School of Media, Creative Arts and Social Inquiry

Art for science communication: The transformation in the personal sphere of adolescents in response to climate change

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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 acknowledgement has been made.

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

Human Ethics

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) - updated in March 2014. The proposed study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HRE2022-0111.

Signature Truong Thi Kim Oanh

Date January 6, 2023

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To myself of the future, I am always proud of who I am and believe that I will become a professional researcher one day. Do believe in yourself!

PREFACE

Back to the inspiration for this study to be conducted as my Master of Philosophy thesis at Curtin University, there are untold stories about why I am determined to get involved in art-based development research. In 2018, I met a teenage participant at a community centre in Ho Chi Minh City, Vietnam as a project coordinator for a community project. He asked me, "Why do you not have learning activities through arts for teenagers like us as you are doing with the younger ones here. We also want to learn new things and express ourselves". At that time, it was just a pilot project to examine how creativity-based development activities could help vulnerable children tell their stories and develop a sense of self-worth. His question left me with an irresistible impulse to provide more creative processes and invite youth to contribute to challenging topics of our modern society.

Being a practitioner in several applied community development projects, I recognise that by setting the atmosphere for the creative process and creating opportunities for engagement, participants are free to access science knowledge and enjoy a creative learning experience. This approach also increases their capacity to think, act and become independent decision-makers. For vulnerable adolescents, especially in developing countries, who intend to give up their education path because of a lack of financial resources and encouragement from their families, learning through creativity-based development activities is crucial for developing a sense of self-worth and personal development.

Two years later, I had a very different experience since I worked with a significant volume of participants who were local farmers to collect data and find out how they adapted to drought and saltwater in one Province in the Mekong Delta, Vietnam. To make the household survey questionnaire ready to ask the farmers, I had to ensure that the Vietnamese language used in the household survey was utterly understandable to our target population, who did not finish their education, and some of them were illiterate. The challenge started! Scientific terms for local farmers, how can we ensure that all questions are approachable for them to understand and answer? It should be a proper approach with a friendly user to access accurate data.

By inviting my students to imagine themselves in two roles: a data collector and a farmer, and think about what they should do to make the interview context effective, I found which Vietnamese context was not suitable for the farmers' level of understanding and flexibility, so I changed words into a better explanation for better communication. I found that communication in science with the public is crucially essential since, as a science communicator, it is the practice of informing, communicating, educating, and training to raise awareness of science-related topics, awakening the audience's fierce passion, and discoveries

and inviting joint initiatives from the public. Lastly, it is a great way to establish and maintain trustful cooperation with the public for substantial future work!

From many professional experiences while working with those groups, I have gradually enhanced my hands-on skills and scientific knowledge to create an ideal space for critical thinking changes and empowering vulnerable groups to promote sustainable development. This study opens up opportunities for me to obtain a deeper understanding of an individual's transformation and potential to embark on their future as a climate fighter for themselves are the stories of my professional experiences while working in public. How about my personal experience with art and science of mine?

I have always remembered one of my first globally exposed-cultural experiences was visiting art museums in Italy and Germany. Investigating hours and hours of walking spontaneously on the streets of Milan and Rome, Italy and leading myself passionately through Pinacoteca di Brera (Brera Art Gallery) and Vatican Museums are unforgettable experiences in one's life. By being exposed artistically to such a great combination of science and art at the museums, from that moment, the audience can realise how art could tell us stories of beauty and science of our human society through centuries.

From my personal experiences as a Vietnamese being raised and formally educated in Vietnam, studying abroad and working internationally, the professional experiences in academia and industry, consciousness-raising and cooperation with several stakeholders from diverse backgrounds helped me diversify my vision and multicultural perspective both from both my Asian roots and international exposure. It was a touching moment to discover the essential meaning of science when I visited the Humboldt Forum in Berlin. Here I agreed with the idea of the Humboldt Lab Exhibition that the sciences could not be isolated from the media with which they work. Moreover, science is always actively involved in our lives and is barrierless. Science should be interpreted socially, especially in environmental destruction and climate change and communicated creatively to the lay society.

Communicating research is never an easy task but not an impossible mission to make it friendly to the public!

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ABSTRACT

Ensuring the quality of art-informed science communication toward participants has been a growing concern for several years. While several studies have focused on the role of art in science communication practices, there has been a paucity of research on participants' transformative experiences toward the quality of an art-combined approach in science learning. Our investigative study investigated how experiences from art-science collaboration on climate crisis may shape adolescents' reactions to climate change and demonstrate the potential of transformational pathways created through integrated art-based science communication at the level of the subjects' sphere. We applied Solomon's four-group experimental design using two control and two experimental groups to study the transformation between groups (Solomon, 1949). This research design allows researchers to assess the fundamental revision of testing, treatment/intervention and the remarkable correlation between testing and treatment (Daily, 2017).

Interviews were conducted with two experimental and control groups and recorded into transcript documents. Central themes contributing to participants' experiences were identified, coded, and systematised using MAXQDA. This research revealed that flexibility, creativity, ease of connection to open discussion and communication, personal transformation, and peer relations were participants' positive experiences. Although this research is a small-scale exploratory study, the results are validated using multiple data collection and analysis methods.

At the core of the study, it aims to make an in-depth and critical interpretation based on the data analysis through codes. The codes vary in the length of the text to highly conceptual answers (given by four groups: control and experimental groups). The study advocates that proper science communication through art-informed collaboration should be considered to achieve sustainability outcomes. The findings are expected to develop and show how arts can influence and effectively communicate with adolescents as the future generation through creative and attractive narratives with proper knowledge of climate change adaptation. The study results may have implications for climate change policy makers.

1 CHAPTER 1: INTRODUCTION

1.1 Purpose of Study

This investigative research study explores how art can be utilised in science communication practices to raise climate change perception. It also attempts to study the influence of art-science collaboration through scientific stories of the climate crisis on adolescents and define changes in their personal development through art-based science communication. While the study focuses on outcomes of personal development in the transformation of adolescents, it attempts to elicit how such experiences of the participants may be shaped in reaction to climate change through art involvement and demonstrates the potential of transformational pathways created through an integrated art-science process at the level of the subjects' sphere. Moreover, the case study is presented and critically analysed them. The study's results present scientific recommendations on applying arts in science communication learning for educators and experienced practitioners and practical implications of Sustainable Development Goals.

Arts can brilliantly convey a sense of awareness of climate science thanks to its readily accessible pragmatism by captivating the visual imagination to take the initiative and change behaviours (Thomsen, 2015). Given the quality of utilising arts to enhance climate change literacy and responses, the present study advocates considering which aspects of effective science communication are desirable through art. To investigate the development of participants' subjective transformation angles, we implement the framework of the personal sphere delineated by O'Brien and Sygna (2013). Through this research, based on the design of experiments of control and experimental groups and in-depth interview analysis, we examine the critical differences in the personal sphere of transformation among those groups.

The differences are not pointed directly to which sphere is more important or has more powerful consequences than other spheres. The differences in this research suggest that proper science communication through art-informed collaboration, which is scarce in the research community, should be considered to achieve future sustainable outcomes. The findings within this study are expected to develop and illustrate how art can get involved and effectively educate adolescents, as a future generation, with a creative and attractive story with appropriate knowledge of climate change adaptation. It is not only educating; this approach also gives participants a creatively generous space to express their interests, concerns and future actions and raise their voices toward climate change.

1.2 Research Objectives

The research objectives are to furnish a scientific conceptualization of personal sphere development in participants' awareness, engagement, appreciation and future actions through art-based science communication. This study will develop a more prolonged impact on practical and political spheres.

Solomon-four group research design and change measures with pre-test and post-test data will be deployed and explored in this research, potentially allowing educators and scholars to gain a conspicuous understanding and exert the effects of learning sessions. More importantly, this study shows that the arts can propose scientific advancement to develop adolescents' sense of climate change ownership and a noticeable form of translation and communication to diverse, complex topics through art-science collaborations.

Research's potential contributions: The study's findings may support demonstrating the potential of transformational pathways created through an integrated art-science approach at the subjects' sphere level and directly benefit society, scientists and policy makers with practical implications and critical assessment through examining the analyses of participant-produced drawings, observation summaries and in-depth interviews. The results of this study will offer scientific recommendations on applying arts in science communication learning to educators and experienced practitioners.

The findings of the research fall into two main categories:

- ways art can contribute to the effectiveness of science communication activities;
- the transformation in the personal sphere of adolescents in response to climate change between groups attending and not attending climate change learning sessions.

1.3 Research Questions

There is an urgency to provide current evidence on science communication in theory and practice in Vietnam, which this study explores. This study seeks to address three questions:

(1) What is the use of art involvement to transform climate change response in adolescents?
(2) To what extent do art-based techniques contribute to participants' personal transformation sphere?
(3) To what extent does the potential of an art-science partnership galvanise changes in study participants' relationships with peers?

Questions are raised about the values and how to convincingly demonstrate the effectiveness of science communication toward the science awareness of the general public or lay society. In this study, it is purposeful to adopt the thought pattern to science communication, which should be emerged in relatively creative and flexible formats for adolescents. Developing our existing expertise of the insights from young audiences about what they see and think about climate change encourages us to change the ways of communication in any science topic and make the transferred messages and insights more accessible and approachable to a broader audience.

Answering these questions could potentially improve the usefulness of art-involved science communication to the public, especially adolescents. Bucchi and Trench (2021) assert that longstanding pitfalls of impact and effectiveness of science communication are put into a new context, not merely navigating efficiently dominant themes (science, science-media theories) but also presenting radical departure (art-science interactions) and the integration of science communication into the culture as "the social conversation around science". As the task is about building a global picture of science communication, Bucchi and Trench (2021) present four key indicators of global spread by devoting meticulous attention to the presence of communication in countries and regions outside western Europe and North America. According to Bucchi and Trench (2021), the global spread of science communication has been strongly driven by the shared culture of scientists through ideas and attitudes across continental collaborations and the movement of personnel and globalisation factors in politics and economics. Therefore, four indicators of this global spread include (1) government programmes to boost science awareness, (2) training and other supports for scientists in public communication, (3) initiatives to support media attention to science, and (4) university programmes in science communication teaching and research.

Questions are raised about the values and how to effectively demonstrate the potential contribution of science communication toward the science awareness of the general public or lay society. In the background of this study, it is purposeful to guide the pragmatism to science communication which should be introduced and presented in relatively creative and flexible formats to adolescents. By developing our existing expertise of the insights the audiences share and discovering from what they see and think about climate change, it encourages us to be able to change the ways of communication in any topics of science in which they are presented and used to make the transferred messages and insights more accessible and approachable to a broader audience.

1.4 Design of Study

This section presents an overview of the research design for the study. It is to be noted that a more detailed description of this study's research methodology will be presented in the following chapter.

Solomon's four-group design is applied to the study, which allows researchers to assess the fundamental revision of testing, treatment/intervention and the remarkable correlation between testing and treatment (Daily, 2017). Solomon's four-group experimental design is considered a potential research design for training programs on account of using two control groups and two experimental groups to testify the transformation between groups (Solomon, 1949).

Learners gain knowledge and skills through arts-based science communication, with arts engagement as a crucial medium where changes are observed, and the facilitator collects qualitative data. Testing learning sessions and drawing comparisons between groups within the context of the research help educators, practitioners, and researchers continuously assess the specific period to array effective interventions to boost the effectiveness of arts-based learning and enhance participants' personal sphere. These experimental research designs' evident strength lies in their ability to establish an in-depth understanding and observe the effects of interventions in control and experimental groups.

A qualitative approach uses various complementary methods in a case study model. This study is expected to present initiatives into the personal sphere changes connected with climate change where participants engage in an arts-engaged basis. The six measures applied include two actions before learning sessions (at time T1), one for the first experimental group and one for the first control group (Groups 1 & 2). The learning sessions are provided (at time T2) to the two experimental groups (1 & 3). Then (at time T3), four other measures are done after the learning sessions, one for each study group. This research's qualitative method analyses texts collected in interview data from respondents. The number of interviews required in qualitative research based on experiences and observation was carried out, including:

- 30-60 interviews are needed for ethnographic studies (Bernard, 2000; Morse (1994);
- 20-30 interviews are required for grounded theory studies (Charmaz, 2006; Creswell, 1998);
- 20 interviews are recommended (Green and Thorogood, 2009) to 50 interviews suggested (Ritchie and Lewis, 2003) for general qualitative research;
- 6-10 interviews are considered for phenomenological studies (Morse, 1994; Starks and Trinidad, 2007);
- 5 interviews are necessary as a general rule of thumb (Hagaman and Wutich, 2017);
- 20-40 interviews are needed for researchers planning multi-sited or cross-cultural research (Hagaman and Wutich, 2017).

Although this research is a relatively small-scale exploratory study (46 interviews from four groups), confidence in the expected research results is enhanced by using multiple methods. Given the study's remit, aspects relating to the low level of participants' readiness for art experience and potential threats to their punctual presentation dominate the findings. More details will be discussed in the following chapters of this thesis. At the core of the study, it aims to make an in-depth and critical interpretation based on the data analysis through codes. The codes are various in the length of the text, from which group (control or experimental groups) to highly conceptual answers (given by four groups).

The case study selected to present in this study is developed from the interviews. This also helps to focus on the personal changes of participants involved in different phases of the experimental activities. The main body of the research contains two parts: to characterise and describe the potential of transformational pathways created through an integrated art-science approach at the subjects' sphere level and to develop an applicable framework for applying arts in science communication learning to educators and experienced practitioners.

Based on insights from data collection applied Solomon's four-group approach, including pre-test (as a survey), learning sessions with dialogue, sharing, act making and reflection, and interviews with four groups of participants along with a literature review, this study provides essential advancement to transformation research. First, it brings our conceptual understanding of transformation in the personal sphere (which can be used later in another term, "inner transformation"). Secondly, it outlines how art-based science communication can activate participants' climate change response through art-making activities with the guidance of the research facilitator as a science communicator. Thirdly, it presents practical examples with case studies particularising how to communicate with adolescents about climate change and discusses how art-based science communication plays a role in a systematised and structured perception to construe inner transformation.

The following part of the thesis is a thorough review of the literature in the science communication field and the importance of art in raising awareness and understanding of climate change in adolescents. We also present a statement demonstrating how this study will contribute to this research landscape.

1.5 Study Structure

The structure of the research has driven the structure of the thesis. There are five chapters of a standard thesis. The thesis structure is:

1. **Introduction**: The introduction chapter gives an outline of the thesis structure. By asking the question "why is the topic studied?", giving the readers the study interest and a quick overview of research design as a way to find the answer with scientific evidence found in the study, the introduction of the thesis briefly explains how the research should be done and how researchers can reach the research goal.
2. **Literature review**: The literature review of this thesis introduces previous studies and findings, identifies explicit research gaps to which this study contributes, and the importance of this study.
3. **Research methodology**: This chapter sets out the research methodology of the whole study, provides details of the qualitative approach to data analysis and data collection

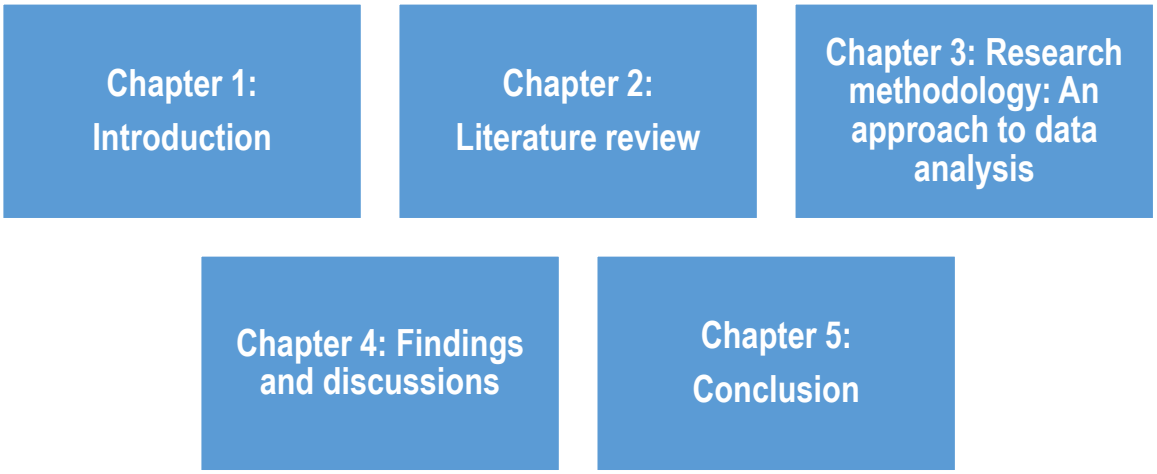
methods used, describes the analytic techniques employed, and the foundational flow of the research findings of the data analysis process based.

4. **Research findings and discussion**: The results chapter outlines the study's discoveries in proportion to the research questions. It covers what the research has found and presents visual forms to help readers read the study's results better and have a mind of evaluation and comparison through tables and figures. The discussion includes a thorough interpretation and analysis of the data gathered, comments and explanations on the findings and their significance. In this chapter, the study's limitations and further suggestions for future studies and practices within the research field are presented
5. **Conclusions**: The conclusion chapter highlights how the research objectives have been achieved and the study's contribution to the research field and all stakeholders involved in the project.

A thesis flow is presented in Figure 1.1, as below:

Figure 1.1

Thesis flow



2 CHAPTER 2: LITERATURE REVIEW

2.1 Literature review: when art meets science

2.1.1 First glance at science communication

The study is engaged in the applications and contributions of art in communicating climate change to adolescents aged 16 and 18. The transformation in the individual sphere, namely at worldview and level of social consciousness in response to the climate crisis, is observed through the researcher's observation, participants' reflective journals per learning session, case studies, and individual sharing and interviews. While the climate crisis has been actively requiring governments around the world to have more precise and determining actions and policies, adolescents, considered the future of the world, more or less realise the negative impacts of climate breakdown affecting their daily life and getting worse when it combines with the COVID-19 pandemic. The problem here and now is that they realise how climate change is happening in some aspects of their daily life and what causes climate change. However, there are some gaps in what they know precisely, how science communication or climate change communication can inform them, encourage them to express their ideas and interest in this topic and what they can do to adapt to it. This study presents science communication practices on climate change topics with adolescents and their personal transformation. The investigative study refers to pertinent research conducted in science communication to create a framework for the thesis.

The traits suggested by Yager (1991) crucial to establishing informal science communication are (1) using open-ended inquiries, (2) motivating respondents to impose their ideas and predictions of consequences for events mentioned in each question, (3) treating all viewpoints, individuality and variation with respect and (4) exhorting self-analysis of each individual to reflect on their new experiences. Dialogue activities and events where communicating is a process of exchanging information and sharing knowledge have become part of science communication community activities (Riise, 2012). According to Kuchel (2019), the critical key to becoming an effective science communicator is identifying their target audience and the purpose of their communication and understanding the communication context. For a more measurable improvement, monitoring the effectiveness of the work is essential for science communicators.

When it comes to science and communicating science with adolescents, researchers, or saying in another way, science communicators must clarify the learners' three "I" letters, including *Intention*, *Insight*, and *Interest* in the participation group. At their age, with a lack of real-life experience and full of curiosity, they are eager to know more, actively seek helpful information for the next stage of their future, and build a solid foundation to solve real-life challenges they may have. Science communicators must be the bridge to narrow the border between "do not know yet", "want to know more", and "want to act properly" from

adolescents and keep a spirit that they do not have to be remarkable or outstanding to join entirely in science activities.

To motivate public climate protective actions through science communication (Loy and Spence, 2020), researchers and educators could consider its five aims by the definition of Burns et al. (2003) to increase awareness, enjoyment, interest, opinion-forming, and understanding. Before stepping deeply into the meaning of Burn et al. (2003) about science communication, it is essential to understand Gregory and Miler's findings (1998) on communication definition. Cited in Gregory and Miler (1998), communication is a negotiation process where participants join a mutual being familiar with science communication and create and develop new and mutually acceptable knowledge, attitudes, and practices. In this pattern, negotiation is a two-way process to access a familiar voice and deliver a message. Burns, Conner, and Stocklmayer's definition of science communication (2003) clearly state that the implementation of felicitous media, skills, doings, and debates is to initiate one or more of the subsequent personal reactions to science, which can be classified as a set of five vowel letters "***AEIOU***":

- ***A***wareness, to see the level of acquaintance with incipient features of science;
- ***E***njoyment, to appreciate science as a way to entertain;
- ***I***nterest to cogitate the readiness of voluntary involvement with science;
- ***O***pinions, to ponder about the format and reform of science-correlated attitudes;
- ***U***nderstanding of science, its coverage, patterns, and social factors

The quality of knowledge transfer between science communicators and the public can be better when communicators make clear choices about objectives concerning a solid background in social science research (Bennett et al., 2019). Bennett and colleagues (2019) discover how science communicators can engage better with the public and point out prominent features driving science communication quality. Two important traits of an effective scientist-public dialogue are using approachable language and abstracting specific terms from the talk. By applying these two traits, Bennett and colleagues (2019) believe that it may create a more communicative rapport and a belief that scientists value their audience and intensify their attempt at introducing and communicating their research approachable and understandable to their listeners. The more positive the quality of the scientist-audience is, the more active the involvement of participants is. Bennett and colleagues (2019) conducted interviews, and the interviews' findings demonstrate that science communication's content only really matters when there is a place for a healthy dynamic for information exchange. In essence, Kuchel (2019) addresses that the need to make the complexity of science more approachable is growing to raise human beings' awareness

and proper pro-environmental behaviour related to long-standing controversies such as climate change and physical and mental well-being and global food supply-chain issues.

In the chapter titled "Evaluating science communication training", Barel-Ben and Baram (2019) give readers a throughout overview of how science communication programs are evaluated. Two authors give evidence to determine the effectiveness of training programs and evaluation approaches pre, during and after the intervention in the science communication landscape and call for actions to be taken. Moreover, Barel-Ben and Baram (2019) continue their analysis and agree that it is necessary to have ground-breaking studies and assessment criteria for science communication training programs and agendas to assist professional specialists in communicating effectively with the public.

However, Baram-Tsabari el. al. (2019) acknowledge that only a few studies have evaluated science communication training programs with their objectives strongly linked to improving participants' skills as well as the effectiveness and usefulness of the programs. In this chapter, we present what previous studies have attempted in these two broad areas and investigate how this present study will contribute. The two broad areas of existing research used in this thesis are:

- Science communication and transformation in practice
- Climate change for adolescents

2.1.2 What is Science communication?

In Science Communication in Theory and Practice, a publication that was considered an outstandingly standard textbook on the communication of science from theoretical and practical points of view, Stocklmayer et al. (2001) describe communication as a matter of listening and talking to and with each party involved in the process and sharing some understanding of the other (Stocklmayer et at., 2001). At the beginning of the book, the conversation between readers - both the non-professional and very professional authors start with how important it is to have a great connection with any involved listeners. According to Stocklmayer and her colleagues (2001), communication must be a process that offers any audience an interactive environment to communicate effectively. Starting from the viewpoint that communication is dynamic activities that go on between people, another two crucial points related to Stocklmayer and co-authors' definition are the popular image of science communication activities in our human communities and the practice of science communicators in increasing a person's appreciation of science. In other words, the concept of Stocklmayer et al. (2001) has been considered one of the earliest and most active orientate approaches for further research within science communication and its application in any field of study.

