor

Q2. Please tick the number of years you have been in your current job?

- ◯ Less than 1 year
- ◯ 1 -3 years
- ◯ 4-5 years
- ◯ More than 5 years

Q3. Please tick your level of knowledge in regard to e-nudging techniques in higher education.

- ◯ High
- ◯ Medium
- ◯ Low

Q4. Please share with us your general knowledge and experience of e-nudging in higher education.

Q5. From your experience, what are the important factors that should be considered prior to introducing e-nudging into a learning management system such as Blackboard at SA universities?

The Planning Stage: In this stage, stakeholders are informed of the aims of nudging and how these can be achieved. This stage comprises three factors namely "***e-nudging goals***", "***e-nudge constraints***" *and* "***mapping the decision process***"

Q6: **Please rate the importance of the following factors that influence the e-nudging model.**

#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	e-nudging goals					
2	e-nudge constraints					
3	mapping the decision process					

Q7: Please provide one or more reasons for this rating.

Q8: Do you believe that the factors under the "Planning Stage" are related to each other and can be grouped under the same Stage?

- ◯ Yes.
- ◯ No. Please give your reason(s).

The Analysis Stage: In this stage, e-nudging elements are determined based on what is required to improve students' decisions. This stage contains two factors, namely "***e-nudging techniques***" and "***optimal e-nudging moment***".

Q9: **Please rate the importance of the following factors that influence the e-nudging model.**						
#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	e-nudging techniques					
2	optimal e-nudging moment					

Q10: Please provide one or more reasons for this rating.

Q11: Do you believe that the factors under the "Analysis Stage" are related to each other and can be grouped under the same Stage?

- ◯ Yes.
- ◯ No. Please give your reason(s).

The Design Stage: The aim of this stage is to determine the e-nudging design that will best influence students' decisions. One or more designs can be proposed to achieve the desired e-nudging goals. Stakeholders can then decide the best e-nudging design that will improve students' decisions. The stage contains three factors namely "***usability***", ***Human computer interaction "HCI"*** and "***e-nudging prototype***".

Q12: **Please rate the importance of the following factors that influence the e-nudging model.**						
#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	Usability					
2	Human computer interaction "HCI"					
3	e-nudging prototype					

Q13: Please provide one or more reasons for this rating.

Q14: Do you believe that the factors under the "Design Stage" are related to each other and can be grouped under the same Stage?

○ Yes.

○ No. Please give your reason(s).

Implementation Stage: The chosen e-nudging design will be implemented at the end of this stage. This stage has one factor named "***implementing the e-nudging***" model. In this stage, the implementation of e-nudging is carried out.

Q15: **Please rate the importance of the following factors that influence the e-nudging model.**						
#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	implementing the e-nudging					

Q16: Please provide one or more reasons for this rating.

Q17: Do you believe that the factor under the "implementation Stage" is adequate for this stage and can be under this Stage?

◯ Yes.

◯ No. Please give your reason(s).

The Test Stage aims to test the e-nudging impact and how e-nudging appears in the system among other elements in the interface. This stage contains two factors, namely "***Test e-nudging***" and "***Environmental Influence***".

Q18: **Please rate the importance of the following factors that influence the e-nudging model.**						
#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	Test e-nudging					
2	Environmental Influence					

Q19: Please provide one or more reasons for this rating.

Q20: Do you believe that the factors under the "Test Stage" are related to each other and can be grouped under the same Stage?

- ◯ Yes.
- ◯ No. Please give your reason(s).

The Training and Support Stage: this stage will assist users adapt to changes after the implementation of e-nudging. User support will help individuals to avoid mistakes and other issues. Also, it helps the user to accomplish tasks efficiently and effectively. This stage contains two factors, namely "***Training instructors and students***" and "***support instructors and students***"

Q21: **Please rate the importance of the following factors that influence the e-nudging model.**						
#	*Factors*	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
1	Training instructors and students					
2	support instructors and students					

Q22: Please provide one or more reasons for this rating.

Q23: Do you believe that the factors under the "Training and supporting Stage" are related to each other and can be grouped under the same Stage?

○ Yes.

○ No. Please give your reason(s).

The Evaluation Factor: aims to assess and examine the outcomes of each of the e-nudging model stages. In this stage, a summative assessment is given prior to the final e-nudging intervention.

Q24: **Please rate the importance of the following factors that influence the e-nudging model.**					
Factors	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*

Evaluation					

Q25: Please provide one or more reasons for this rating.