Stocklmayer, Gore, and Bryant (2001) explained that communication is participatory and involving. Therefore, the position of the science communicator is not merely a collector, evaluator, observer or surveyor but a dynamic participant and facilitator. Stocklmayer and colleagues (2001) mention two fundamental conditions for practitioners successfully participate in and facilitate science communication activities with the audience. The first condition is that science communication as a science facilitator must obtain a clear mindset of what can lead to achievements or malfunction of the science object. The next one is that the science communicator must know that communication is not simply about transferring the massage to the learners but also about participating in the observational process.

There is a similarity in this point with Stocklmayer found in Kim (2012) in her term of engagement as the key to communicating science effectively. Kim (2012) finds that the complete sequence of engaging activities is vital in accomplishing active learning experiences. Reincke, Bredenoord and Mil (2020) observe that science communication includes a reciprocal flow of information exchange from scientists to laypeople and vice versa, based on the dialogue model. The crucial complexion of science communication is the process of mutual learning in which diverse interests, viewpoints, values and experiences are drawn on to learn with and from each other. In summary, the conversation model invites an active collaboration between experts and non-experts sharing an equal position and two parties are expected to learn with and from each other.

Several formats for discussing science were inaugurated over a couple of decades. The science cafés or cafés Scientifiques are considered the most informal and well-known format (see Riise, 2012). Formats for Discussing Science defined by Riise (2012) include:

1. Student or Science Parliaments
2. Student or Pupil Forums
3. Junior Science Cafés
4. Citizens' Conferences
5. Consensus Conferences
6. Citizens' Exhibitions
7. Twenty-First Century Town Meetings
8. Joint Fact Finding

The term "science communication" has various interpretations and terminology used internationally and intentionally by countries and their situation before and after WWII (Gascoigne et al., 2020). The editorial board of the book "Communicating science: a global perspective" asks authors involved in writing the book to define the most suitable date for their country's science communication appearance, and the answer from 39 countries was between 1945 and 1980 possibly. The editorial board recognises the first

and foremost science communication activities, such as associations of science writers, media reports and museums before that time. However, the 1970s-1990s witnessed a revolutionary transition. They shaped the public attitude towards science communication, namely new interactive science centres, new occupations and new programs and courses at universities to satisfy the requirements of the labour market in the field of science communication and new programs and initiatives to convince the public's cooperation and investment of time and interest in science significantly. The current definition of "science communication" used by Gascoigne (2020) is as follows:

> Science communication is to inform, engage, persuade, change behaviours and support better decision-making. Science communication aims to lift the social, environmental and economic standing of a nation's people. Authors report that science communication revolves around problems in diverse regional and cultural contexts: health, economic opportunity and jobs, urban resiliency, food and agriculture, clean energy, and managing the development of new technologies and innovation. It may also support the participation of citizens in setting the agenda for scientific research, a democratic motivation.

Gascoigne (2020) displays three concepts of science communication development, which is:

1. as a discipline of practice (indicators such as the date of an association/organisation of science authors or journalists or communicators the first interactive centre were established;
2. as a media subfield (indicators such as the date of the first significant radio or television programs on science were broadcast)
3. as an academic discipline (indicators such as the dates when new courses and programs at the University were launched to train science communicators or when the first master's or PhD students in science communication graduated).

It is a significantly different picture for different people and groups when they hear about “science communication” (Kuchel, 2019). For science researchers, "science communication" includes images of professional authors writing their scientific research papers, guest speakers presenting at public events with the community and active users on social media sites, but rarely all three. According to Kuchel (2019), they rarely invoke "engagement", interpersonal skills, or casual conversations about science with friends and family. There are different aspects regarding how professional science communicators and teachers of science respond to the public's feedback or their targeted audience in another way.

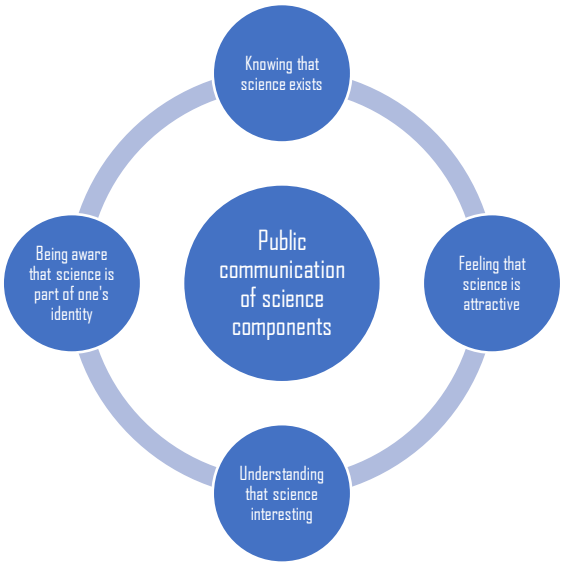
The dialogue between teachers and learners and among their peers aims to help them obtain new knowledge and, in some cases, develop teamwork skills (Herok, Chuck, & Millar, 2013). The first group replied with their thoughts on activities that meet, evolve and create understanding, enthusiasm, reactions,

excitement and curiosity in topics in science. The second group - of science teachers interact with their students through learning and teaching through written and oral works, which can be graded and evaluated. The response in each group and among people in one of two groups varies from each professional discipline and personal experience. Persuading participants to communicate in the ways described above requires various skills and efforts. The main point in creating constructive communication between science communicators and participants is that they must clarify a shared meaning with their audience.

In other words, Burns and colleagues' five aims of science communication (2003) are to increase awareness, enjoyment, interest, opinion-forming, and understanding (as was pointed out previously). The latter point has been devastatingly critiqued by Sánchez-Mora (2016) with her simplified description of public communication of science events. Sánchez-Mora (2016) proposes four science components in order to make the public (1) aware that science exists, (2) feel for science, (3) be interested in science and (4) connect science with one's identity. An illustration of public communication of those components is designed and presented in Figure 2.1.

Figure 2.1

Components of public science communication



Note. Adapted from Sánchez-Mora, M. C. (2016). Towards a taxonomy for public communication of science activities. Journal of Science Communication. 15, 1-8. DOI: 10.22323/2.15020401

Kappel and Holmen (2019) illustrate two paradigms of science communication. The dissemination paradigm sees a one-way knowledge transfer about science from professionals to the public. Public participation is the second paradigm that understands the dialogue and discourse on science

communication between audiences, experts, and decision-makers. Gastil (2017) strongly affirms that most science communication models with public participation focus on facilitating two-way communication. Before Kappel and Holmen (2019) and Gastil (2017), Rowe and Frewer (2000) formalise a wide range of public participation methods to appraise their effectiveness of participation methods.

2.1.3 Climate change for adolescents

It is not the first time we have heard about climate change and how urgently we must take action to cope with it. Concerning global problems, adolescents are often mentioned as the most vulnerable group to exposure to potential minefields and threats (Eckersley, 1999; Reid, Payne, & Cutter-Mackenzie, 2010). It has been well-defined that young people worldwide have been facing the consequences of the climate crisis, especially those living in developing countries.

Ojala (2012) defines three adaptation mechanisms related to environmental engagement and well-being among 293 Swedish 12-year-olds, including problem-centred dealing, de-emphasising the severity of climate emergency, and meaning-centred coping. Ojala (2012) strongly prescribes that research on confronting climate change in a social context and ascertaining how youth talk about climate change and share their feelings and thoughts with peers, parents and teachers are recommended to be conducted in future studies (Ojala, 2012). As the world's future, it is vital to nurture the youth's interest in science, especially in ecological issues globally (Blanchet-Cohen, 2008; Chawla & Flanders Cushing, 2007). Young participants have acquired the capacity for fundamentally conceptualising and critical thinking and the intention to take action, allowing them to use hypotheses and express their interests and concerns about the situation (Evenshaug & Hallen, 2001). Studies conducted by Homburg & Stolberg (2006), Homburg, Stolberg, & Wagner (2007), Reser & Swim (2011); Stokols, Misra, Runnerstrom, & Hipp (2009), Swim et al. (2009) recognise climate change is a trigger of stress and break with tradition by raising the question of how human beings cope with this crisis could be essential for their active engagement and well-being.

However, young people are not only victims of the climate crisis; they have their concerns, thoughts, ideas, freedom of expression and capacity to become climate communicators, influential activists and essential contributors to climate action in their community and country. According to Bartlett (2008), Cocco-Klein & Mauger (2018), Lawler & Patel (2012), Mitchell & Borchard (2014) and Polack (2010), the correlation between children's vulnerability to climate change and children's potential contributions is rarely recognised in the research community. Treichel (2020) states that examples and explanations of how future generations can lead the way to undertake climate change adaptation activities are mainly lacking.

Treichel (2020) provided an overview of child-centred climate change adaptation approaches and practised literature with the target children and young people. She focused on how child-centred responses to climate emergencies could build communities' resilience. According to Treichel (2020), it is high time we consider involving children and young adults in taking climate change actions more effectively and broadly. More importantly, Treichel (2020) also addressed that the literature demonstrates that participating and being climate change action takers promote children's confidence and self-assurance. However, adaptation actions for the young generation and proper strategies for this matter remain significantly under-researched (Treichel, 2020).

Critics have also argued that young adults' awareness of climate breakdown is highly dominated by mass media (Rousell and Cutter-Mackenzie-Knowles, 2020). However, there are still many undefined questions about how to bring young voices and hands to join climate actions with their communities and ways to express their concerns, interest, worries and understandings about climate emergency. Rousell and Cutter-Mackenzie-Knowles (2020) indicate a clarion call for more empirical research to be implemented adequately. The coherent framework for climate change education should be creative, participatory and constructive since very little is currently known about this land in literature. Rousell and Cutter-Mackenzie-Knowles (2020) call for a new educational initiative on climate change. With this approach, inviting young people's involvement in addressing the different complex aspects of climate change issues, such as environmental, social, ethical and scientific attributes, could be more direct and effective in participants' attitudes and behaviours.

Participatory and creative perspectives remain relatively new resources for inspiring youngsters about climate change (Rousell and Cutter-Mackenzie-Knowles, 2020). The evidence presented thus far supports the idea that there is urgent action in research to grant young adults both a hand and a voice in tackling the climate crisis and environmental challenges. They call for more practical initiatives of bringing climate emergency and urgency of climate actions closer to children and adolescents through approachable ways of inclusivity, which will be discussed later. Above that, Rousell and Cutter-Mackenzie-Knowles (2020) urge more investigations to interrogate children and young people's global climate enlightenment. By that approach, we can see how we - researchers can work directly and cooperatively with young people in creative and imaginative ways in the educational setting of climate change.

Climate change is not merely a continuously growing menace of global challenges to ecological communities but also the emergence of large-scale environmental hazards to human development's mental health (IPCC, 2019; Watts et al., 2019). Taking the findings of Hauer (2017) and Neumann, Vafeidis, Zimmermann, and Nicholls (2015) as an example, sea-level rise is considered in a significant

correlation with the shortage of various livelihood models and the entire community-level displacement. Loy and Spence (2020) readdress ways of communication about the climate crisis's impacts and action plans and find that the climate crisis has a visible effect on people's livelihoods and communities. Loy and Spence (2020) recognise that strategies to increase awareness of climate emergencies should be operated to support people to cope physically and psychologically with the stresses concerned with climate change.

Critical and reflexive frameworks have been well acknowledged in the growing literature on transformation and adaptation (Blythe et al., 2018; O'Brien & Selboe, 2015; Pelling, 2011; Pelling et al., 2015) by the worldwide research communities. However, a broader goal is to debase the lack of concentration and promote actions to tackle climate change. Bentz (2020) strongly urges for more spaces of future imagination for young people to participate flexibly in ideational and experiential ways, raise their questions and concerns, get encouraging expert feedback, and be free to experience. The findings from Bentz (2020) show that art can accompany climate change education through its flexible movement and bring a more profound realisation of transformation for learners. Lou and Zhao (2021) conducted a recent study that shows that framing and visualisation are communication approaches to facilitate attention and cognitive flexibility.

This study intends to discover how the transformation in young adults' personal sphere, including changes in personal transformation and peer relations, may develop regarding climate challenges, environmental engagement, and intended actions against climate breakdown. Despite that, the convolution of climate change requires highly responsive and inventive pragmatism in educational practices. Among various angles, art is becoming an effective medium for interchanging science as a commanding pattern for building an interactive connection with the public within the context of climate breakdown (Bentz and O'Brien, 2019) and offering transformative experiences to adolescents (Bentz and O'Brien, 2019; Dieleman, 2017). Climate-related art activities open up all sorts of imaginative possibilities. The present study invites participants to think more independently and prepare a possible scenario. This may assist them in being responsible beings with increasing levels of social consciousness and changing worldviews toward sustainable transformations.

In the framework of this study, it is purposeful to introduce the field of science communication to the public through art and find out how art can be the ideal approach for young adults to learn new things about science (such as climate change), investigate their perceptions of art-science partnership in their learning and how they think about a given topic of science on the individual level. By following and adapting the recent trends of research in the realm of science communication, this study attempts to contribute to the theory building of the field with the target group of participants in a developing country, Vietnam - one of

the counties most affected by climate change and also add more evidence of utilising art as an interactive medium into communicating science with the public.

2.1.4 Transformation and the three spheres of transformation

In this study, the definition of the personal sphere in the transformation is adapted from the research of O'Brien (2013, 2018) and findings from Wamsler et al. (2018, 2019, 2020, 2021) and Woiwode et al. (2020, 2021). The personal sphere includes subjective beliefs, consciousness, values, worldviews, human-nature relatedness and paradigms that influence how people adapt, delineate or reform systems and structures and their behaviours and practices. At the individual scale, Woiwode and colleagues (2021) use the term "inner dimensions", which are also defined under the term "mindsets" (Wamsler, 2018, 2020).

According to Wamsler (2019), there should be more research on sustainability science and education focusing on the inner dimensions and capacities of people's cognitive and socio-emotional processes and the relations of those processes to people's life choices and decision-making. Wamsler (2019) argues that another critical aspect neglected is the inner dimensions of individuals. Few inner or personal transformations have been recently identified in sustainability science and education (Wamsler et al., 2018; Frank et al., 2019; O'Brien and Leichenko, 2019).

Regarding "inner transformation", Wamsler (2020) defines that:

> Inner transformation describes changes related to people's mindsets, which are made up of their values, beliefs, worldviews, and associated cognitive/emotional capacities (such as mindfulness, self-awareness, compassion and empathy), and thus involves changes in people's consciousness. They lie at the root of many sustainability challenges; they can be important leverage points for change and are thus fundamental to solutions to the world's greatest challenges (Abson et al., 2017; Meadows, 1999).

Wamsler et al. (2021) list internal transformative qualities/capacities systematised into five interrelated clusters, including:

- *Awareness* - the capacity to understand, listen and communicate and openness to change (Dietz et al., 2005; Wamsler et al., 2020).
- *Connection* - the concept of human-nature interdependence.
- *Insight* - the concept of perspective-taking, sense-making, and acceptance of different ways of knowing (Bentz and O'Brien, 2019; Wamsler et al., 2020, Woiwode, 2016, 2020)
- *Purpose* - the concept of activation, the reflectivity of one's values, a sense of purpose, intentions and responsibility and mean-making (Ericson et al., 2014; Frank et al., 2019; Wamsler et al., 2020).

- *Agency* - a sense of empowerment and related qualities/skills that can foster and enhance collaboration, co-production and co-creation of meaning and action-taking (e.g., Bentz and O'Brien, 2019; Robison and Jansson-Boyd, 2013; Walsh et al., 2020).

By incorporating those clusters into the study, we could have a better goal of setting up a friendly and interactive learning environment for the audience and bringing more space for the participants to learn, share and get involved intensively in the working group. Moreover, by enhancing those as much as possible those clusters, facilitators can see the fact that it is more reasonable and insightful for the rapport between the science communicator and respondents to communicate and express their sensitivity to given topics about their thoughts, future actions and ideas about how they will communicate and share their knowledge to their peers, family and community.

To move forward to more sustainable futures in sustainability transition research, Woiwode et al. (2021) highlight that inner transformation is a key to sustainability transformations. The work undertaken by Woiwode and colleagues (2021) has exemplified that inner transformation and dimensions are considered crucial aspects to provide for personal and collective signs of development of each individual's awareness and relationship to their inner self, society and the environment.

Moreover, inner dimensions and transformation can influence social change towards sustainability (Woiwode et al., 2021). The processes within the conceptualisation of inner transformation with sustainability are related to self-reflection and recognition of an individual, the activation of core values, associated behaviours, human-nature relatedness, sustainability-centred social learning and innovation toward sustainability. According to Woiwode and colleagues' research (2021), safe spaces and joint actions are necessary for each individual's self-reflection and change development.

However, it is easier said than done since the field of inner transformation is still a gap to be narrowed with traditional approaches and structures, which can be solved by integrating various modes of knowledge from scholars and practitioners in a cross-disciplinary way (Woiwode, 2020). Instead of wasting so much time debating the issue, Woiwode et al. (2021) strongly suggested that by integrating inner and outer sustainability (Wamsler, 2020), the formulation of the strategy should be the emergence of the environmental humanities and innovation courses and approaches. New forms presented by Woiwode et al. (2021) should be co-creative and reflexive, creating knowledge co-production and exchange such as multidisciplinary, action-orientated and transformative studies (Lang et al. 2012; Fazey et al. 2018). Self-reflection and individual and group activities with self-discussion and with peers and group participants facilitate an excellent opportunity to express their knowledge and new information co-creation and develop their inner dimensions, which are vital aspects of the present study.

As explained earlier, this study uses the conceptual model for transformational capacity explored by O'Brien (2018). According to O'Brien (2018), there are three spheres of transformation: practical, political, and personal. This study focuses on developing the personal sphere of individuals through art-based science communication activities. The study explores three spheres of transformation in the research community through the table below before heading to our detailed results within the research framework. O´Brien and Sygna (2013) characterise transformation as an elaborate operation that entails changes in the personal, cultural, organisational, institutional, and systems levels within the context of climate change. O'Brien (2018) also describes three spheres of transformation:

- Personal sphere refers to one individual and their shared understanding and conceptualisation of the world, which influence their perception, interpretation, and reality construction;
- Political sphere refers to the systems and structures that facilitate or constrain practical responses to the given topics of climate change;
- Practical sphere refers to climate change mitigation and adaptation research, policies, and actions.

All of the notions of these three spheres can be used as an instrument for more insights into why, where and how transformations toward sustainability may occur (O'Brien & Sygna, 2013). Within the context of this study, we only focus on the personal sphere, which is presented below:

> The personal sphere represents individual and shared understandings and assumptions about the world, which influence perceptions, interpretations and constructions of reality. It also defines what is individually and collectively imaginable, desirable, viable and achievable based on different understandings of causality, levels of social consciousness and future consciousness, perceptions of the agency, and assumptions about leadership (Schlitz et al., 2010; O'Brien & Sygna, 2013; Sharpe et al., 2016; Manuel-Navarrete & Pelling, 2015). These subjectivities influence and inform whether, where and how boundaries are drawn between 'us' and 'other,' who or what is included or excluded (or allowed or prohibited) and who or what is considered to have power in any given relationship.

The transformation development in the personal sphere embraces cognitive processes related to beliefs, paradigms, values, and worldviews (O'Brien and Sygna, 2013) but with more growing sensations and inner feelings related to personalised drives and motivations.

In this study, the definition of the personal sphere is as follows:

> The personal sphere of transformation is subjective beliefs, values, worldviews, and paradigms influence how people perceive, define or constitute systems and structures, as well as their behaviours and practices. The personal sphere of transformation represents both individual and shared understandings and assumptions about the world influence perceptions, interpretations and constructions of reality.

Despite this recognition, there is a noticeable gap in the current experimental research to foster changes and actions at all three personal, practical and political levels of transformation and uniquely assess the shift in adolescents' personal sphere to climate change through arts-based science communication, notably in Vietnam. Given the ample room for limited research on transformation in the notion of the personal sphere within the adolescent group on the subject of climate change, this study highlights an understanding of how such personal changes in worldview and level of social consciousness come in the process of scientific knowledge production through art communication routes about among the participants.

2.2 Study directions through an analysis of relevant literature

The issue of how scientists can communicate science effectively to non-specialists has received considerable critical attention. Over the last ten years, the interaction between science and art has long been criticised. Once social issues intersect with science, there are always rooms for researchers and artists to communicate and exchange ideas together (Wegener & Samantha, 2019).

Zaelzer (2020) finds that the problematisation with contemporary science communication is that science communicators tend not to notice that science is a dynamic learning and knowledge acquisition in the conversation between researchers and the public. Zaelzer (2020) presents that science-art collaboration is a two-way engagement monument to learning and information exchanging between participants, which is crucial for increasing enjoyment and recognition of the scientific endeavour and building up public trust in science. The collaborative model creates "bridges across disciplines and to communicate science with the public through art". (Zaelzer, 2020).

Wehbi et al. (2018) found that an arts-informed approach within the classroom brings a creative space for students and educators and creates a window of opportunities for more active involvement and greater levels of self-reflection, self-care, self-expression and personal transformation for students. Secondly, the research findings address that by providing a creative space for learners, they learn through living experiences, develop trust, participate in collective interaction and contribute mutually with their peers.

Transformative experiences are essential for students and educators to develop a sense of authenticity and passion (Wehbi et al., 2018). However, according to Wehbi et al. (2018), it is not easy to invite and

encourage both students and educators to enter and utilise this arts-informed method since it implies a "risky" action to become a beginner again and get involved in innovative teaching approaches. Creating a space of artfulness for participants to express what they think and share their ideas with others is the most important task for educators. Wehbi et al. (2018) confirmed that this shift is crucial as it changes their mindset from focusing on artistic techniques to being free and creative to express themselves while learning. Originating participation with art in this way can potentially contribute to students' and educators' personal and social transformation, which will be an integrated approach in the present study.

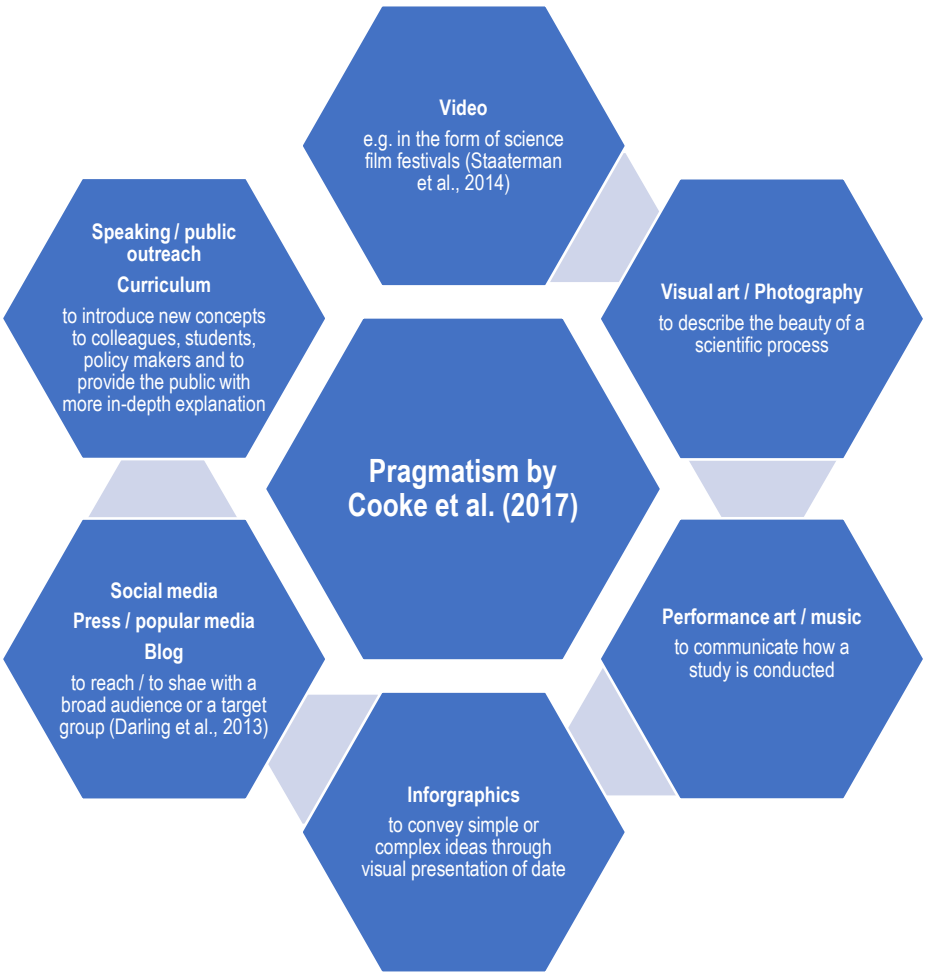
An approach called "future-oriented learning", presented by Illeris (2014) is how people see themselves and their world. It can activate a profound transformation of an individual. This approach encourages participants to expand their abilities from question-based learning to discovering more spaces for challenging, reflexive and playful experimentation (Kagan, 2012) with processes of transformational value and for active bodily learning (Heras & Tàbara, 2014). However, according to Tschaket et al. (2019), in the domain of social transformation and climate change, research to date has not yet paid adequate attention to consider some crucial components of the role of people's visions toward sustainability. Only a limited number of learners' perspectives on creative and artistic development in adolescence and controlled studies that compare differences before and after art-based intervention have been identified.

Much uncertainty still exists about the importance of subjective transformation encounters, such as beliefs, emotions and worldviews (Gosnell et al., 2019). Research on cultural attributes of adaptation and transformation has not been fully developed in literature (Gosnell et al., 2019; Adger et al., 2013; Brown et al., 2019; O'Brien, 2013; Moser, 2012; Hulme, 2014) despite the crucial correlation between raising people's awareness and behavioural change involving inspiration, enthusiasm and curiosity.

Varner (2014) has questioned and argued that science communication is a recursive cycle that demands assessment, reflection, and adaption without interruption. Cooke et al. (2017) provide a list of constructive pragmatism in science communication practice, as shown in Figure 2.2, and from their perspective, these techniques should be combined practically to have the most efficient operation in reality.

Figure 2.2

Constructive pragmatism in science communication practice



Note. Adapted from Cooke, S. J., Gallagher, A. J., Sopinka, N. M., Nguyen, V. M., Skubel, R. A., Hammerschlag, N., Boon, S., Young, N., and Danylchuk, A. J. (2017). Considerations for effective science communication. FACETS 2: 233–248. DOI:10.1139/facets-2016-0055

Similarities are found in Harold's study with colleagues (2016), Wong-Parodi (2020), Goldberg (2020), and other scholars to narrow the difference between perception and reality. Harold et al. (2016) suggested that simple, accessible, and interactive visualisation effectively informs people about Greenhouse gas emissions. An open conversation encourages the acquiescence of climate change, for example, by offering a self-assertion exercise before exposing participants to climate information (Wong-Parodi, 2020). Other examples include inviting discussions on global climate issues with peers and family members to learn incontrovertible evidence (Goldberg, 2020), expressing points of view which is opposite to the adherence (Guilbeault, Becker, and Centola, 2018), or furnishing people with additional information that explains the scientific information (van der Linden et al., 2017; Cook and Lewandowsky, 2016). As indicated above, Lou and Zhao (2021) argue that it demystifies sophisticated climate change topics and presents more information transparency about climate change.

Thudt and colleagues (2017) stated that personal storytelling through visualisation and techniques for

exchanging individual experiences in subject visual narratives exists at the intersection of research, design, and art. Their research findings also view subjectivity in visualisation and data art with a more profound understanding. On the authority of Thudt and associates (2017), telling stories about personal insights from the narrator's viewpoint through visual data representations is defined as personal narrative visualisations.

Matias et al. (2021) consider another issue: how under-represented groups can get involved in customised science communication activities since these groups are different in their social background from other groups. Science communication is a new field, and science communicators intend to approach as many people as possible within the general mainstream. The work of Matias and colleagues (2021) suggests that science and art-informed programs are effective with distant public. In their impressive analysis, Matias and colleagues conclude that art can positively contribute to exchanging ideas, thoughts, opinions and knowledge effectively, and science can be involved in daily life through art (Matias et al., 2021).

Matias and colleagues (2021) approach science-art collaboration in their science communication with the public by giving examples of the reality of Antarctica. More than that, the researchers enhance the audience's understanding of science and foster open and honest thoughts by directly involving students in exhibited art about climate. The audience is not the only beneficiary of the project. They are "turned into ambassadors for art and science". According to Matias et al. (2021), learners and their families can quickly receive environmental messages thanks to science-art integration. This is what Kennedy (2010) calls knowledge-connected "social marketing", which is effective and efficient (Matias et al., 2021).

Notwithstanding, there is a lack of empirical consideration of the quality of the visualisation research community (Thudt et al., 2017). Arts can brilliantly convey a sense of awareness of climate science thanks to its readily accessible pragmatism by captivating the visual imagination to take the initiative and change behaviours (Thomsen, 2015). Given the quality of utilising arts to enhance climate change literacy and responses, the present study advocates considering which aspects of effective science communication are desirable through art.

To investigate the development of participants' subjective transformation angles, we implement the framework of the personal sphere delineated by O'Brien and Sygna (2013). At a small scale of this research, based on the design of experiments of control and experimental groups and in-depth interview analysis, we examine the critical differences in the personal sphere of transformation among those groups. The differences are not pointed directly to which sphere is more important or has more powerful consequences than other spheres. The differences in this research are only for the suggestion that proper science communication through art-informed collaboration should be considered to achieve sustainability

outcomes. The findings within this study are expected to develop and give an example of how art can get involved and effectively tell adolescents, as a future generation, a creative and attractive story with proper knowledge of climate change adaptation. Not only telling, but this approach also gives participants a creatively generous space to express their interests, concerns and future actions and raise their voices toward climate change.

3 CHAPTER 3: RESEARCH METHODOLOGY: AN APPROACH TO DATA ANALYSIS

This chapter presents the study's research methodology and comprehensively describes the qualitative approach used for data-gathering and analysis. It further describes the analytic techniques employed and the foundational flow of the research findings. The findings will be discussed thoroughly in the next chapter, with links to the current literature identified.

3.1 Background of qualitative research

The study has considered the most appropriate definitions from leading scholars and researchers for what constitutes qualitative research approaches, including the design, development, and applications, as advocated by Billups (2021) in "Qualitative data collection tools: Design, development, and applications" by Billups (2021). In her latest book, Billups (2021) started with the question: "What is qualitative research?" and referred to examples of definitions from Creswell and Poth (2018), Denzin and Lincoln (2011), Maxwell (2005, 2013), Merriam (2002), Patton (2015), Merriam (2002) and Saldana's (2015). This study deploys Denzin and Lincoln's definition of qualitative research (2011) as it ascribes to the study's objectives:

> Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. (Denzin & Lincoln, 2011, p. 3)

Madondo (2021) highlights the strengths and shortfalls of qualitative philosophy (or can be used in a place of worldview/paradigm/approach). It is stated that qualitative paradigm studies have smaller detailed samples and can be applied to study individual cases. More importantly, a qualitative worldview has a significant power to describe and give an insightful understanding of a complex phenomenon. Qualitative research is good for cross-case comparisons and is responsive to the changes that unfold during the study (Madondo, 2021). On the other hand, qualitative research methods have some deficits. It is not suitable for studies of a large population due to the demanding and time-consuming data collection process.

On the other hand, Liamputtong (2012) points out that qualitative research has been widely adopted to study people's subjective experiences and understand their meanings and interpretations (Liamputtong, 2012). Nevertheless, there are still some foundational issues and challenging questions in qualitative enquiry, according to Liamputtong (2012), which are methodological frameworks, sampling strategies,

study validity, ethics considerations, and the rigour of its findings. Adapted by Liamputtong's (2012) ideas, this chapter will discuss qualitative research as it applies to two aspects. These two aspects are linked to the methodological framework and sampling strategy development within the circumstances of this study in order to recruit potential research participants.

3.1.1 Methodological frameworks

As a qualitative researcher, one must understand the importance of appropriately understanding the methodology involved in the process. Research methodology is the backbone of a study that helps researchers interpret data accurately. Methodological frameworks are foundational for the rigour and value of qualitative research and influence the sampling strategies (Liamputtong, 2012). The present study focuses on two methods, phenomenology and case study, with detailed descriptions of how it applies to the study.

3.1.1.1 Research design

In terms of research design, this study applies Solomon's four-group design, which allows the authors to assess the fundamental revision of testing, treatment/intervention and the remarkable correlation between testing and treatment (Alen, 2017). Solomon's four-group approach provides meaningful insights and differences between experimental and controlled groups, which is expected to offer essential contributions to transformation research. The present study employed a modified control group design with potentialities for demonstrating and weighting specific interaction effects compared to Solomon's four-design group method (Solomon, 1949).

46 participants were assigned randomly to four groups involved in the concept of climate change, followed by the research model as emphasised in Table 3.1:

Table 3.1

Research model: Solomon four-group group design

	Group	Time (T) →				
		T1		T2		T3
		Pre-Test		Learning sessions		Post-Test
Solomon Four-Group Design	Group 1	Survey	→	Climate Change Training	→	Climate Change Interviews
	Group 2	Survey	→	-No Session-	→	Climate Change Interviews
	Group 3	-No Survey-	→	Climate Change Training	→	Climate Change Interviews
	Group 4	-No Survey-	→	-No Session-	→	Climate Change Interviews
In an ideal case - desired observed differences		No Difference		-		Significant Differences 1|2; 3|4 No Difference 1|3; 2|4

* Groups 1 & 3 as two experimental groups to undergo the prescribed learning sessions

* Groups 2 & 4 as two control groups to receive no session and serve as the benchmarking point of comparison.

Learners gain knowledge and skills through arts-based science communication, with arts engagement as a crucial medium where changes are observed, and the facilitator collects data. Testing interventions and drawing comparisons between groups within the context of the research help educators, practitioners, and researchers continuously assess the specific period to array effective interventions to boost the effectiveness of arts-based learning and enhance participants' personal sphere. The evident strength of these experimental research designs lies in their capacity to establish cause-and-effect correlations and observe the effects of the pre-measurement and that of the measurement.

In addition, a qualitative approach was adopted using various complementary methods. The study is

committed to providing insights into the personal sphere changes connected with climate change where participants engage in an arts-engaged basis. The six measures applied by the researcher include two actions before the learning sessions (at time T1), one for the first experimental group and one for the first control group (Groups 1 & 2). The learning sessions are provided (at time T2) to the two experimental groups (1 & 3). Then (at time T3), four other measures are done after the learning sessions, one for each study group.

3.1.1.2 Phenomenology

Within the context of this study, we adopted phenomenology - one of the most widely used methodological theories in qualitative research. According to Eberle (2014) and Liamputtong (2012), the German philosopher Edmund Husserl established the school of phenomenology.

The term "phenomenology" can be traced back to Husserl's idea of "the things themselves", according to Eberle (2014). This qualitative research methodology is a philosophy with an analysis of 'the things themselves, which claims to be rigorous science. The main focus of phenomenological designs is primarily originated and guided by Husserl's science of phenomenology ([1936/54], 1970; [1939], 1973; [1913], 1982) and is continuously interpreted by scholars and researchers with importantly crucial questions, namely (1) What is the essence of the lived experience under study? (Billups, 2021), (2) What is his or her subjective consciousness? (Eberle, 2014) and (3) How is consciousness experienced? (Liamputtong, 2012). It means the individuals' inner experiences can be examined by how a person or a group of people experience things and represent their transformative personal journeys in their emotional and transformative aspects. It is plausible to conclude that phenomenology is a theoretical perspective (Liamputtong, 2012). It requires researchers' meticulous endeavours to generate a means of the reality in which participants experience and gain knowledge about how respondents think and express their thoughts and worldview about some given topics. Adu (2019) discusses that the phenomenological approach can be used when researchers study a phenomenon directly or indirectly experienced by a group of people or when researchers aim to explore how participants experience things and expect them to share their thought about the experience.

In this study, we applied the hermeneutic phenomenological approach in which the primary data source is written documents as reflective journals of participants in each session. We desire to view respondents' experiences through art-based climate change communication by interpreting the underlying meaning of written documents collected after completing each session.

In order to collect and present a holistic aspect of the individual's inner experiences of participants of this research, a detailed table is introduced about qualitative research designs (including phenomenology and

case study, which will be discussed after this section), followed by data collection strategies and tools employed.

3.1.1.3 Case study

As stated by Billups (2021), case study designs are essentially situational analyses and primarily based on the context where the viewpoints of all stakeholders are collected, interpreted and integrated through a particular event, process, setting or circumstance. Many qualitative researchers and scholars define case studies as the extensive study of a bounded system by place and time (Madondo, 2021), as an approach to examining data accomplished from a single case or a group of cases by the implementation of several data gathering methods (Adu, 2019; Madondo, 2021) for a descriptive or explanatory purpose (Madondo, 2021). The case study approach is used when qualitative researchers use multiple data collection strategies to generate data about the study's specific context (Adu, 2019). For example, in this study, we apply in-depth interviews, observations, documents (written journals and participant-produced drawings), and survey collection to describe and compare the similarity and differences in unique cases. Through an analysis based on the context, the perspectives of all audiences are presented and analysed. The outcomes reveal empirical and mutual angles contributing to seeing the light of the phenomenon under study (Billups, 2021). This approach collects and generates data from multiple sources and analyses it with a deep investigation. Cases selected and studied from multiple perspectives of all participants involved offer qualitative researchers a comprehensive awareness of how we can explore the experiences of participants toward a given topic, the flow of activities relatable to the topic (the process) and how we understand that process of personal transformation occurred and impacted each respondent. Here we refer to Billups (2021), who writes, "How do stakeholders describe this process or event, and what does it tell us about future practice(s)?" in order to guide our methodological framework, which helps us discover changes in the worldview of participants about the given topics, relationships between oneself with others within the framework of this qualitative study design.

The trustworthiness of a qualitative case study is determined by the data collection and sampling methods (Madondo, 2021), which will be presented in the following parts of this chapter. By giving readers and ourselves a better understanding of which type(s) of case study we apply in our study, we present here our agreement with the viewpoint of Liamputtong (2012), which was referred to as Stake's case study category (1995, 2005, 2008) into three groups:

1. the *intrinsic case study* - the case itself since the case bears a notable or unique condition (Stake 2005, 2008) to describe or bring to light the distinctiveness of a case (Adu, 2019) - the case as the principal storyteller,

2. the *single or instrumental case study* - the case is of 'secondary interest', playing a supportive role (Stake, 2008) and illustrating how researchers and theorists' concerns make sense in the case (Stake, 2008) - the role of the researcher as a storyteller, and
3. the *collective or multiple case study* - including multiple cases to be selected as 'representative cases' (Creswell, 2012; Liamputtong, 2012) to present the issue with different aspects in a holistic approach.

The collective cases may offer researchers more full-scale and insightful investigation for two reasons: (1) it involves worldviews about the given topic of participants whose experiences are different, and (2) each case is thoroughly studied and presented individually. For the present study, we focus on the third type - the collective or multiple case study applied in our study, for which a detailed account is presented in the next section.

3.1.2 Sampling strategy development

3.1.2.1 Purposeful sampling and strategies of purposeful sampling

Liamputtong (2012) states that qualitative research primarily involves a profound understanding of subjects' development within the research context through a rigorous examination. Liamputtong (2012) emphasises that qualitative research relies strongly on respondents who can provide good illustrations of their experiences. Qualitative researchers do not seek answers to "how much" or "how many" but instead look into "what" and look for the meanings given by respondents and how meaningful transformation is developed for each. As Patton (2002: 72) emphasises (cited by Emmel, 2013):

> The point is to do what makes sense and report fully on what was done, why it was done, and the implications for the findings.

According to Liamputtong (2012), the predominantly two main types of sampling can be listed as follows: purposive sampling (in other terms used by Patron (2002) and Emmel (2013): purposeful sampling) and convenience sampling. For the best sampling strategies of qualitative research, we followed Patton's 14+1 purposeful sampling strategies and avoided one strategy, convenience sampling, as Patton (2002) suggests. As Patton (2002) emphasises:

> The (purposeful) sampling strategy must be selected to fit the purpose of the study, the resources available, the questions being asked, and the constraints being faced.

Liamputtong (2012) and Emmel (2013) agree with Patton (2002) that

> The logic and power of purposeful sampling lie in selecting information-rich cases for study in depth.

Patton's 14+1 strategies of purposeful sampling are listed in alphabetical order as follows: confirming and disconfirming cases, criterion sampling, critical case sampling, extreme or deviant case sampling, homogeneous sampling, intensity sampling, maximum variation sampling, opportunistic or emergent sampling, purposeful random (of small units), sampling politically essential cases, snowball sampling, stratified purposeful sampling, theory-based / operation construct sampling and typical case.

However, the present study focuses on the purposeful sampling strategy and applies maximum variation sampling. Cases are selected purposefully. We applied this strategy of purposeful sampling for its potential strength. With this strategy, it is feasible for researchers to collect two varieties of data: detailed descriptions of the cases' uniqueness (such as age, gender, and interest in the given topics) and a typical series of actions or events, valuable experiences and significant aspects of the selected cases.

In this study, we recruited four groups: two groups undergoing a set of learning sessions of climate change learning sessions and another two not attending any sessions. Those four groups experienced one in-depth interview. The significant chain of actions, experiences and mutual aspects found in variation provide insight into their personal transformation.

3.1.2.2 Sample size

The qualitative method analyses participants' texts in reflective journals and interview formats. The number of interviews required to reach data saturation in qualitative research is suggested in several recommendations presented in Table 3.2.

Table 3.2

Examples of the number of interviews needed in qualitative studies

Authors	**Sample size (N)**	**Notes**
Bernard (2000) and Morse (1994)	30-60	for ethnographic studies
Green and Thorogood (2009) Ritchie et al. (2003)	20-30	for general qualitative research
Starks and Trinidad (2007) Morse (1994)	6-10	for phenomenological studies
Hagaman and Wutich (2017)	5	for each new occurrence of common themes as a general rule of thumb

Authors	Sample size (N)	Notes
Hagaman and Wutich (2017)	20-40	for multi-sited or cross-cultural research to reach data saturation
Adler and Adler in Baker and Edwards (2012)	12-20	Student's assignment as a practical opportunity to gain qualitative research skills
	30	for a practical consideration and acceptable to external powers

Although this research is a relatively small-scale exploratory study (46 interviews from four groups), confidence in the expected research results is enhanced by using multiple methods. Given the study's remit, aspects relating to the low level of participants' readiness for art experience and potential threats to their punctual presentation dominate the findings. However, it could be solved by the collaboration and encouragement of onsite officers of centres and ways of efficiently working with the author.

3.1.3 Ethical considerations

The data collection process of this study commenced after gaining Ethics Approval from the Human Research Ethics Committee at Curtin University, Australia, with the Approval number: RE2022-0111. The study is committed to fully complying with the strict requirements described in National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2007).

Since this study involved the participation of human participants as respondents to join research activities within this study, ethical principles regarding the conduct codes of the research must be discussed. Ethical concerns are addressed in this qualitative study to protect participants, their identities, privacy, and the way the data is used and reported (Billups, 2021). In this section, we focus on three issues: informed consent, confidentiality and risk and harm, which we adapted from Liamputtong (2012).

3.1.3.1 Informed consent

It is required that researchers must receive informed consent from participants before carrying out any activities of the research. In this study, we presented each participant with two forms, including (1) Participant Information Form and (2) Participant Consent Form, to ensure that participants fully understand the background of the research, the responsibilities of the participant's involvement, and possible risks associated with their participation in this project and are completely aware that their participation in this research project is wholly voluntary.

Moreover, these two forms were given to each respondent to make sure that they knew that:

- Their responses are recorded when they answer questions in this study.
- Photographs and video recordings are carried out during the research context's surveys, learning sessions, interviews, and research activities under this study and are only used for data analysis in the thesis.
- Photographs, videos and audio recordings, and information provided by the respondents in this study are stored and kept under secure conditions at Curtin University for seven years after publication or completion of the project or until subjects have reached 25 years of age, whichever is later, and then it will be destroyed.
- Reflective journals required for each learning session within the project context are used for research purposes.

All research participants were required to read two forms thoroughly and acknowledge that they were free to raise questions satisfied with the answer. Each participant signed the Participant Consent Form, and we collected all signed forms from all participants.

3.1.3.2 Confidentiality

Confidentiality refers to the protection of the true identity of the participants (Liamputtong, 2012). To protect their identities, privacy, and the way the data is used and reported, we applied our codes of conduct, including:

- The laptop and all hard drives/devices used during this study are password protected.
- The information collected in this research study is re-identifiable through codes, which means any information collected to identify the participant is removed and replaced with a code when analysing the data. Any information collected is confidential and used only in this project unless otherwise specified.
- All information will be stored securely at Curtin University.
- The information collected in this study is re-identifiable. Participants are de-identified in data analysis, storage, and data management systems for the study. Participants are not identified in any results that are published or presented.

3.1.3.3 Risk and harm

There are no known risks associated with participation in this study. Due to the current COVID-19 situation, particularly in Ho Chi Minh City, Vietnam, we were committed to following guidance and

instructions strictly from the Ministry of Health in Vietnam, the Department of Health in Ho Chi Minh City, and HCMC Center for Disease Control, which include 5K Message and Vaccine:

1. Khẩu trang (Face mask): regularly wear face masks in public places and crowded areas and medical masks at medical facilities and quarantine areas;
2. Khử khuẩn (Disinfection): regularly wash hands with soap or hand sanitisers; clean surfaces and frequently contact objects;
3. Khoảng cách (Distance): keep a safe distance from others
4. Không tụ tập (No gathering): avoid mass gatherings
5. Khai báo y tế (Health declaration): make a health declaration on nationally approved apps, and install BlueZone, which will help detect the risk of COVID-19 infection.

The facilitator (also a student researcher) has been fully vaccinated since September 2021 and received a booster shot on December 28, 2021.

In this study, we have considered carefully to ensure that the given tasks do not distress participants. Nevertheless, if any questions cause an anxious feeling in participants, they can simply deny answering. Apart from giving up participants' time, there are no inconveniences or risks related to participating in this project.

3.1.3.4 Qualitative research designs, data collection strategies and tools

This study aims to look for the answers to three questions below:

(1) What is the use of art involvement to transform climate change response in adolescents?
(2) To what extent do art-based techniques contribute to participants' personal transformation sphere?
(3) To what extent does the potential of an art-science partnership galvanise changes in study participants' relationships with peers?

The research design, purpose, and questions are combined (Billups, 2021). Table 3.3 highlights the connections between this study's qualitative design, three research questions, purpose statements, research questions, keywords, data collection strategies, and data collection tools.