Awareness of e-nudging Factor: this is a controversial factor regarding the nudging topic. Sometimes, a person does not want to be controlled or does not want e-nudging although this can be done according to individual preferences. In such cases, the nudge does not have the intended effect. On other hand, when a person understands and appreciates the nudge, its influence is stronger and the person is more likely to make a better decision.

Q26: **Please rate the importance of the following factors that influence the e-nudging model.**					
Factors	*Extremely important*	*Very important*	*Moderately important*	*Slightly important*	*Unimportant*
Awareness about e-nudge					

Q27: Please provide one or more reasons for this rating.

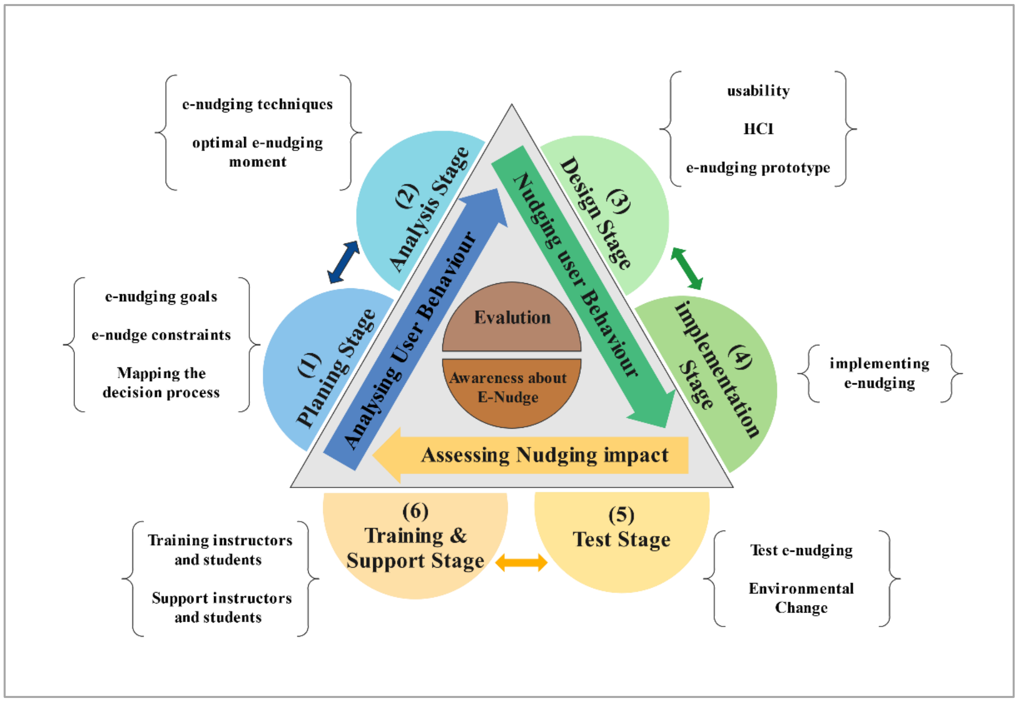

Figure.0.1: enhanced e-nudging model for higher education in SA. "Developed by researcher".

Q28: Based on our interview, what is your evaluation of the enhanced e-nudging model for higher education in SA?

◯ Effective

◯ Moderately effective

◯ Ineffective

Please provide one or more reasons for your response

Q29: Do we need to add new factors to this e-nudging model?

◯ Yes.

◯ No

Q30: If 'yes', what are the new factors you consider important but are not included in the above model? Why?

Q31: Do we need to merge, or delete any factors from the above model?

◯ Yes

◯ No

Q32: If' yes', what factors need to be merged or deleted in the above model? Why?

Q33: Do we need to change the position of any factors in the above model?

◯ Yes

◯ No

Q34: If 'yes', what are the factors that need to be re-positioned in the above model? Why?

Analysing user behaviour phase*: this is the first phase in developing e-nudging in a digital environment. This phase contains two stages: planning and analysis s.*

Q35: From your perspective, do you think the stages under the "Analysing user behaviour phase" are related to each other and can be grouped under the same phase?

◯ Yes.

◯ No. Please give your reason(s).

***Nudging user behaviour Phase**: this is the second phase in the development of e-nudging in a digital environment. This theme consists of two stages: design and implementation.*

Q36: Do you believe the stages under the "Nudging user behaviour phase" are related to each other and can be grouped under the same phase?

- ○ Yes.
- ○ No. Please give your reason(s).

***Assessing Nudging impact Phase:** is the final phase in the development of e-nudging in a digital environment. This theme includes the testing stage and training and support stage.*

Q37: Do you believe that the stages under the "Assessing nudging impact" are related to each other and can be grouped under the same phase?

- ○ Yes.
- ○ No. Please give your reason(s).