Table 3.3

Qualitative research designs, data collection strategies and tools applied in the study

No.	Research design	Research questions	Purpose statement	Keywords	Data collection strategies	Data collection tools	Data collection types & purpose	Approach towards analysing data
1	Phenomenological	What is the use of art involvement to transform climate change response in adolescents?	This phenomenological study aims to uncover how the art-based experience can foster respondents to express their climate change responses.	uncover, ascribe, perceive	Reflections Interviews Transcript Documents	Reflective practice through Interview Participant-produced drawings Interview protocol	Reflective questions during the interview for participants to capture their perspectives about their artwork during each learning session Reflective journals as self-produced records of each participant's experience that are written after completing each session reflect personal perspectives Images are visualised using art materials (such	The interpretative phenomenological analysis is used to perceive and interpret participants' views about the process they have experienced, present their message through their drawing per session and their response to interview questions at the
2	Case Study	2. To what extent do art-based techniques	2. This qualitative case study aims to assess the effectiveness of the	report, describe, assess				

No.	Research design	Research questions	Purpose statement	Keywords	Data collection strategies	Data collection tools	Data collection types & purpose	Approach towards analysing data
		contribute to participants' personal transformation sphere? 3. To what extent does the potential of an art-science partnership galvanise changes in study participants'	art-informed science communication learning sessions contributing to the development of respondents' worldviews. 3. This qualitative case study aims to assess the potential contribution of art-science collaboration in developing respondents'				as watercolours and paper) and produced by participants, and the messages participants present through their drawings to raise their concerns, experiences, feelings and voices and to get a deeper understanding of participants' worldview. Interviews are used with listed questions on an interview protocol to guide the conversation between the researcher and participants as well as to provide the researcher with	third stage of the study. The framework approach of five stages of data analysis is adapted from Pope and Mays (2006). According to Pope and Mays (2006):

No.	Research design	Research questions	Purpose statement	Keywords	Data collection strategies	Data collection tools	Data collection types & purpose	Approach towards analysing data
		relationships with peers?	relationships with peers.				the flexibility to probe the participant for additional details (thoughts, feelings, and opinions)	

3.2 Characteristics of research participants

3.2.1 Demographic Characteristics - Biodata of respondents

Participants aged 16 to 18 attend community centres in Ho Chi Minh City, Vietnam. Participants in this research are voluntarily and actively joining activities in centres occasionally. Before officially entering the research activities, participants had to read through the participant information form and sign the participant consent form for voluntary involvement. In those forms, they were informed of how this research will be conducted and their role as research participants. Before administering participant and consent forms, the project objectives were explained to the potential participants.

This study used mature minor consent with participants aged 16-18; therefore, there will be no requirement for guardian/parental consent.

The centres where participants attend occasionally or live at centres are located in Ho Chi Minh City, Vietnam. The centres are social protection organisations established by members to support and provide care for many social protection beneficiaries or those needing social assistance. These organisations aim to provide social security services, organise extra-curricular classes, life skills and English learning activities, and semi-boarding classes at the centres for children with financial difficulties.

These groups of participants were chosen for this study as they have less accessible opportunities to participate in extra-curricular activities and learn science through creative approaches due to their low-income family background. This study allows the underprivileged to articulate their voices on an impacted topic like climate change.

Table 3.4 describes the number of participants and their backgrounds into four groups according to this research design:

Table 3.4

Description of participant's background

Number	46
Socio-demographic background	
Age	16-18 years old
Reasons for this age range	According to the theory of psychosocial development constructed by Erik Erikson, this fifth stage of the human life span shows identity versus role

	confusion during adolescence at the age of 12 and 18. At this stage of development, adolescents seek a sense of self and personality traits. Adolescents usually can think critically about abstract problems, which requires them to comprehend social knowledge to answer, argue and consider a wide range of viewpoints (Dole & Sinatra, 1998). This capacity must be fostered and scaffolded for most students to engage with information in a critical fashion. These explanations are considered an excellent approach for the author to evaluate changes in worldviews and levels of social consciousness.
Gender	Both male and female participants were recruited
Location	Participants attend occasionally or live at Community Centres in Ho Chi Minh City, Vietnam

3.2.2 Participant recruitment strategy

As mentioned above, this study contacted centres where the select groups of participants were involved via telephone calls at the beginning to present our study and enquired about their interest in participating and permitting us to do this research project at their centres. The call scripts are about the following:

1. Introduction: The study and the researchers

2. Activities of the Study at the local community groups: the number of visits, the length of each learning session, the aim, and the ways of collecting feedback from participants

3. Researchers' commitment to research the local community groups.

After gaining the approval of cooperation from the Centres with this study, the research student visited Centres according to schedules in agreement with Centres and participants.

3.2.3 Phases of data collection

The research student of the study collected data for three periods: pre-test with two groups, learning sessions with two groups and post-test with four groups, as presented below:

Firstly, one pre-test activity was conducted with two participant groups: Firstly, with group 1 and group 2. The researcher asked participants aged 16-18 at centres in Ho Chi Minh City, Vietnam, to partake in one pre-test activity. By joining the pre-test activity, participants met with the researcher to discuss their knowledge, attitudes towards climate change, and practices to be taken or considered helpful in climate change adaptation and their media preferences. Each participant in the first two groups presented this pre-test activity, gave a survey and completed it. This survey was taken within 30 minutes via face-to-

face interaction or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam at the centres where adequate facilities are available. By involving in the pre-test activity of the study titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change", participants were reimbursed for their time as a grace token. Reimbursement for time is equal for all participants in the study.

Secondly, learning activity group sessions were conducted in two groups. With groups 1 and 3, we had four learning sessions at centres to provide activities for participants. We directly assessed participants' changes based on their completion of learning sessions, tasks requested per session, reflective journals, and group discussions. Each session took 60 to 120 minutes and was facilitated by the research student.

The list of six sessions is presented below. One important note is that sessions one and two were incorporated into sessions three and four due to limited access to participants during the pandemic. The last two sessions, five and six, were conducted independently.

1. Session 1: Climate change overview to help participants understand climate change and raise awareness and understanding of climate change effects and climate change causes to help participants recognise how human activities are causing climate change
2. Session 2: Actions to protect ourselves and our families from climate change from helping participants to reduce negative impacts of climate change and Participant assignment: Be an investigator about climate change to discover how participants are aware of climate change
3. Session 3: Participant assignment: Be an activist about climate change to encourage participants to come up with participants' ideas to help reduce climate change and raise other people's awareness
4. Session 4: Participant assignment: Climate change exhibition to present participants' ideas to the rest of the group using one or more of the following: a graph or chart, a drawing, a collage, photographs, a model, and a video

Photos and digital videos were taken per session with participants' permission, proved by consent forms approved by Human Research Ethics Committee, Curtin University. As part of each session, participants were encouraged to write a reflective journal. Writing their reflective journal helped them to articulate their analysis of their participation, ideas and interests after attending each session within the research context and their assessment of the group interactions that might have occurred during the session.

Thirdly, a post-test activity was presented with climate change interviews for all participants in four groups. We asked participants to complete six interview questions, taking 60 minutes via face-to-face interaction or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam at the centres where adequate facilities were available.

The list of eight questions includes the following:

1. The global climate is changing. What do you think about this statement?

2. Climate change is caused by natural factors, human actions or both. What do you think about this statement?

3. How will you feel if you and your family are affected by climate change?

4. How will you feel if you are responsible for reducing climate change?

5. How will you feel if art can contribute to telling you more about climate change?

6. How will you feel if art-based science learning activities can develop your cooperation with your teammates?

7. What will happen if we do nothing?

8. What will you do to cope with climate change?

Digital audio and video recordings were made to concentrate on what they said and not distract ourselves from taking notes. By involving in the post-test activity of the study titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change", participants were reimbursed for their time. Reimbursement for time is equal for all participants in the study.

Participants agreed to have their photos taken and videos recorded with their consent during each session. As part of each session, participants were required to keep a reflective journal. This personal reflective report was used to express participants' analysis of their participation, ideas and interests after attending each session within the research context and their assessment of the group interactions that may have occurred during the session.

These qualitative data-gathering methods were used to define the experiences of research participants, to gain a sense of transformation in the personal sphere over time of each individual after receiving the training and compare essential differences between the four groups. The primary qualitative data collection method was chosen to allow respondents to expound their cognisance in their own words without hesitation and, based on their voluntary participation, open their ideas and interests through creative activities with art materials. The reflective journal was chosen to complement the data gathered

and to capture participants' reflections on their experiences since completing each training session.

3.2.4 Data collection venue

The researcher conducted all research activities (pre-test, learning sessions and post-test) at a mutually convenient time for research participants and at the Centres where they have occasional participation or live. Before having any research activities with participants, the researcher always mentioned principles and general information to understand the activities and their voluntary participation best. To avoid any disturbance and interruption from outside factors and preserve each activity's privacy, we agreed with the Centre's manager to sign "Meeting now. Do not disturb" right on the door of the room chosen for organising activities. For convenience, the comfortable status of the research participants as well as the less formal atmosphere, the researcher encouraged each participant to bring a bottle of water, choose a seat within a two-meter distance as guided by COVID-19 guidance in Vietnam and offered them candies and cookies, which minimised the barrier between researcher and the research participants but still kept a professional rapport.

3.3 Data gathering instruments

The process of data collection in this research was conducted over a continuous period of three months, from April to June 2022. This investigative study used three data collection methods: Knowledge - Attitude - Practice (KAP) survey, interventions such as four learning sessions about climate change with artworks, reflective journals during and after each session, and individual interviews. According to Solomon's four-group design, the KAP surveys were administered and functioned as pre-training, and the interviews acted as post-training. The personal reflective journal of each participant attending learning sessions was administered immediately after the training and then collected and used for data analysis as case studies.

These data-gathering methods were used to amplify research participants' experiences, gain insight into personal transformation over time of each one's journey after receiving the training and compare the differences between those attending and not attending training sessions. The primary method of qualitative data collection was that of personal interviews, and this was chosen to allow participants to tell and share their stories, interest and concerns about climate change in their own words and their awareness. Moreover, this method uncovered ideas and pre-environmental behaviours of each participant that were not estimated at the beginning of the research training. The reflective journal was chosen to capture participants' reflections on their experiences since completing the training. This provided a more personal record, otherwise hidden, of four weeks between the training and the final interview. A detailed definition and description of the reflective journal and individual interviews are explored below. The flow of data gathering presentation depends on the data collection phases, including

one pre-test activity with two groups - The knowledge Attitude Practice (KAP) survey; one intervention carried out through learning sessions with two groups; and one post-test activity presented by climate change interviews.

3.3.1 A Knowledge Attitude Practice (KAP) survey

A Knowledge Attitude Practice (KAP) survey was presented for the first phase of the data collection process, called "pre-test activity". This KAP survey was designed to collect all the necessary information to help the researchers explore and identify participants' knowledge, attitudes towards climate change, and practices to be taken or considered helpful about climate change adaptation and their media preferences. For that reason, the KAP survey was divided into five parts:

1. Part 1: Socio-demographic background (7 questions). Part 1 consisted of general questions regarding the participants' profiles. This part aimed to identify participants' information access about climate change and art-based projects on climate change and general information about participants (age, current level of education, gender).
2. Part 2: Knowledge of climate change (3 questions). Part 2 included questions regarding how much participants agree or disagree with the provided information presented in each row.
3. Part 3: Attitude on climate change (1 question). Part 3 focused on the importance of the provided aspects of youth attitude on climate change in each row to participants.
4. Part 4: Practices toward climate change (1 question). Part 4 focused on how much participants agreed or disagreed with the provided information in each row.
5. Part 5: Climate change information access through Media. Part 5 listed preferred media usages for participants as sources of information on climate change.

As previously stated, the survey began with a brief introduction of the main features of the study and continued with the consent form. The KAP survey schedule included instructions to researchers to discuss the study's ethical issues and participation to ensure that we gained the consent of participants as well as the wholly answered form of the KAP survey.

The KAP survey schedule was divided into five main sections to explore what participants knew about climate change, their attitudes and practices, and their preferences for media used for a climate change dialogue. This was aimed at understanding the experiences, interests and concerns of respondents. The full version of the KAP survey is included in Appendix.

As mentioned in part "Data collection instruments", the five sections of the KAP survey uncovered a better understanding of participants' perceptions and opinions of the climate crisis. Before starting their

participation in the KAP survey, participants were encouraged to raise questions if they might find any words or terms used in the survey challenging to understand. More than that, giving themselves a friendly space by establishing a comfortable room thanks to arranging from the Centres was adequate for open communication between researcher and participants. While completing the KAP survey, participants experienced and found some unfamiliar terms. The researcher actively answered, gave the best simple explanation, and motivated them to finish the survey.

Lastly, a closure section was included to thank participants for their involvement in the first stage and arrange a follow-up appointment for the subsequent activities within the framework of this study.

3.3.2 Learning sessions

We designed and facilitated the flow of each learning session and guided activities of all sessions. Although each session had the same structure with five parts - 5K (in Vietnamese: Khởi động, Kiến thức, Kiến tạo, Kết nối, Kết thúc) which were translated into English as 5C, *Commencement, Cognisance, Creation, Connection,* and *Closure* respectively to provide participants with a piece of basic solid knowledge about climate change, there were a variety of flexibilities based on participants' interest and concerns and media to be used per session which led to more often two-way communication between themselves and their peers along with the facilitator. This approach effectively allowed researchers to identify and explore issues for a deeper investigation of case studies, which will be discussed further in the following chapters of this thesis. The content of all sessions was thoroughly selected from several sources to ensure that it would not be too high to reach the age group of 16-18 in this study. Planning, reading and deciding which content should be used to find a suitable match between what is happening in Vietnam and what this age group may be interested in climate change is crucial.

Moreover, this developed and guided firmly and efficiently the interview questions about environmental behaviours and actions to ensure consistency in the data collection. This qualitative research process was relatable to foster participants' experiences in a combination of art making and ideas expression through artwork created themselves. Each participant explored their journey with colour and art materials creatively. Their reflections on the training process were expressed via circle sharing with the facilitator and peers and reflective journals at the end. All personal experiences of the participants observed were original and personal, and the diary read gave the researcher a richer eye-opener and enriched our interpretation of participants' reactions and openness to the experience of receiving climate change training.

The structure of the learning session encouraged researchers to activate participants' interests and underlying knowledge and strongly invited them to share their opinions. The detailed sessions developed in this research are in Appendix.

In the process of interventions, several qualitative data collection tools were applied to collect extensive data, as outlined below. These tools were practical to cultivate the researcher's sense of intuition and judgment and offer nonverbal and contextual clues to deepen understanding of the phenomenon.

3.3.3 Types of qualitative research methods

This section describes the types of qualitative research methods applied in this study. According to Liamputtong (2012), there are nine types of qualitative research methods, including ethnography, focus groups, grounded theory research, in-depth interviewing, memory work, narrative enquiry methodology (life and oral history, life story, and biographical research), participatory action research, qualitative case study research and unobtrusive methods. Since this study is art-based research with drawing as the primary visual form used, we also used one of the arts-based research methods presented by Ward and Shortt (2020), which is called participant-produced drawing, as a research method in our qualitative research.

One more important note is that in this study, we applied (1) unobtrusive methods to collect data through reflective journals written by participants and evaluators' observation during each learning session of the intervention program (as mentioned above) and (2) an in-depth interviewing method. The following parts as presented below:

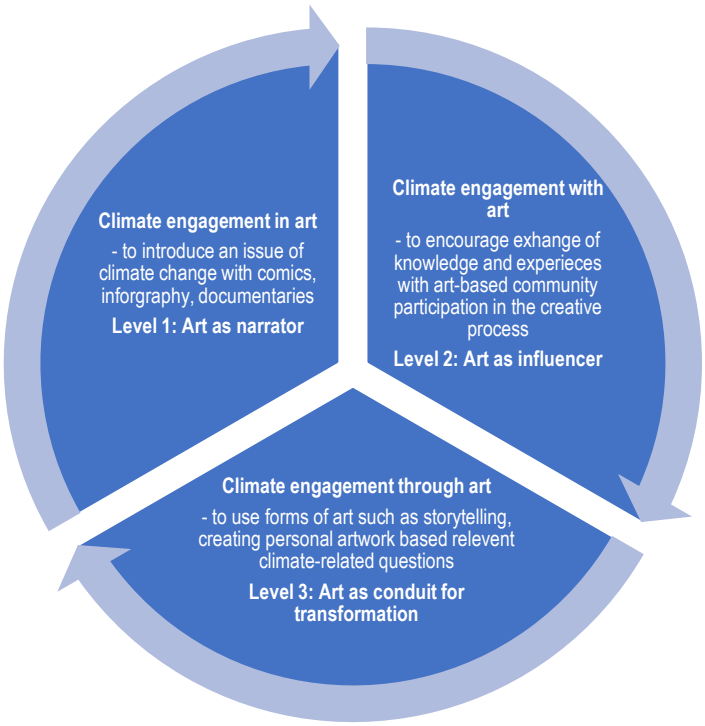
3.3.3.1 Unobtrusive methods

3.3.3.1.1 Participant-produced drawing

In this part, we present drawing as a research tool and explain why participant-produced drawing was applied in our study to elicit unique insights from research participants. Bentz (2020) developed a framework for art-based science communication research. Figure 3.1 presents three depths of engagement in the given topics of climate change:

Figure 3.1

The three depths of engagement in given topics of climate change



Note. Adapted from Bentz, J. (2020). Learning about climate change in, with, and through art. Climatic Change 162, 1595-1612. https://doi.org/10.1007/s10584-020-02804-4

Thudt and colleagues (2017) stated that personal storytelling through visualisation and techniques for exchanging individual experiences in subject visual narratives exists at the intersection of research, design, and art. Their research findings also view subjectivity in visualisation and data art with a more profound understanding. On the authority of Thudt et al. (2017), storytelling about personal insights from the narrator's viewpoint through visual data representations is defined as personal narrative visualisations. Notwithstanding, there is a lack of empirical consideration of the quality of the visualisation research community (Thudt et al., 2017), which the present study focuses on. Arts can brilliantly convey a sense of awareness of climate science thanks to its readily accessible pragmatism by captivating the visual imagination to take the initiative and change behaviours (Thomsen, 2015). Given the quality of utilising arts to enhance climate change literacy and responses, the author suggests considering which aspects of effective science communication are desirable through arts.

Participant-produced drawings are artwork created by participants attending learning sessions facilitated by researchers. The researcher asks participants to draw a drawing relatable to the topic, typically using art materials such as watercolours. Through this approach, participants are invited to work visually and present their ideas, experiences, feelings and thoughts on paper, and researchers can discover rich responses by discussing participants' drawings.

3.3.3.2 Reflective practice tools

Billups (2021) addresses the importance of reflection in qualitative research. According to Billups (2021), the ultimate power of reflective practices is that these practices provide researchers with an insightful approach to participants' reflections and unique experiences. Reflective practices help researchers open a window to understanding the learning process and the transformation of oneself when participants are invited to express their ideas and thoughts in, with and through art.

Although there are various formats to capture reflective data in qualitative research, we only describe the formats we applied for our study here in this chapter: reflective questionnaires and reflective journals.

3.3.3.2.1 Reflective questionnaires

Before concluding the session's topic and right after the participants completed their drawing, one reflective question was raised for them to present their message through their artwork. As mentioned in Billups (2021), this type of reflective tool is used to capture participants' thoughts and perspectives, close a conversation with participants and ensure that any remaining insights are told and shared by the respondents. By this approach, researchers can collect participants' underlying comments, personal stories, thoughts, ideas and pro-environmental behaviours and have a better way of defining assumptions and meanings before gaining new understandings. Moreover, reflective questions at the end of each session are a great way to build a cooperative rapport between researchers and participants where both sides can have their reflections and have more trust and cooperation for future activities within the research framework.

3.3.3.2.2 Reflective journals

After giving and sharing messages through the artwork, each participant was required to complete one reflective journal to capture their learning and experiences about the session. The written records completed by respondents focus on their personal journals and reflections of themselves and describe their perspectives, experiences, and interactions with other participants. The design of the reflective journals encourages informants to express their analysis after attending each session within the research context and their assessment of the group interactions that may have occurred during the session. Reflective journals can be considered adequate for delineating their experiences and personal transformation and developing cooperation with their peers.

3.3.3.2.3 In-depth interviewing method

The post-test activity presented by an interview was designed and conducted by the facilitator (student researcher) to gather opinions and attitudes about climate from all participants from four groups. In order

to reach the goal, they were asked some questions and encouraged to share their honest thoughts and voice with the research student. The student researcher moderated the talk. By making video recordings during interviews with participants' participation consent, I concentrated on what they said and did not distract myself from taking notes.

The articulation of the interview process is divided into seven parts. Before asking the participants interview questions, the interviewee started by introducing herself to the participant, her role as an interviewee, the purpose of the interview, the ground rules while having the interview and the introduction of the participants. The central part occurred right after and was followed by a closure of the interview. Participants' thoughts and remarks gave researchers many different ways to see this issue of climate disruption and environmental collapse through their eyes. The content collected in this study is re-identifiable in data analysis, storage, and data management systems for the study to develop research papers and presentations.

The interview questions included three parts, looking for participants' knowledge, attitude and practice, which seems similar to the KAP survey at the beginning, but the data collected was presented in words in a qualitative approach. The main differences are between groups attending learning sessions and groups not receiving training sessions, which will lead to new light in discovering the personal transformation of each participant when it comes to the personal sphere. The full version of the interview template developed is attached in Appendix C.

4 CHAPTER 4: FINDINGS AND DISCUSSIONS

4.1 Introduction

This study investigates the role of art in science knowledge construction and the climate attitude of adolescents through art-integrated science activities. This chapter details a comprehensive analysis of the data gathered for the study. The layout of this chapter focuses on the following aspects respectively:

- Describe the recruitment process and descriptive details of the study participants
- Describe the data collection stages of the study corresponding to each data collection instrument
- Describe the qualitative data analysis process, including the analysis stages, the process of code system formation and the code system table of the study.
- Present the findings of the study, including findings from the KAP survey and qualitative analysis
- Present a discussion of the study's findings, contributions, and limitations.

The findings from this study suggest that art could be used as a new approach to science education for educators, practitioners and learning designers. The findings in the data analysis for this study are depicted in three sections aligned with three research questions, which include:

1. What is the use of art involvement to transform climate change response in adolescents?
2. To what extent do art-based techniques contribute to participants' personal transformation sphere?
3. To what extent does the potential of an art-science partnership galvanise changes in study participants' relationships with peers?

Following each research question are the interview results related to the three constructs of art contribution to climate change response, personal transformation sphere and peer collaboration through art. We used the qualitative data gathered from interview sessions with participants from four groups and generated categories, identified themes and built patterns for the study. Research question 1 is categorised as Category 1 Climate Change Response. Research question 2 is identified as Category 2 Personal Transformation Sphere through art. Last, research question 3 is systemised by Category 3 Peer collaboration through art. Table 4.1 shows the main content of each category and which interview questions were categorised.

Table 4.1

The list of interview questions per category

Category	Purpose	Question No.

Category 1	The Category 1 questions asked participants about their point of view on how they see art playing a role in telling them climate change knowledge.	Interview questions 1 to 4, 7 and 8
Category 2	The Category 2 questions asked participants how they think about their personal transformation if they are exposed to learning about climate change through art.	Interview question number 5
Category 3	The Category 3 questions asked participants to describe or imagine how they think about the role of art in peer collaboration development when learning science topics.	Interview question number 6

The transcripts revealed themes and patterns and were translated word by word into English from Vietnamese. The qualitative approach was necessary to understand the perceptions of participants.

4.2 Social-demographic distribution of the sample

4.2.1 Participant recruitment process

As a crucial requirement in gaining Ethics Approval for this study, Table 4.2 breaks down six steps of the participant recruitment process to find voluntary participants to join research activities.

Table 4.2

Six steps of participant recruitment

Step	Actions taken
Step 1 **Centre Searching**	Searching Centres which (1) have participants 16-18 years old attending occasionally or living, (2) are willing to cooperate with research activities of the study, and (3) have a physical location where we can organise the research activities. Creating a list of potential Centres which meet the three requirements above. Calling all potential Centres to find the most suitable Centres and ask for their contact for further steps. (Call Scripts of how I conducted my call to the Centres were in the Annex of this study)
Step 2 **Letter to Centre**	Once a confirmation through call was made, an email (letter) was sent to each Manager of each Centre for their official confirmation of their cooperation with the study and any questions they might have after having a call with researchers. A letter of support from each Centre was sent to me as evidence for the final Ethics Application of this study.

	A letter of support template was included in the Annex of this study.
Step 3 **Meeting with Centre**	An in-person meeting was held between each Centre and me to discuss the research's purpose, activities, the role of each participant and how we could cooperate during the research activities, and the schedule of all activities. The meeting's result was that each Centre sent the list of participants from their Centre to the research team.
Step 4 **Participant selection**	After receiving the list of participants from Centres, which mentioned their availability to join research activities, I created a list of potential participants for the survey activity and learning sessions. All participants were informed and agreed to join the last activity of the study: interview.
Step 5 **Meeting with participants**	I met with all participants of each Centre to discuss their role in this study, providing them with a participant information form (PIF) and participation consent form (PCF). Each participant acknowledged that their participation was voluntary. Each participant was required to read the PIF and sign their PCF.
Step 6 **Research activities**	Research activities were conducted as scheduled.

Establishing complete steps in recruiting research participants contributes to the effectiveness of communication and transparency between researchers and Centres. Specifically, answering the first questions from the managers of the Centres helps researchers identify potential partners for research in terms of relevance in the time of organization and the target audience. In addition, the establishment of professional cooperation between researchers and the Centres is the foundation for the successful organization of research activities because the Centre's learning rooms are where the researchers organise their research activities with participants.

4.2.2 Descriptive Statistics of Respondents and Uses of Instruments

In this study, we applied Solomon's four-group design. Four groups were assigned randomly based on their time availability and willingness to participate in research activities. As seen in the following Table, the number of participants in groups 1 and 2 is equal, while there is a very slight difference between group 3 (9 participants) and group 4 (11 respondents). However, there is a visible difference between the two genders: 32 male and 14 female participants. Table 4.3 presents the study's research design and the number of respondents based on gender per group. Figure 4.1 illustrates the number of boys and

girls joining each research activity, while Figure 4.2 gives us an overview of gender distribution in this study group.

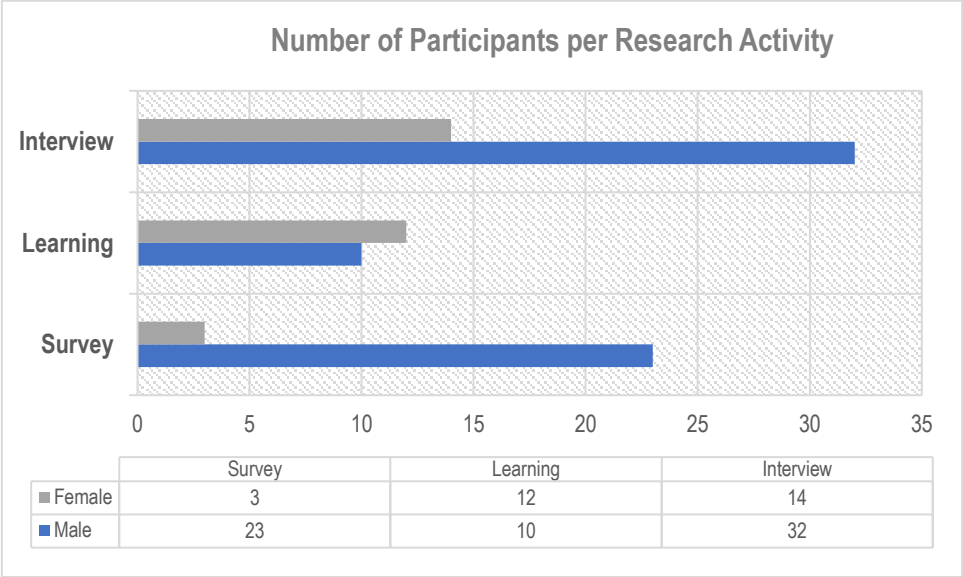
Table 4.3

Research design and the number of participants per activity and gender

	Group	Time (T) →					Number of Participants	Number of Participants per Gender	
		T1		T2		T3			
		Survey		Learning Sessions		Interview		Male	Female
Solomon Four-Group Design	Group 1	KAP of Climate Change	→	Climate Change Learning	→	Climate Change Interviews	13	10	3
	Group 2	KAP of Climate Change	→	-No Session-	→	Climate Change Interviews	13	13	0
	Group 3	-No KAP-	→	Climate Change Learning	→	Climate Change Interviews	9	0	9
	Group 4	-No KAP-	→	-No Session-	→	Climate Change Interviews	11	9	2
Number of male and female participants per research activity		Nmale = 23 Nfemale = 3		Nmale = 10 Nfemale = 12		Nmale = 32 Nfemale = 14			
In an ideal case - desired observed differences		No Difference		-		Significant Differences 1|2; 3|4 No Difference 1|3; 2|4	N = 46	Nmale = 32	Nfemale = 14

Figure 4.1

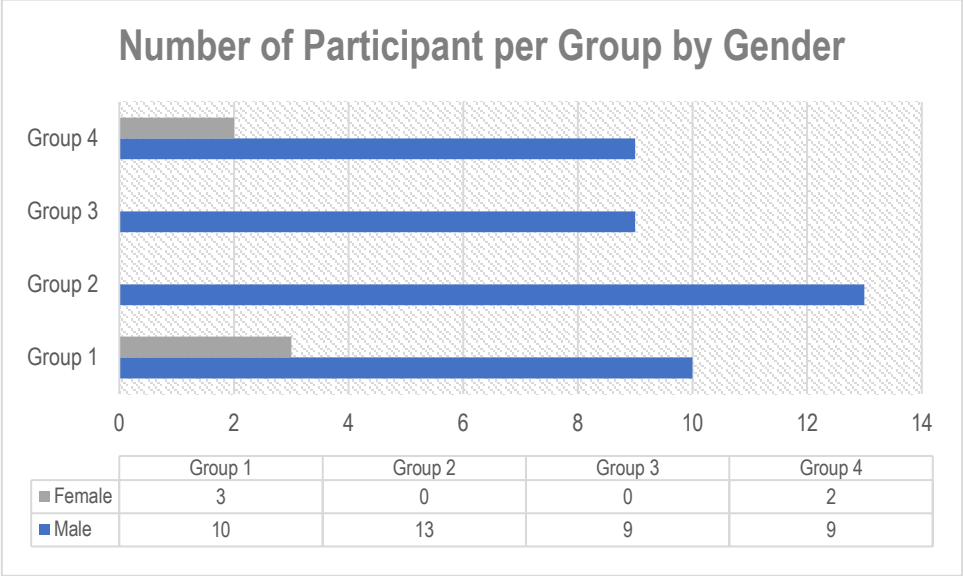
The number of both male and female participants per research activity



	Survey	Learning	Interview
Female	3	12	14
Male	23	10	32

Figure 4.2

Gender distribution in four groups of the study



	Group 1	Group 2	Group 3	Group 4
Female	3	0	0	2
Male	10	13	9	9

4.3 Data collection procedures

4.3.1 Knowledge Attitude Practice Survey Stages

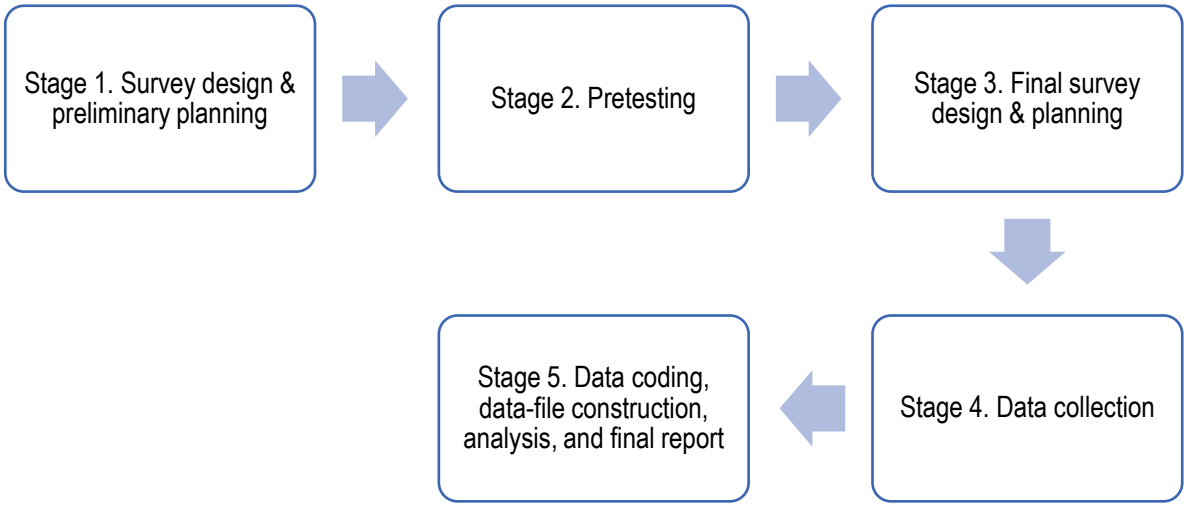
According to the research design presented above, the first two groups of the study received an invitation to join the pretesting - Knowledge Attitude Practice (KAP) survey. This KAP survey was designed to collect all the necessary information to help the researchers explore and identify participants' knowledge, attitudes towards climate change, and practices to be taken or considered helpful about climate change adaptation and their media preferences. More importantly, since this survey was to collect the respondents' knowledge, attitude and

practices toward climate change, the age group is 16-18 years old; closed-ended questions were offered with five-level Likert responses for their choices of answers instead of their own words. Another point to be considered was how to make the involvement of the participants quickly done and managed. It was solved by the friendly and professional rapport between the survey facilitator and respondents: they were free to give their answers since there are no right or wrong answers and to raise any inquiries when they found they did not understand the questions.

This survey was set up in face-to-face meetings with respondents. Twenty-six respondents from the first two groups joined face-to-face meetings with us. A setting of face-to-face meetings allowed the researcher to share the survey's intent, understand the level of awareness and concern towards climate change by participants, and explore future collaboration areas. To collect data from this KAP survey instrument, we presented five stages to design, plan and collect data from respondents, which we adapted from Czaja and Blair (2005). Figure 4.3 displays conceptual mapping for the data gathering and analysis process of the first research activity in this study.

Figure 4.3

Five stages of designing a survey



Note. Adapted from Czaja, R., & Blair, J. (2005). Designing surveys. Pine Forge Press, DOI: https://dx.doi.org/10.4135/9781412983877

We agreed with Czaja and Blair (2005) that data collection through a survey involves the researchers' persuasion of participants and showing active and collaborative social interactions between interviewers and them. The completeness of interviews and questionnaires depends on each individual's cognition, language comprehension and openness to cooperate with researchers. Since the primary purpose of surveys is to collect information (usually by questionnaire) (Czaja & Blair, 2005), applying Czaja and Blair's (2005) survey design stages to this study helps researchers to define the work to be done for a complete and standardized survey

design, to visualize the future scenarios and actions to be taken in order to finalise the design before putting it into practice.

4.3.1.1 Stage 1. Survey design and preliminary planning

At this stage of survey design, we reviewed the research and research design goals to ensure each stage aligned with the framework design. The Knowledge Attitude Practice (KAP) survey examined how many participants in one experimental group and one control group were aware of climate change and climate topics. A Knowledge Attitude Practice (KAP) survey was presented for the first phase of the data collection process, called the "pre-test activity".

The KAP survey was used for the first two groups according to Solomon's four-group research design as we applied it to this study: one experimental group and one control group. Although participants were designated randomly into two groups, the activities they joined were different. They both gave their answers to the KAP survey and attended the interview. However, group 1 had learning sessions, while group 2 did not have any learning sessions. The primary intention of the KAP at this stage was to evaluate how well participants were aware of climate change and their attitudes and practices toward this global problem. On the other hand, the crucial transformation development between the first two groups can be evaluated from the first interaction with the topic through the KAP survey to their interview performance and provide a good comparison of how participants demonstrated climate change awareness and understanding with and without learning sessions.

The survey was divided into three main sections, as mentioned in Chapter 2. The format of the five-level Likert items was used in this study per main sections, including:

- Knowledge of Climate change

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No information / Do not know

- Attitude on Climate change

1	2	3	4	5	99
Not at all important	Slightly important	Important	Fairly important	Very important	No information / Do not know

- Practices toward climate change

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No information / Do not know

4.3.1.2 Stage 2. Pretesting

A questionnaire was designed, piloted and reviewed by the primary research supervisor. According to Czaja and Blair (2005), we should consider two aspects of questionnaire development. First, researchers must do a "rehearsal" of the questionnaire before collecting the data. It is considered one of the essential components of a survey. Due to the age group joining this research from 16-18, all questions must be clear to be within their awareness and experiences and should not be too long and complicated. It ensured that the respondents understood the questions and that what I wanted to do was feasible.

The second aspect with which data collectors should concern is the questionnaire length. At the beginning of designing our KAP survey, the first draft was too long to work on a respondent. Since the main aim of the KAP survey is to access participants' knowledge, attitude and practices toward climate change, we had anticipated problems and questions based on three main sections to ensure that "if the questions are answered, the data are valid" to avoid any faulty assumption.

Lastly, since all respondents speak Vietnamese, the KAP survey needed to be understandable, considering that all resources were used in English to design the survey. We revised the questionnaire survey structure, translated it into Vietnamese, and repeated it until it was comprehensible. The designed questions utilised terms the respondents would understand to prevent misinterpretation or confusion.

4.3.1.3 Stage 3. Final survey design and planning

During this stage, final amendments were made to all documents and materials used for the data collection with participants and a list of participants joining the survey to get the desired number of completed surveys.

4.3.1.4 Stage 4. Data collection

After gaining ethics approval for this research, we commenced collecting data. The activity was the KAP survey with two groups. Our field notes data confirmed the following:

1. Ensured no questions were missed and complete information was obtained through suggestions to check their KAP form and kindly asking them to complete missed questions/questions they had not finished.
2. Minimised attrition. Through establishing a transparent and clear mindset of working with respondents, their participation is voluntary and highly encouraged for the study's results. Researchers must ensure that the research's purpose and objectives are communicated clearly and that any ideas and sharing from their side are welcome.

4.3.1.5 Stage 5. Data coding, data-file construction, analysis, and final report

The final stage of our data collection through the KAP survey included coding, analysing the data and presenting the survey results. The survey results will be illustrated in the following parts of this chapter.

4.3.2 Learning Sessions. Procedures of learning activities

The detailed learning sessions are in the Appendix of this thesis. In this section, I only focused on the flow of each learning session and how I conducted each learning session. Although each session had the same structure with five parts - ***5K*** (in Vietnamese: Khởi động, Kiến thức, Kiến tạo, Kết nối, Kết thúc) which were translated into English as ***5C***, *Commencement, Cognisance, Creation, Connection,* and *Closure* respectively to provide participants with a piece of basic solid knowledge about climate change, there were a variety of flexibilities based on participants' interest and concerns and media to be used per session which led to more often two-way communication between themselves and their peers along with the facilitator.

4.3.2.1 Learning session 1. Climate change effects and causes

In the first learning session, we aimed to give participants the first overview of climate change to help them understand and raise awareness and understanding of its effects. Furthermore, we also gave knowledge of climate change causes to help them recognise how human's activities are causing climate change. Table 4.4 comprises five steps and the content of each step during the first session of learning facts about climate change and ecological footprint drawing and sharing activities.

Table 4.4

A detailed description of the learning session 1 "Climate change effects and causes."

No.	Step	Content
1.	Commencement	Yes/No questions about climate change are asked to increase participants' concentration and interest in the session topic.
2.	Cognisance	Some facts about climate change and its causes are given during the sessions, not only by lecturing but also through videos.
3.	Creation	Assignment: My ecological footprint With the support of an instructor, participants are invited to participate in calculating their ecological footprint through https://www.footprintcalculator.org/home/en and talk about their ecological footprint results. The activity is continued by drawing a picture of their Eco Footprint, stating the solutions the participant thought they could implement in the community. Participants take turns sharing their ideas with the study group members.
4.	Connection	Connecting exercise: Write a reflective journal The instructor provides instructions on how to complete the reflective journal for participants.

No.	Step	Content
5.	Closure	Summary of today's lesson. Briefly describe the activity of the upcoming class, time and preparations.

4.3.2.2 Learning session 2. Climate change investigation

In the second learning session, the facilitator's main task was to encourage participants to imagine their role as investigators to act for climate change and discover how people know it. Table 4.5 portrays five steps of the second learning session about Earth facts and participants' imagination of an ideal Earth.

Table 4.5

A detailed description of the learning session 1 "Climate change investigation."

No.	Step	Content
1.	Commencement	Quick facts about Earth to activate participants' interest in the new topic of Earth.
2.	Cognisance	Facts about Earth are given, including: - Earth in the Solar System - Earth's orbit - Earth's rotation - Earth's atmosphere - Earth's surface
3.	Creation	Assignment: Earth investigator! Each participant uses their imagination and available materials to create the Earth and convey the message of protecting the Earth from the effects of climate change. This activity can be done independently or in pairs. Each participant presented their model of the Earth and the message through their creation.
4.	Connection	Connecting exercise: Write a reflective journal The instructor provides instructions on how to complete the reflective journal for participants.
5.	Closure	Summary of today's lesson.

No.	Step	Content
		Briefly describe the activity of the upcoming class, time and preparations.

4.3.2.3 Learning session 3. Climate change actions

In the next learning session, we presented information on how our nature has been destroyed by climate change throughout the years by showing photos of several locations affected by climate change. Through a provision of actions to protect themselves and their families from climate change, this session was expected to encourage participants to take action against climate change and come up with their ideas to reduce the negative impacts of climate change and raise other people's awareness. Table 4.6 depicts a detailed process of conducting this session with participants.

Table 4.6

A detailed description of the learning session 1 "Climate change actions."

No.	Step	Content
1.	Commencement	A quick overview of the previous lesson
2.	Cognisance	Images of change Six pairs of photos of 6 locations on Earth under climate change impacts are shown. Participants are encouraged to name crucial changes per location through the years.
3.	Creation	Part 1. Question of the day: What can you do to reduce the impact of climate change? Participants thought and expressed ideas about actions to respond to climate change. The instructor introduces a few examples that participants can practice at home. These guidelines are based on the UN Act Now Guide. The facilitator introduces action topics (information cards) for participants to get more ideas. Part 2. Question of the day: Do you enjoy creating dynamic visual content to tell a specific story? You can share and express your thoughts on how you can take action to respond to and mitigate the impacts of climate change.

No.	Step	Content
		Imagine you are a climate activist. You make a model or product to present your ideas using art tools. All ideas are welcome!
4.	Connection	Connecting exercise: Write a reflective journal The instructor provides instructions on how to complete the reflective journal for participants.
5.	Closure	Summary of today's lesson. Briefly describe the activity of the upcoming class, time and preparations.

4.3.2.4 Learning session 4. Climate change exhibition

After three learning sessions, in the last one, in the beginning, we concluded all knowledge we shared with them about climate change during the last three learning sessions. Then, we invited each of them to present their ideas to the rest of the group portrayed in their artwork. Last but not least, once all presentations were invited, we arranged the interview time frame suitable for each participant and looked forward to having their participation in the last stage of this study - the interview. Table 4.7 presents how we conducted our last learning session with participants.

Table 4.7

A detailed description of the learning session 1 "Climate change exhibition."

No.	Step	Content
1.	Commencement	Participants shared the most impressive things about the past sessions.
2.	Cognisance	The instructor summarises the knowledge of the past lessons.
3.	Creation	Each participant is encouraged to share their story and ideas through their work.
4.	Connection	Connecting exercise: Write a reflective journal The instructor provides instructions on how to complete the reflective journal for participants.
5.	Closure	Summary of all learning sessions. Briefly describe the activity and arrange the interview time frame for each participant.

4.3.3 Interview stages

The in-depth interview stages in this study were adapted from Ritchie and Lewis (2003) to get the most insightful inputs from the respondents and create a professional rapport between the researchers and participants. According to Ritch and Lewis (2003), the main task of qualitative researchers is to bring the interviewee from their daily communication and "social level" to "a deeper level" at which they can concentrate on the topic of the interview and express their opinions. The researcher must ensure that (s)he must complete the interview questions as planned before leaving the participant.

The list of eight questions includes the following:

1. The global climate is changing. What do you think about this statement?

2. Climate change is caused by natural factors, human actions or both. What do you think about this statement?

3. How will you feel if you and your family are affected by climate change?

4. How will you feel if you are responsible for reducing climate change?

5. How will you feel if art can contribute to telling you more about climate change?

6. How will you feel if art-based science learning activities can develop your cooperation with your teammates?

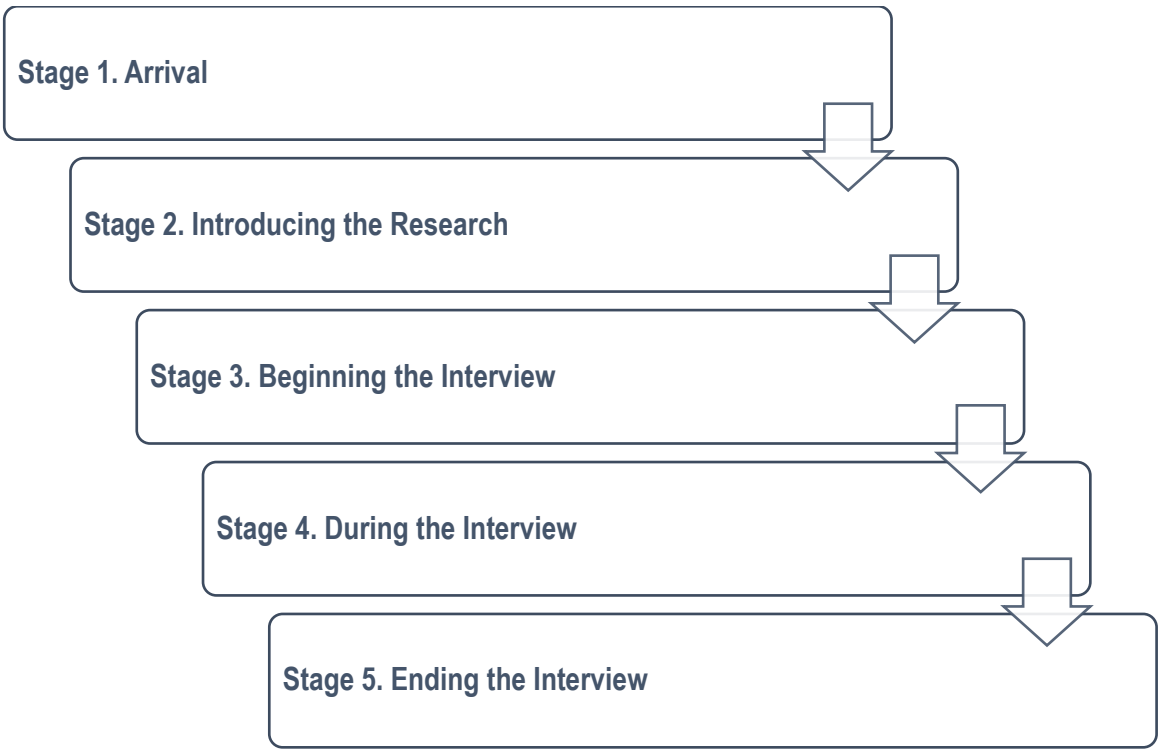
7. What will happen if we do nothing?

8. What will you do to cope with climate change?

In this study, we adopted Ritchie and Lewis's interview stages (2003). Figure 4.4 illustrates six stages of the interview. By applying Ritchie and Lewis's six stages (2003), we established a professional rapport with interviewees, providing them with a space where they knew that all they said during the interview was only for the research purpose with the highest confidentiality.

Figure 4.4

Six steps of conducting an interview



Note. Adapted from Ritchie, J., & Lewis, J. (2003). Qualitative Research Practice - A Guide for Social Science Students and Researchers. London, Thousand Oaks, CA: Sage Publications Ltd.

4.3.3.1 Stage 1. Arrival

Our arrival at the Centre was scheduled, and each respondent was informed of our interview time. Before officially asking interview questions, we gave the respondent two forms: A participant Information Form and a Participant Consent Form for their reading. Once they read the two given forms carefully, we gave them the most appropriate answers to questions raised by their side. Once they understood and felt satisfied with our answers. I started to set up our camera. The interview process began right after we finished our camera setting for recording and filming the interview. The audio and visual recording were done after the participants had obtained permission.

The first few minutes were crucial and a key factor for a successful in-depth interview, as we could establish trust between the researcher and the participant. We knew it was helpful to ask them how they were today and about their school day to put them at their ease. Our role at this stage was a guest talking to the participants in a confident and relaxing approach and getting into a conversation naturally but "avoiding the research topic" until the interview began. The interviews only started and moved to stage 2 once the participant said that (s)he felt comfortable.

4.3.3.2 Stage 2. Introducing the research

At this stage, we introduced the research topic and the research's background and purpose, reaffirmed confidentiality and data privacy, and asked the participants' permission to videotape the interview. We also ensured the environment was private, quiet and comfortable for the interview to proceed without distraction.

4.3.3.3 Stage 3. Beginning the interview

To allow the conversation between the participant and researcher to flow more freely, we mentioned some ground rules:

1. There are no right or wrong answers, only different opinions.
2. Only one person will speak at a time.
3. It is a confidential discussion because I will not report the participant's name or who said what.
4. The interview will be recorded. We want to concentrate on what we share and not distract ourselves from taking notes and other outside factors. We do not identify anyone by name in our report. Participants and his/her provided information will remain anonymous.
5. The participant can have a break if (s)he thinks (s)he needs it, and (s)he just lets me know when (s)he is ready to continue the talk.

Before we started, we invited participants to let us know what names they wanted to be identified with us: a pseudo name or their real name. An icebreaker question followed this for their great imagination: What would it be if you could have a superpower? Why?

According to Ritchie and Lewis (2003), in the middle of the interview, researchers can change the flow of the conversation by asking for “factual background information”. Additionally, the opening questions about their age, hobbies, and favourite subjects allow researchers to encourage interviewees to understand that their role is to unlock themselves and talk about their opinion since there is no wrong or correct answer and give complete answers. These questions are asked to make respondents feel they are not attending an interview with a formulated list of questions.

4.3.3.4 Stage 4. During the interview

This was the main section of the interview, where I asked participants questions and listened carefully to their answers. Moreover, each question was explored in depth. When participants did not give a complete answer, some follow-up probe questions that started with "*Why…*" and "*How…*" were applied to receive a better understanding. At this stage, the interviewees and the interviewer worked together at a deeper, more focused level than usual. This stage aimed to discover participants' ideas, thoughts, and feelings about given questions.

4.3.3.5 Stage 5. Ending the interview

It was a signal for both sides: the respondent and me, that we were approaching the end of the interview, which allowed the interviewee "*gradually to return to the level of everyday social interaction*" (Ritchie & Lewis, 2003). Useful phrases were used, including: "*now we are coming to the last topic of our talk today*", or "*Great! I only*

have one more question for you". It was vital to check whether participants had any comments or thoughts unexpressed about the previous questions or their interest in sharing more.

When the camera was switched off, we thanked the participant for their participation and time involved in the interview and moved the atmosphere from the interview context to the out-of-interview mode by saying how crucial their contribution was and how it would support the research. The use of the interview data and confidentiality was mentioned again. What I told them after the interview was:

> "Thank you for spending time with us today and discussing climate change. Your thoughts and comments have given us many different ways to see this issue."

The interview was completed, and the participants left the interview space feeling 'well'.

4.4 Qualitative data analysis

4.4.1 Five stages of qualitative data analysis

In this study, we adopted Pope and Mays's five stages of data analysis (2006). According to Pope and Mays (2006):

> First, the researcher familiarises him/herself with the data by reading and rereading the notes and transcripts. He/she then creates a list of the anticipated and emerging themes that can be placed within a thematic framework – a series of thematic headings sorted hierarchically into main and sub-themes. These headings are used to label or index the original data (some analysts assign numbers to the various headings to facilitate this, while others use words or phrases). The initial thematic framework and index terms are likely to be refined as the analysis progresses, and it is important to record this developmental work. Once the themes have been identified, they are grouped and sorted, and the original data are distilled into summaries and used to create charts. These describe each theme in a matrix format, displaying sub-themes across the columns and each case as a separate row. These charts can be created on large sheets of paper or using a spreadsheet or data-management software.

Pope and Mays's (2006) five data analysis stages were adopted in this study, including familiarisation, identifying a thematic framework, indexing, charting, and mapping and interpretation. For the study, we used the "MAXQDA" data-management software for our qualitative data analysis and visualising code map and word matrix. A detailed description of the MAXQDA data management software and reasons for deploying it in the present study is available on page 65, section 4.4.1.2 of this study.

4.4.1.1 Stage 1. Familiarisation

By listening to recordings, reading transcripts made from recordings and re-experiencing the interviews, we could transfer raw data to actual data, which we used for the data analysis process discussed in the next chapter.

Firstly, we listened to 46 interviews digitally recorded and did the task of interview transcripts. Through careful listening and reading, all transcripts were written verbatim to identify the collected data's core ideas, concepts, stories, and themes. We also reread the first chapters of this thesis, objectives and research questions of the study and created a map of which interview questions gave insights into which research question. This way, we re-experienced how the interview was meaningful for each participant to share and express their point of view, especially to realise how different it was for those attending learning sessions and without any learning sessions. The process of re-listening and rereading the transcripts and research proposal was the foundation of defining the main themes used for this study. It aided the familiarisation process, giving us a closer connection and better understanding to immerse ourselves in the data analysis and interpretation.

4.4.1.2 Stage 2. Identifying a thematic framework

This stage was to identify the key themes and codes by which the data can be analysed, interpreted and referenced. The main concepts of the framework approach in this study are derived from the research gaps, literature review, research questions and objectives - prior knowledge, and insights raised by respondents themselves.

MAXQDA is a Computer Assisted Qualitative Data Analysis Software (CAQDAS) designed for analysing qualitative and mixed methods data, text and multimedia in academic, scientific, and business institutions (Marjaei et al., 2019). It is being developed and distributed by VERBI Software based in Berlin, Germany and has been accessible since 1989. As a professional software for qualitative and mixed methods data analysis, MAXQDA offers users tools to analyse all data types such as interviews, articles, media, surveys, Twitter and more. From our experiences of analysing data collected from interviews, using MAXQDA effectively assisted our text (words and paragraphs) analysis while handling different interview documents simultaneously with different viewpoints and thoughts from 46 participants. The exemplary interface of MAXQDA helps researchers engage systematically (Barkhuizen & Consoli, 2021) in reflexive practice while being immersed in the already complex dimensions of narrative inquiry.

We conducted a process of discerning recurrent themes and ideas and linking these to a conceptual framework. The conceptual framework of this study was drawn upon issues introduced from a priori knowledge, as mentioned above. It was followed by the kick-off of categories and subcategories when developing a framework. More importantly, we reread the transcripts to find a deeper level of insightful growth of ideas and repeated themes and codes assigned in the text. Using MAXQDA, we conducted a systematic qualitative content analysis from each interview, including parent codes and sub-codes per each parent code. The "Code System", displayed in the next part of this chapter, represents the root of our system of codes, or hierarchical "Code Tree". From this foundation, we built up a system of categories from this point. Moreover, the transcripts of all interviews were cross-checked with subject experts to validate data.

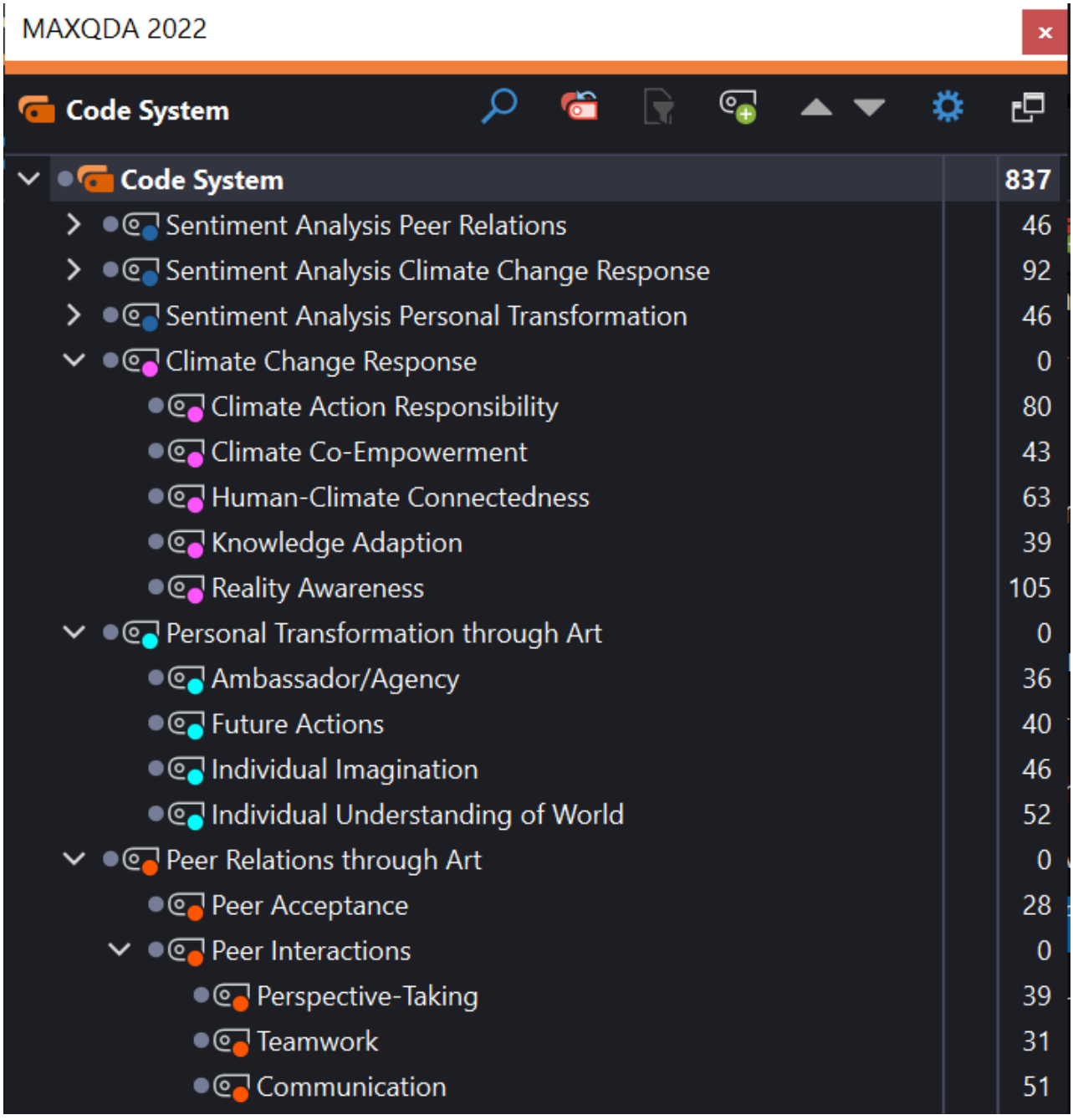
Three key themes were found in this study based on three research questions, including (1) climate change response, (2) personal transformation through art and (3) peer relations through art. These three themes were indexed, and codes tagged to the transcripts' data were allocated.

4.4.1.3 Stage 3. Indexing

Since we applied MAXQDA in analysing qualitative data of this study, this stage involved displaying coded segments in the "Code System". Indexing helps researchers calculate how many coded segments are assigned to a specific code. Figure 4.5 gives an overview of the code system used in this study and how parent codes and sub-codes are connected, and colour-coded textual terms led to the development of charts in this study.

Figure 4.5

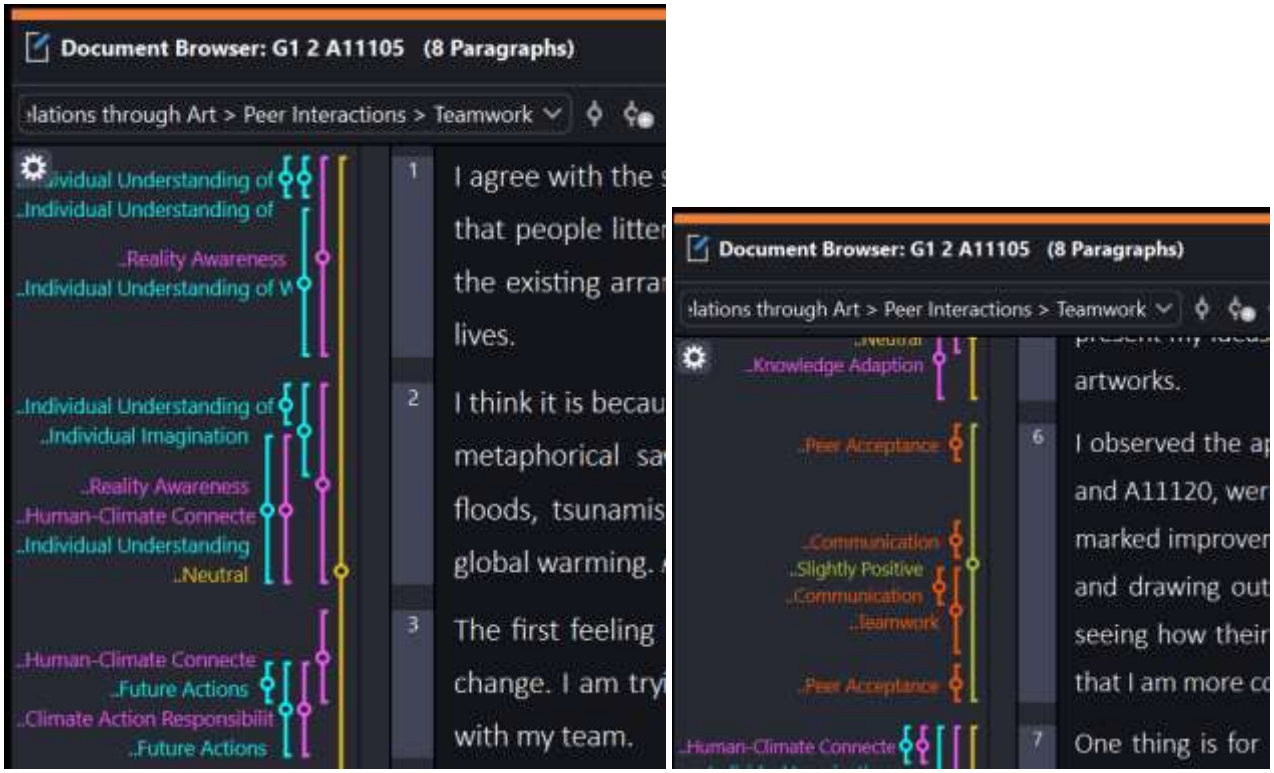
An indexing arrangement of code system in MAXQDA



All parent codes and sub-codes were defined, and the raw data were coded in the same approach (as in Stage 2). Applying MAXQDA in this research helped us save more time because we selected part of a text in each participant interview, and all selected text passages were recorded in the margin of the text in the colour of the parental codes. Figure 4.6 shows how each code was assigned in each text part in different colours.

Figure 4.6

An example of colours of codes concerning text parts

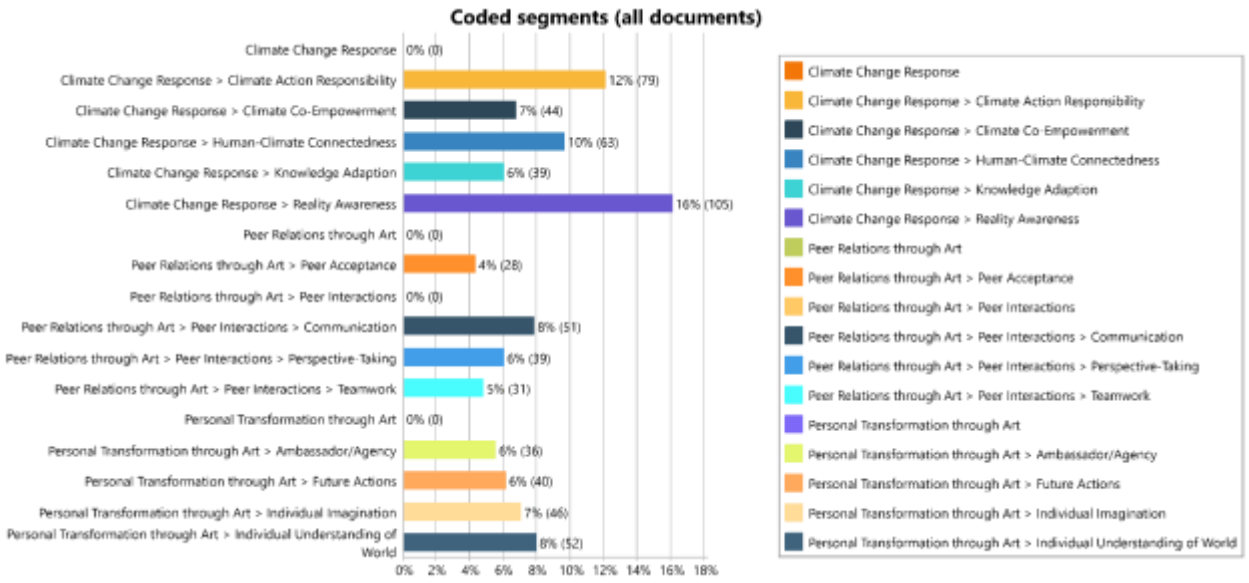


4.4.1.4 Stage 4. Charting

The charting process by applying MAXQDA in this study showed an overview of codes of all documents from four groups with entries for several respondents. Figure 4.7 summarises three activated parent codes in this study: Climate Change Response, Personal Transformation through Art and Peer Relations through Art. The overview in Figure 4.4.3 answers how often each sub-code of three parent codes was assigned to all documents.

Figure 4.7

Coded segments in 46 documents

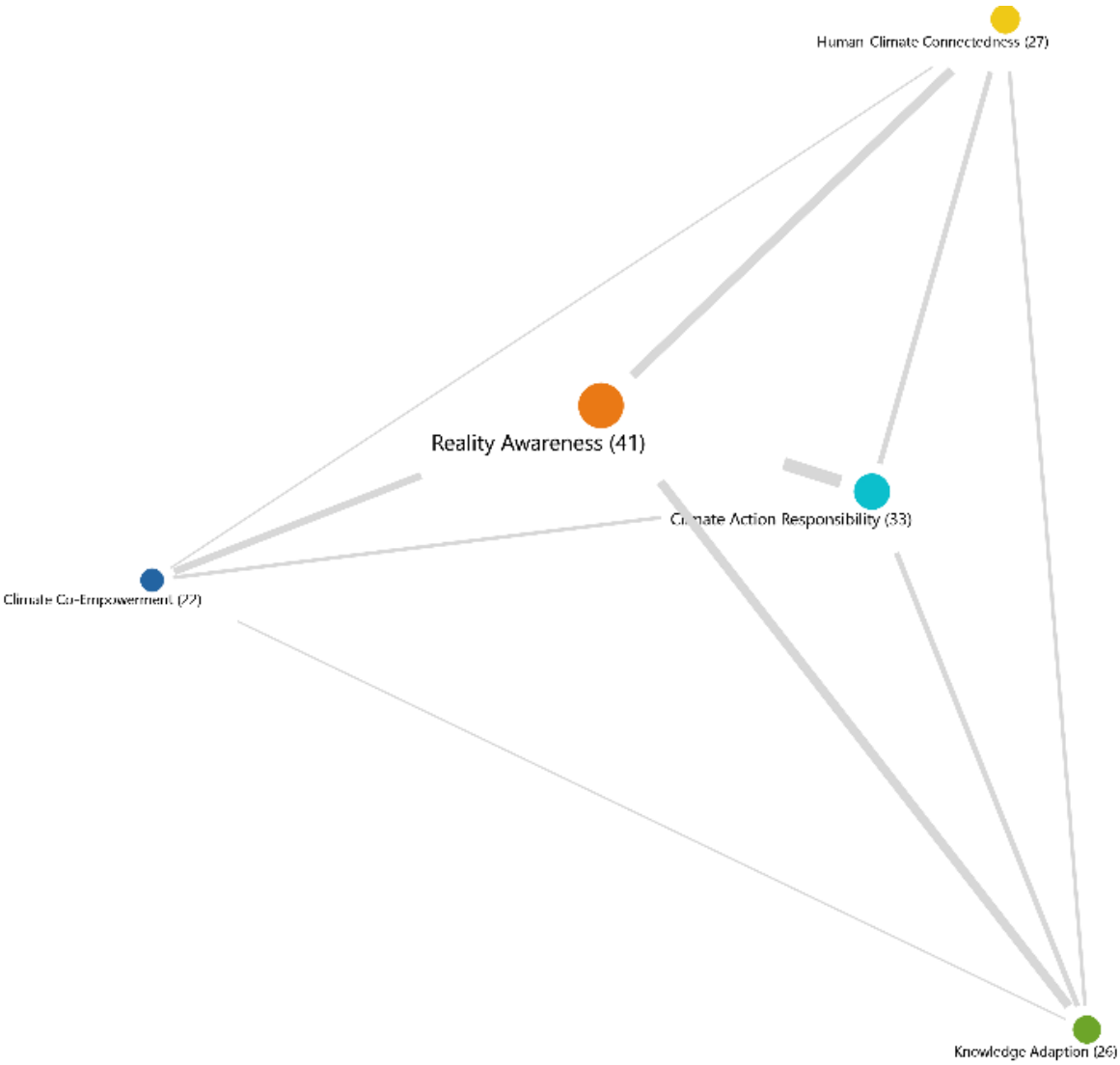


4.4.1.5 Stage 5. Mapping and interpretation

The "Code Map" was used as a technique to present connections within sub-codes of each parent code by using tools in MAXQDA, providing a visual platform of all sub-codes and providing explanations for the findings. Since we defined three parent codes and sub-codes under each parent code, using "Code Map" in MAXQDA helped us find interdependence between sub-codes with a viewable outlook to explain the findings. For example, Figure 4.8 connects all sub-codes of the parent code "Climate Change Response" of Group 1. As shown in Figure 4.8, the sub-code "Reality Awareness" plays a central role and has the most crucial impact on other sub-codes of the parent code. The sub-code "Climate Action Responsibility" plays the second most important role after the sub-code "Reality Awareness". Each colour was set for each sub-code for a better overview of the code map of the parent code in Group 1.

Figure 4.8

Code Map of sub-codes under "Climate Change Response" parent code of Group 1


Human Climate Connectedness (27)
Reality Awareness (41)
Climate Action Responsibility (33)
Climate Co-Empowerment (22)
Knowledge Adaption (26)

4.4.2 Code System

4.4.2.1 Definition of Code System

The code system of this study was based on three research questions. In the next part, we presented how we described parent codes and clarified the sub-codes of each parent code. Furthermore, we also gave some examples of how text parts of each interview were selected for each sub-code. There are three research questions in this study:

1. What is the use of art involvement to transform climate change response in adolescents?
2. To what extent do art-based techniques contribute to participants' personal transformation sphere?
3. To what extent does the potential of an art-science partnership galvanise changes in study participants' relationships with peers?

Three tables below classify how we define sub-codes of each parent code, and some data extracts are presented to show how text parts were selected per sub-code. As stated previously in the first two chapters of this thesis, as well as in the part where we stated how to identify a thematic framework, the main concepts of the study's framework in this study are based on the research gaps, literature review, research questions and objectives - prior knowledge, and insights raised by the respondents themselves. Tables 4.8 - 4.10 enumerate four contents: (1) parent code, personal transformation through art and peer relations through art as the primary keyword of question 1, question 2 and question 3, respectively; (2) description of how we define sub-codes of each parent code; the last two columns present each sub-code with each text part as data extracts.

Table 4.8

The central concept of "Climate Change Response" for research question 1: What is the use of art involvement to transform climate change response in adolescents?

Parent Code	Description	Sub-codes	Data extracts *(examples)*
Climate Change Response	The climate change response of respondents within the context of this study is divided into five clusters based on transformative qualities systemised by Wamsler et al. (2021), including Awareness, Insight, Connection, Purpose and Agency. Moreover, by deeply reading all 46 interviews from four groups, some terms have been rephrased into other words to connect well with the insights collected from the interviews. The five sub-codes of the parent codes are: - Reality Awareness - the communication, openness and opinion sharing to the current reality of the climate change	**Climate Action Responsibility**	I think I will do small actions such as not littering and saving electricity (G1 1 B11102, Pos. 8) "I will not litter indiscriminately, keep the standard hygiene and not waste water. (G2 3 C10107, Pos. 4) I will change my habits by saving electricity and water and spreading what I have learnt before to everyone (G3 2 C01112, Pos. 8) If I can do something, I will sort garbage like my family does (G4 2 D00111, Pos. 8)
		Climate Co-Empowerment	I am trying to communicate with everyone by making posters and media articles with my team. (G1 2 A11105, Pos. 3) advise my family and the people around me that they should not throw garbage into the river to limit river pollution and save more electricity. (G3 8 C01138, Pos. 8)
		Human-Climate Connectedness	Human activities cause earthquakes, floods, tsunamis, air pollution, ozone depletion, and the greenhouse effect, leading to global warming. As a result, the ice melts, and the water level rises, leading to a tsunami. (G1 2 A11105, Pos. 2)

Parent Code	Description	Sub-codes	Data extracts *(examples)*
	- Human-Climate Connectedness - the concept of showing feelings and thoughts about the interdependence between the individual and the nature - Knowledge Adaption - the insights, willingness to take new perspectives and acceptance of different ways of knowing - Climate Action Responsibility - the self-reflectivity of one's values, purpose, intentions, action-taking and responsibilities toward climate change - Climate Co-Empowerment - the concept of sharing knowledge, enhancing cooperation, co-creation of promoting actions toward climate protection		I will feel confused and scared. I think I will feel uncomfortable with the temperature. It seems unfair to me. (G2 2 B10104, Pos. 3) I feel uncomfortable because of the heat. I have a feeling that my health will be adversely affected. (G3 4 C01125, Pos. 3)
		Knowledge Adaption	Pictures helped me visualise climate change impacts and tell me climate change actions which I can apply to my life more (G1 3 B11114, Pos. 5) I was impressed with the Ecological Footprint lesson. Learning through art helped me have a better understanding of climate change topics, and I gained new knowledge. (G3 4 C01125, Pos. 5)
		Reality Awareness	I think human factors cause climate change - activities such as felling trees, deforestation, and littering. (G1 4 B11115, Pos. 2) Human activities include cutting down trees indiscriminately, encroaching on forests, and releasing too much gas into the environment. (G3 9 C01140, Pos. 2)

The first parent code, "Climate Change Response", includes five sub-codes: Reality Awareness, Knowledge Adaption, Human-Nature Connectedness, Climate Co-Empowerment and Climate Action Responsibility.

Table 4.9

The central concept of "Personal Transformation through Art" for research question 2: To what extent do art-based techniques contribute to participants' personal transformation sphere?

Parent Code	Description	Sub-codes	Data extracts
Personal Transformation through Art	As defined in the literature review, the personal sphere of transformation is subjective beliefs, values, worldviews, and paradigms influence how people perceive, define or constitute systems and structures, as well as their behaviours and practices. The personal sphere of transformation represents both individual and shared understandings and assumptions about the world influence perceptions, interpretations and constructions of reality. Within this study's data analysis and research questions, and literature review, we present four sub-codes for the parent code "Personal Transformation through Art." - Individual Understanding of the World - The concept of subjective belief, values, understanding and interpretation of the world - Individual Imagination - the concept of the subjective imagination, self-reflection about their world concerning climate change	**Ambassador/Agency**	sharing messages with friends and family (G1 1 B11102, Pos. 8) take action so that everyone can see my responsibility. (G1 2 A11105, Pos. 4)
		Future Actions	Using water sensibly and not wastefully, using recyclables and reducing plastic (G1 11 D11142, Pos. 8)
		Individual Imagination	if we do not act, our Earth will worsen. More natural disasters will directly affect people, and people's quality of life and living environment will become increasingly degraded. (G1 1 B11102, Pos. 7) The Earth is destroyed. Trees perished, and soil eroded. There is no food left and no place for us to live. There is nothing left. (G3 2 C01112, Pos. 7)

Parent Code	Description	Sub-codes	Data extracts
	- Future Actions - the concept of subjective perceptions, seeing themselves and their world and action orientation in the future - Ambassador/Agency - the concept of sharing knowledge and actions with others, being a pioneer in their community to create positive changes and boost cooperation.	**Individual Understanding of the World**	Learning this way helped me grow to understand more about solutions to reduce the impact of climate change (G3 9 C01140, Pos. 5) Because nature itself is so predestined, the process of human activities on nature has changed nature a lot, especially with the warming of the Earth. (G1 2 A11105, Pos. 7)

The first parent code, "Personal Transformation through Art, " includes four sub-codes: Individual Understanding of the World, Individual Imagination, Future Actions, and Ambassador/Agency.

Table 4.10

The central concept of "Peer Relations through Art" for research question 3: Research question 3. To what extent does the potential of an art-science partnership galvanise changes in study participants' relationships with peers?

Parent Code	Description	Sub-codes (1st level)	Sub-code (2nd level)	Data extracts
Peer Relations through Art	According to Fredricks and Simpkins (2013), "adolescents' peer relations are the outcome or the result of adolescents' participation in organised activities". In this study, we present our findings of peer relations through art by reading through all data collected from 46 interviews of four groups. The sub-codes (level 1 and level 2) are adapted from Fredricks and Simpkins (2013) with interview findings: - Peer acceptance - the concept of being accepted as an individual within the group when participating in team activities and group discussions and exposing themselves to different views. - Peer interactions - the concept of working together as a team, learning, giving and taking feedback,	**Peer Acceptance**		I am more confident and dare to share my feelings and ideas. (G1 2 A11105, Pos. 6) feel more connected with friends (G1 1 B11102, Pos. 6)
		Peer Interactions	**Perspective-Taking**	Share ideas and spread my message of environmental protection. (G1 1 B11102, Pos. 6) gave me some comments and raised questions about my presentation and artwork (G1 12 A11144, Pos. 6)
			Teamwork	better interacting with them and seeing how their progress has improved (G1 2 A11105, Pos. 6)
			Communication	breezily speaking and expressing their own opinions (G1 2 A11105, Pos. 6) interacted and talked with my friends better in the past lessons. (G1 5 B11117, Pos. 6)

Parent Code	Description	Sub-codes (1st level)	Sub-code (2nd level)	Data extracts
	enhancing communication skills, and responsibility delivery.			spread my messages and communicate with my friends. (G1 5 B11117, Pos. 6) more confidence in communicating with friends (G1 1 B11102, Pos. 6)

The first parent code, "Peer Relations through Art", includes two sub-codes, Peer Acceptance and Peer Interactions, with three sub-codes, including Perspective-Taking, Teamwork and Communication.

4.4.2.2 Code System Table

We used MAXQDA to code all data collected from 46 interviews. The code system of this study is divided into two main parts:

- Part 1 is about sentiment analysis which was coded automatically by MAXQDA.

The sentiment analysis by MAXQDA means that each interview's content was evaluated automatically and coded with sentiments for addressing the differences between experimental and controlled groups. The text is sorted and filtered according to participants' sentiments. Using MAXQDA, we attained the sentiment analysis for the qualitative data. We applied the "Smart Coding Tool" in MAXQDA, which uses a lexicon to calculate and assess each word's sentiments. This value is negative for words with negative meanings, close to zero for neutral words and positive for words with positive meanings.

For example:

1. Statements "I found it very useful. "It was terrific.", "Art helped our experiences with learning become more attractive, closer and more accessible", "Art helped us to understand more when learning new topics", etc., are classified as positive.
2. Statements "Climate change is caused by people, factories, and the lack of human consciousness". "For example, indiscriminate waste and factory emissions lead to an increase in temperature", and similar responses are considered neutral.
3. Statements "The situation will not get any better". "More storms and floods". "I cannot imagine anything else", etc., are classified as negative.

The sentiment analysis below presents three parent codes based on our three parent codes.

- Part 2 is about working on coded segments (in this context, we worked with text parts of each interview). This work was done and controlled by the researcher. Since we had three parent codes, the main task of the researcher was to read each text part of each interview to match which text part was for which sub-codes. This work required a significant amount of time. During the coding process, we built a network structure of codes to be used by coding selected segments within a document and coding them by dragging them onto a code in the network map and calculating the codes' frequency.

The Code System Table 4.11 summarises how often a code is repeated. Apart from the automatic evaluation of the sentiment analysis, the second part of the code system helps us collate the participants' understanding: the more frequent a sub-code is, the more critical it is in connection with other sub-codes of the parent code.

Table 4.11

Code System and Code Frequency

Code System	Frequency
Code System	823
Sentiment Analysis Peer Relations	
Sentiment Analysis Peer Relations > Positive	4
Sentiment Analysis Peer Relations > Slightly Positive	29
Sentiment Analysis Peer Relations > Neutral	9
Sentiment Analysis Peer Relations > Slightly Negative	3
Sentiment Analysis Peer Relations > Negative	1
Sentiment Analysis Peer Relations > No sentiment	0
Sentiment Analysis Climate Change Response	0
Sentiment Analysis Climate Change Response > Positive	0
Sentiment Analysis Climate Change Response > Slightly Positive	13
Sentiment Analysis Climate Change Response > Neutral	68
Sentiment Analysis Climate Change Response > Slightly Negative	9
Sentiment Analysis Climate Change Response > Negative	2
Sentiment Analysis Climate Change Response > No sentiment	0
Sentiment Analysis Personal Transformation	0
Sentiment Analysis Personal Transformation > Positive	5
Sentiment Analysis Personal Transformation > Slightly Positive	32
Sentiment Analysis Personal Transformation > Neutral	6
Sentiment Analysis Personal Transformation > Slightly Negative	1

Code System	Frequency
Sentiment Analysis Personal Transformation > Negative	2
Sentiment Analysis Personal Transformation > No sentiment	0
Climate Change Response	0
Climate Change Response > Climate Action Responsibility	72
Climate Change Response > Climate Co-Empowerment	42
Climate Change Response > Human-Climate Connectedness	64
Climate Change response> Knowledge Adaption	27
Climate Change Response > Reality Awareness	105
Personal Transformation through Art	0
Personal Transformation through Art > Ambassador/Agency	38
Personal Transformation through Art > Future Actions	41
Personal Transformation through Art > Individual Imagination	48
Personal Transformation through Art > Individual Understanding of World	53
Peer Relations through Art	0
Peer Relations through Art > Peer Acceptance	28
Peer Relations through Art > Peer Interactions	0
Peer Relations through Art > Peer Interactions > Perspective-Taking	39
Peer Relations through Art > Peer Interactions > Teamwork	31
Peer Relations through Art > Peer Interactions > Communication	51

4.5 Research findings

4.5.1 FINDINGS FROM THE KAP SURVEY

The KAP survey was only conducted with 13 participants of Group 1 and 13 participants of Group 2. In this section, we present the findings from the KAP Survey.

4.5.1.1 Knowledge of Climate Change

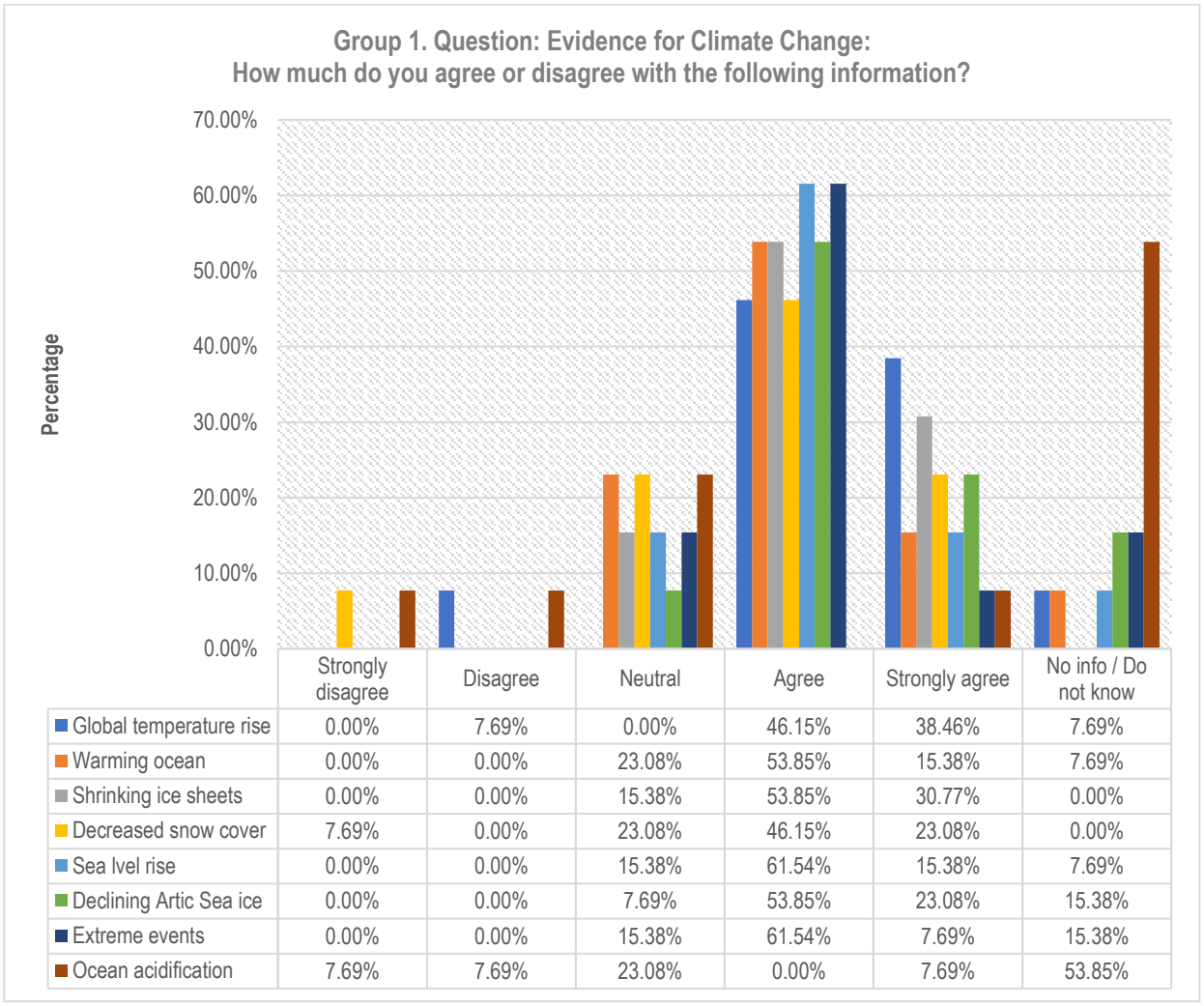
The "Knowledge of Climate Change" part of the KAP survey included three parts: Evidence for climate change, Drivers of climate change and impacts of climate change in Vietnam.

4.5.1.1.1 Evidence for Climate Change

In this part, we presented a list of eight pieces of evidence for climate change and asked participants how much they agreed or disagreed with each piece of information. Figures 4.9 and 4.10 reveal how group 1 and group 2 participants agree or disagree with each piece of information regarding the evidence for climate change.

Figure 4.9

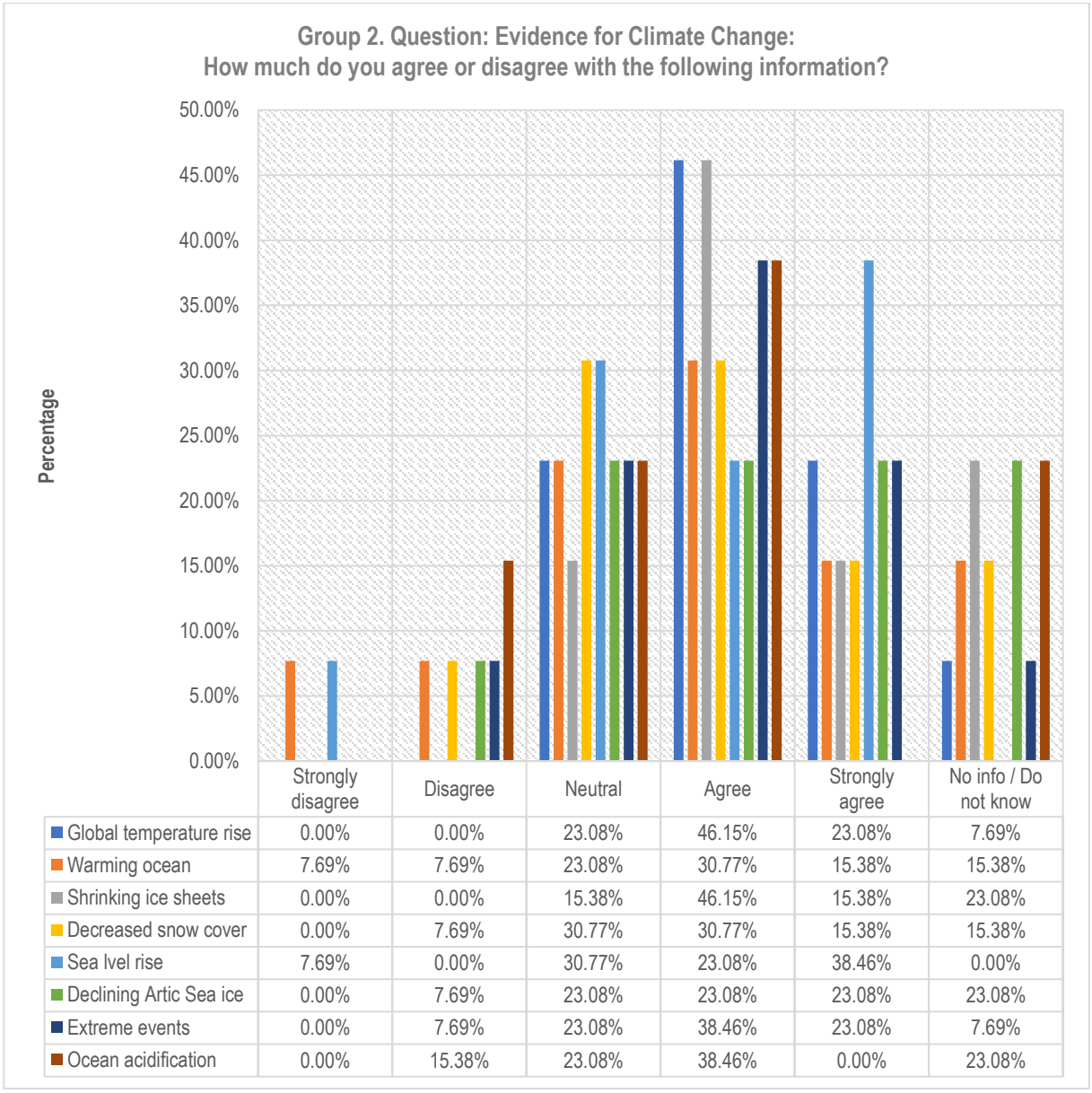
Answers to the question of evidence for climate change from Group 1



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Global temperature rise	0.00%	7.69%	0.00%	46.15%	38.46%	7.69%
Warming ocean	0.00%	0.00%	23.08%	53.85%	15.38%	7.69%
Shrinking ice sheets	0.00%	0.00%	15.38%	53.85%	30.77%	0.00%
Decreased snow cover	7.69%	0.00%	23.08%	46.15%	23.08%	0.00%
Sea lvel rise	0.00%	0.00%	15.38%	61.54%	15.38%	7.69%
Declining Artic Sea ice	0.00%	0.00%	7.69%	53.85%	23.08%	15.38%
Extreme events	0.00%	0.00%	15.38%	61.54%	7.69%	15.38%
Ocean acidification	7.69%	7.69%	23.08%	0.00%	7.69%	53.85%

Figure 4.10

Answers to the question of evidence for climate change from Group 2



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Global temperature rise	0.00%	0.00%	23.08%	46.15%	23.08%	7.69%
Warming ocean	7.69%	7.69%	23.08%	30.77%	15.38%	15.38%
Shrinking ice sheets	0.00%	0.00%	15.38%	46.15%	15.38%	23.08%
Decreased snow cover	0.00%	7.69%	30.77%	30.77%	15.38%	15.38%
Sea lvel rise	7.69%	0.00%	30.77%	23.08%	38.46%	0.00%
Declining Artic Sea ice	0.00%	7.69%	23.08%	23.08%	23.08%	23.08%
Extreme events	0.00%	7.69%	23.08%	38.46%	23.08%	7.69%
Ocean acidification	0.00%	15.38%	23.08%	38.46%	0.00%	23.08%

Figures 4.9 and 4.10 show that the difference in answers represents the level of agreement in groups 1 and 2. Specifically, more than 70% of participants in group 1 agree with the statements regarding the evidence. In contrast, this number ranges from 45% to 65% in group 2. One point that could explain this is the relatively high rate of "neutral" answers in group 2. On average, 24% of participants in group 2 expressed neutrality in their answers.

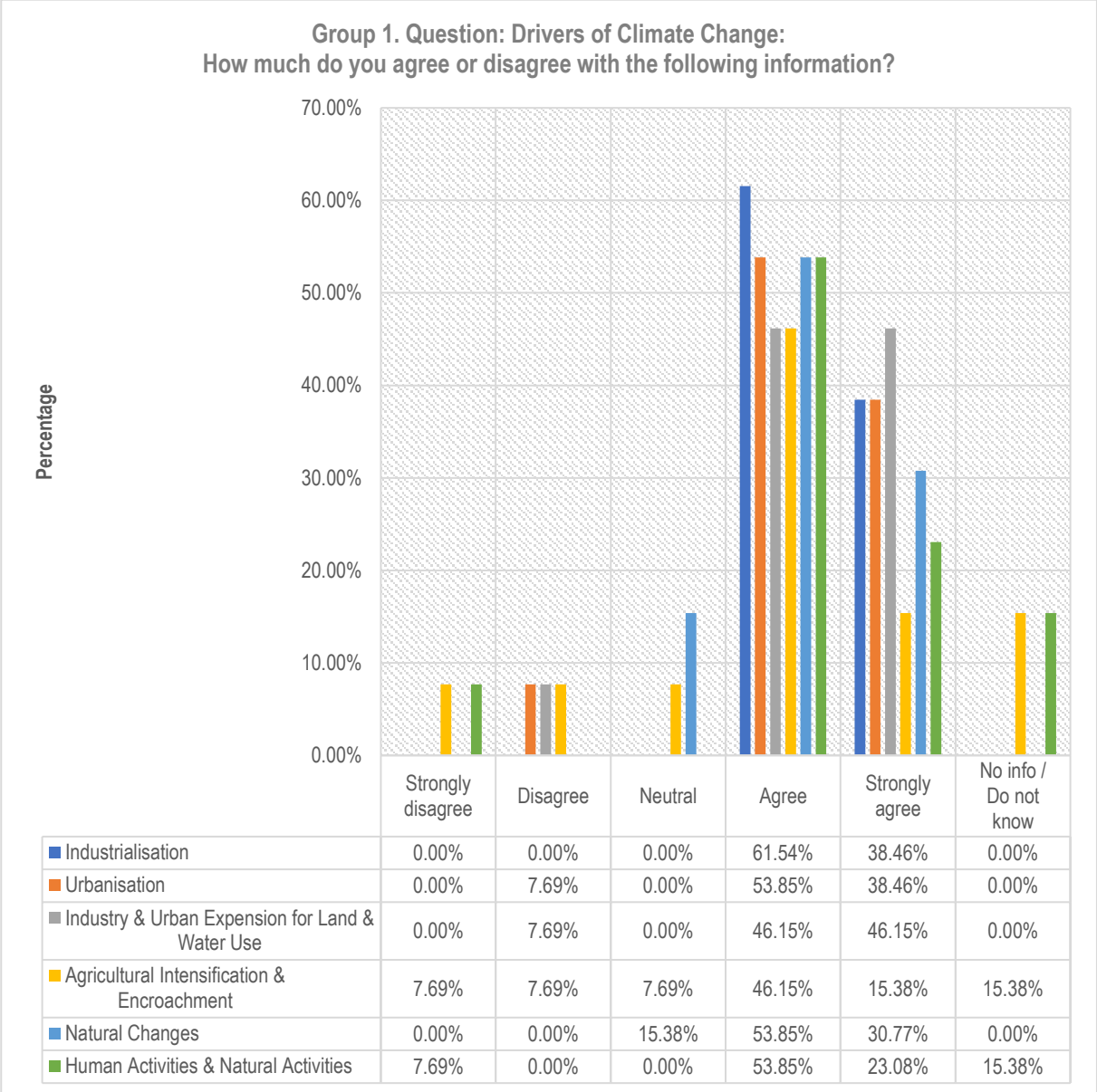
4.5.1.1.2 Drivers of Climate Change

In this part, we presented a list of six pieces of drivers for climate change and asked participants how much they agreed or disagreed with each piece of information. Figures 4.11 and 4.12 reveal how group 1 and group 2 participants show their agreement or disagreement with each keyword. It is seen that there is a different distribution in the responses of the participants from group 1 and group 2. Neutrality in responses is evident in group 2 when the mean percentage is given. The neutral response of group 2 was 20% compared to group 1's 11.5%. In addition, the level of agreement (including agree and strongly agree) for the information related to

climate change causes in group 1 represents a higher percentage (84.6%) in group 1. This rate in group 2 is 62.8%.

Figure 4.11

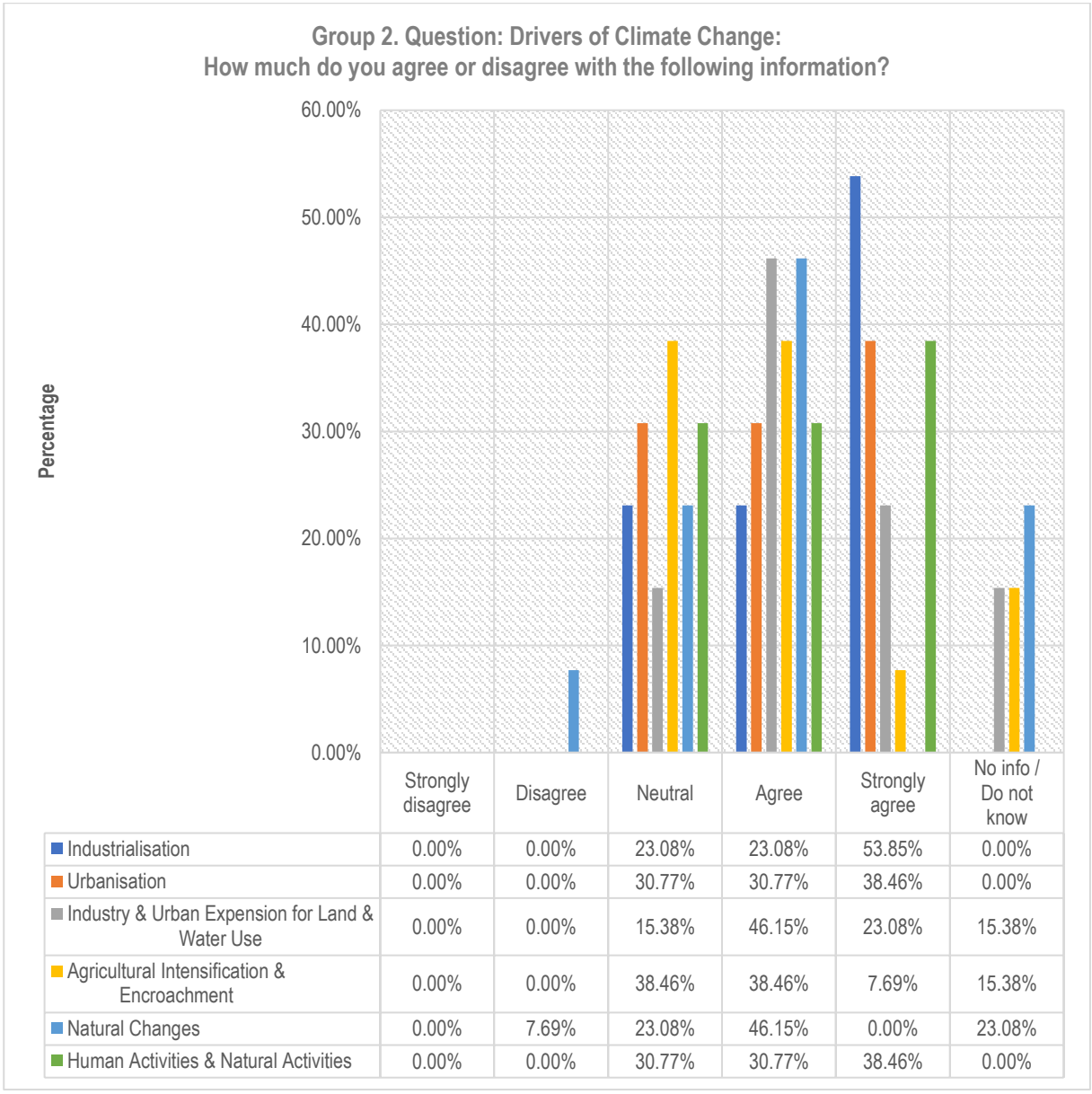
Answers to the question of drivers for climate change from Group 1



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Industrialisation	0.00%	0.00%	0.00%	61.54%	38.46%	0.00%
Urbanisation	0.00%	7.69%	0.00%	53.85%	38.46%	0.00%
Industry & Urban Expension for Land & Water Use	0.00%	7.69%	0.00%	46.15%	46.15%	0.00%
Agricultural Intensification & Encroachment	7.69%	7.69%	7.69%	46.15%	15.38%	15.38%
Natural Changes	0.00%	0.00%	15.38%	53.85%	30.77%	0.00%
Human Activities & Natural Activities	7.69%	0.00%	0.00%	53.85%	23.08%	15.38%

Figure 4.12

Answers to the question of drivers for climate change from Group 2



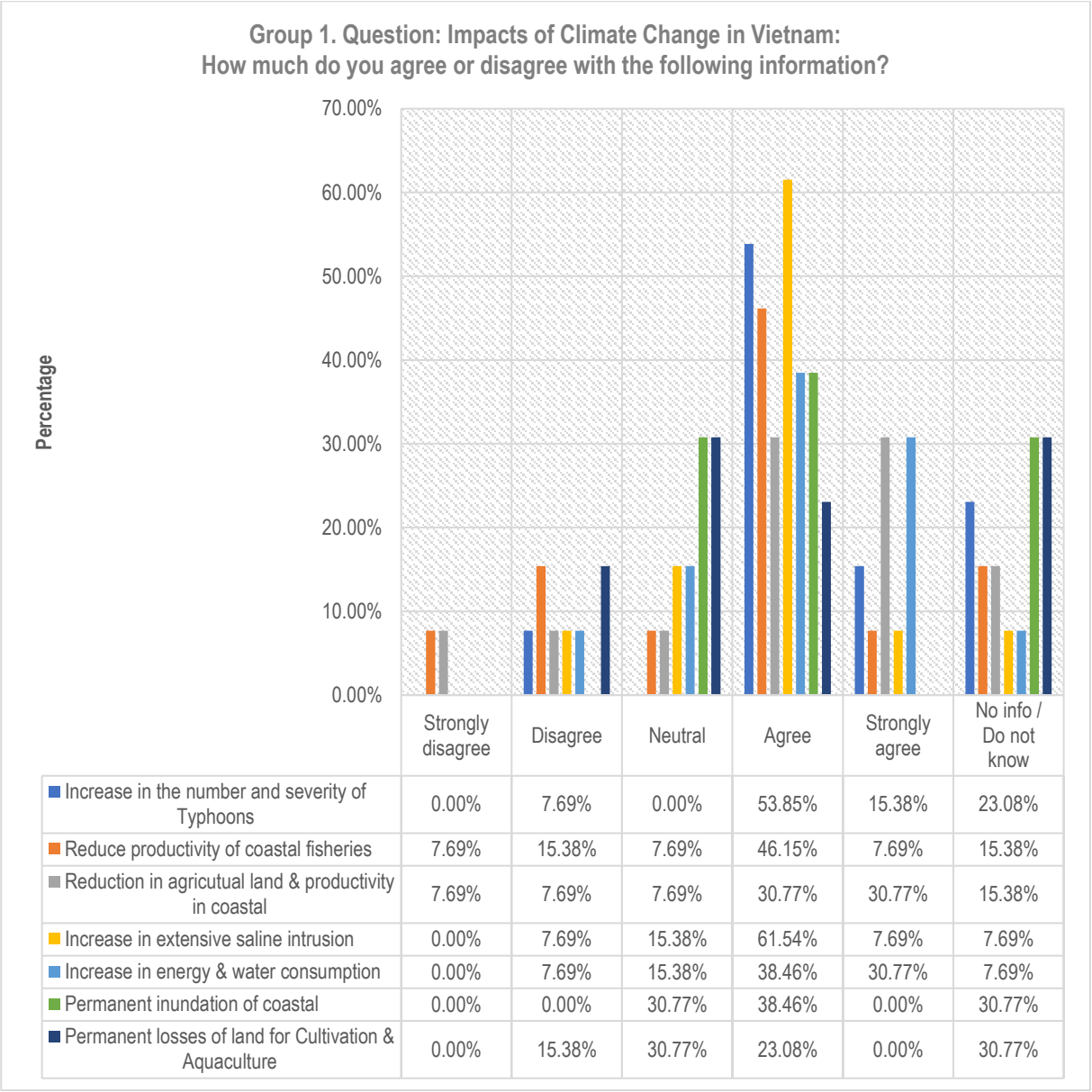
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Industrialisation	0.00%	0.00%	23.08%	23.08%	53.85%	0.00%
Urbanisation	0.00%	0.00%	30.77%	30.77%	38.46%	0.00%
Industry & Urban Expension for Land & Water Use	0.00%	0.00%	15.38%	46.15%	23.08%	15.38%
Agricultural Intensification & Encroachment	0.00%	0.00%	38.46%	38.46%	7.69%	15.38%
Natural Changes	0.00%	7.69%	23.08%	46.15%	0.00%	23.08%
Human Activities & Natural Activities	0.00%	0.00%	30.77%	30.77%	38.46%	0.00%

4.5.1.1.3 Impacts of Climate Change in Vietnam

In this part, we presented a list of seven impacts of climate change in Vietnam and asked participants how much they agreed or disagreed with each piece of information. Figures 4.13 and 4.14 reveal how group 1 and 2 participants agree or disagree with each keyword. Again, the difference in the percentage of participants who answered neutrally in groups 1 and 2 was seen. Specifically, 15.38% of participants in group 1 gave a neutral answer, while this rate in group 2 was 38.46%. Besides, the agreement level (including agreeing and completely agreeing) in group 1 was higher than group 2, at 54.94% and 39.56%, respectively.

Figure 4.13

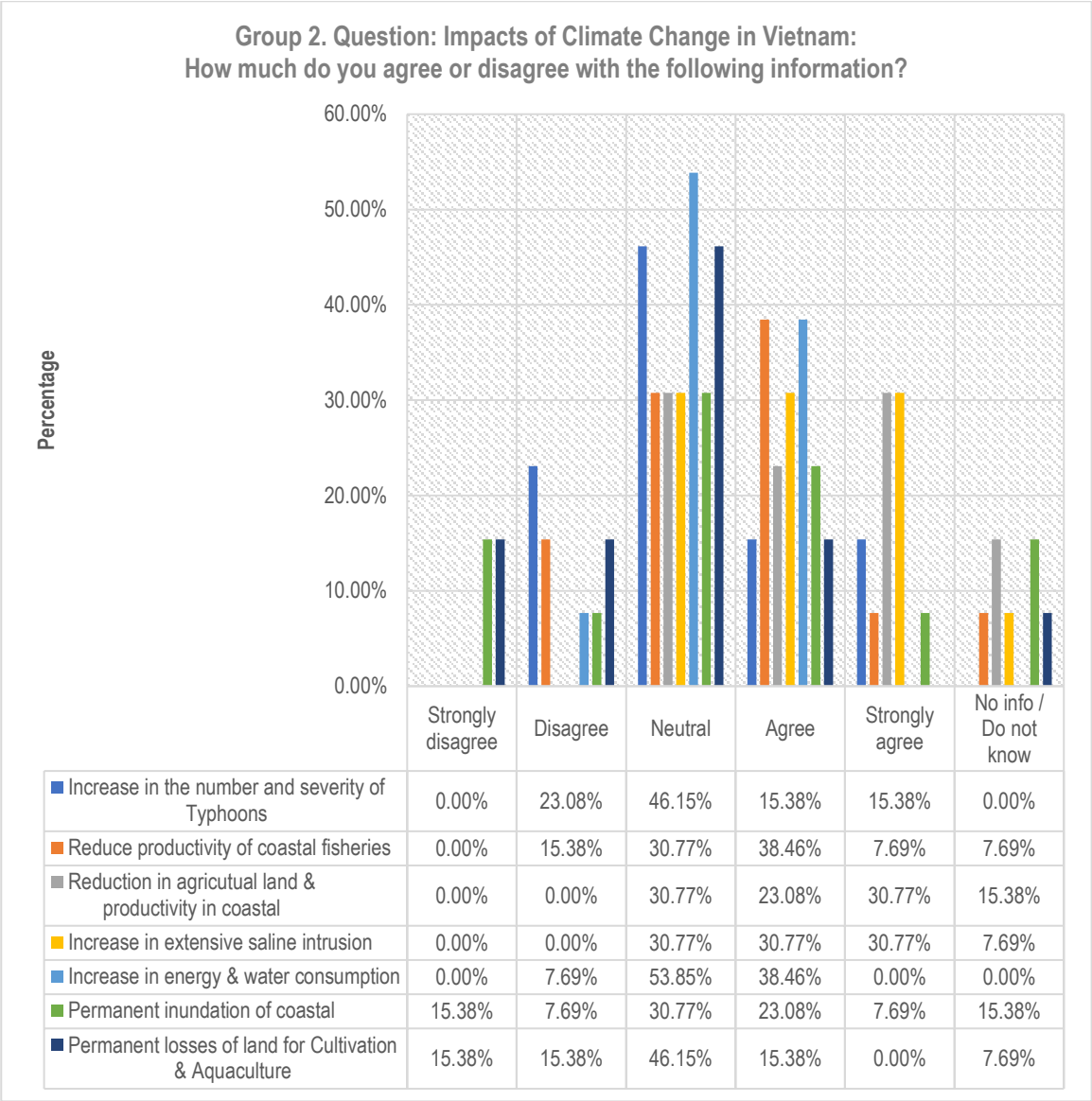
Answers to the question of the impacts of climate change in Vietnam from Group 1



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Increase in the number and severity of Typhoons	0.00%	7.69%	0.00%	53.85%	15.38%	23.08%
Reduce productivity of coastal fisheries	7.69%	15.38%	7.69%	46.15%	7.69%	15.38%
Reduction in agricutual land & productivity in coastal	7.69%	7.69%	7.69%	30.77%	30.77%	15.38%
Increase in extensive saline intrusion	0.00%	7.69%	15.38%	61.54%	7.69%	7.69%
Increase in energy & water consumption	0.00%	7.69%	15.38%	38.46%	30.77%	7.69%
Permanent inundation of coastal	0.00%	0.00%	30.77%	38.46%	0.00%	30.77%
Permanent losses of land for Cultivation & Aquaculture	0.00%	15.38%	30.77%	23.08%	0.00%	30.77%

Figure 4.14

Answers to the question of impacts of climate change in Vietnam from Group 2



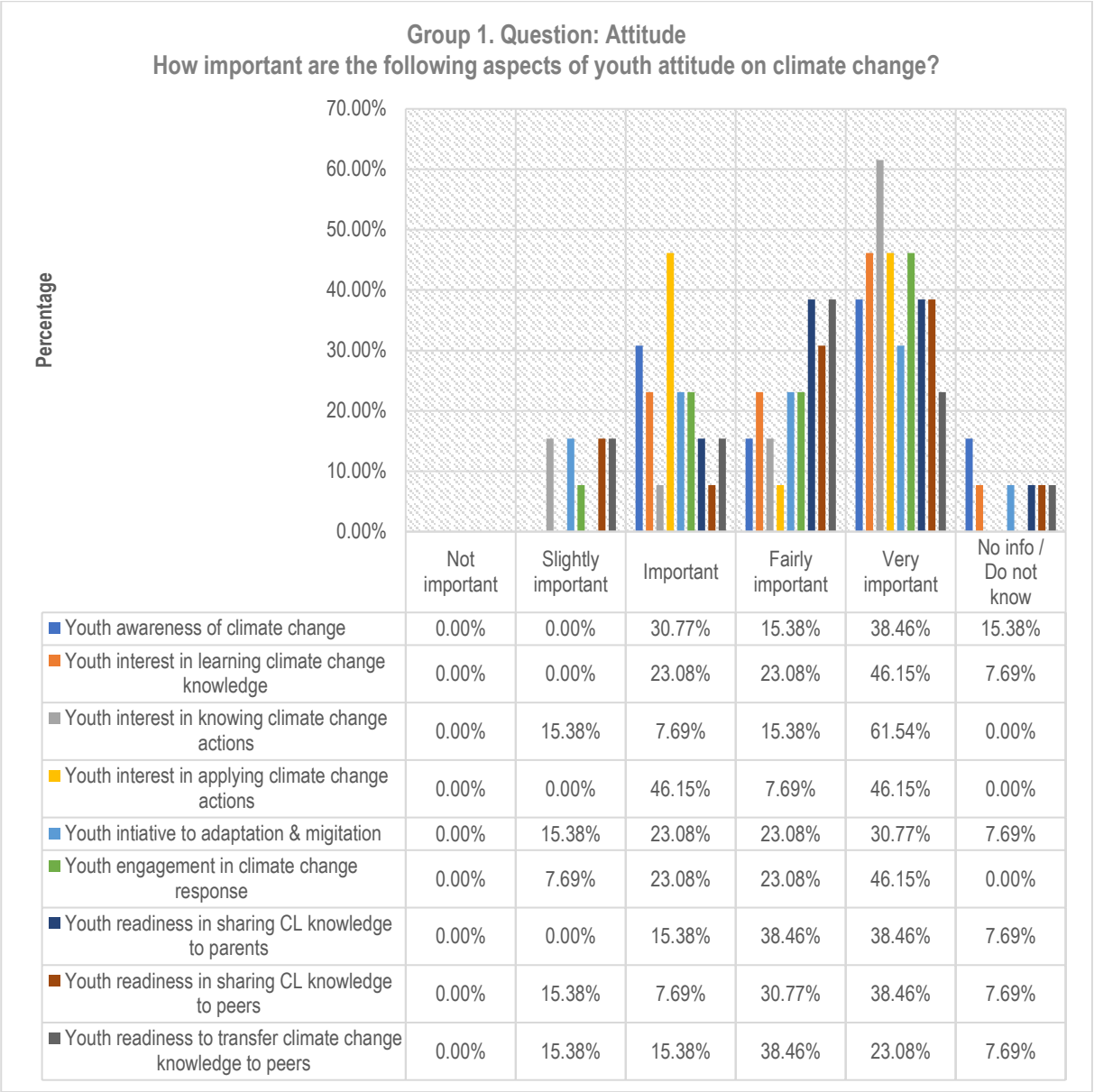
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Increase in the number and severity of Typhoons	0.00%	23.08%	46.15%	15.38%	15.38%	0.00%
Reduce productivity of coastal fisheries	0.00%	15.38%	30.77%	38.46%	7.69%	7.69%
Reduction in agricutual land & productivity in coastal	0.00%	0.00%	30.77%	23.08%	30.77%	15.38%
Increase in extensive saline intrusion	0.00%	0.00%	30.77%	30.77%	30.77%	7.69%
Increase in energy & water consumption	0.00%	7.69%	53.85%	38.46%	0.00%	0.00%
Permanent inundation of coastal	15.38%	7.69%	30.77%	23.08%	7.69%	15.38%
Permanent losses of land for Cultivation & Aquaculture	15.38%	15.38%	46.15%	15.38%	0.00%	7.69%

4.5.1.2 Attitude on Climate Change

We presented a list of nine aspects of youth attitudes toward climate change and asked participants how much they agreed or disagreed with each piece of information. Figures 4.15 and 4.16 reveal how group 1 and group 2 participants think about the importance of each statement. However, there is not much difference in groups 1 and 2.

Figure 4.15

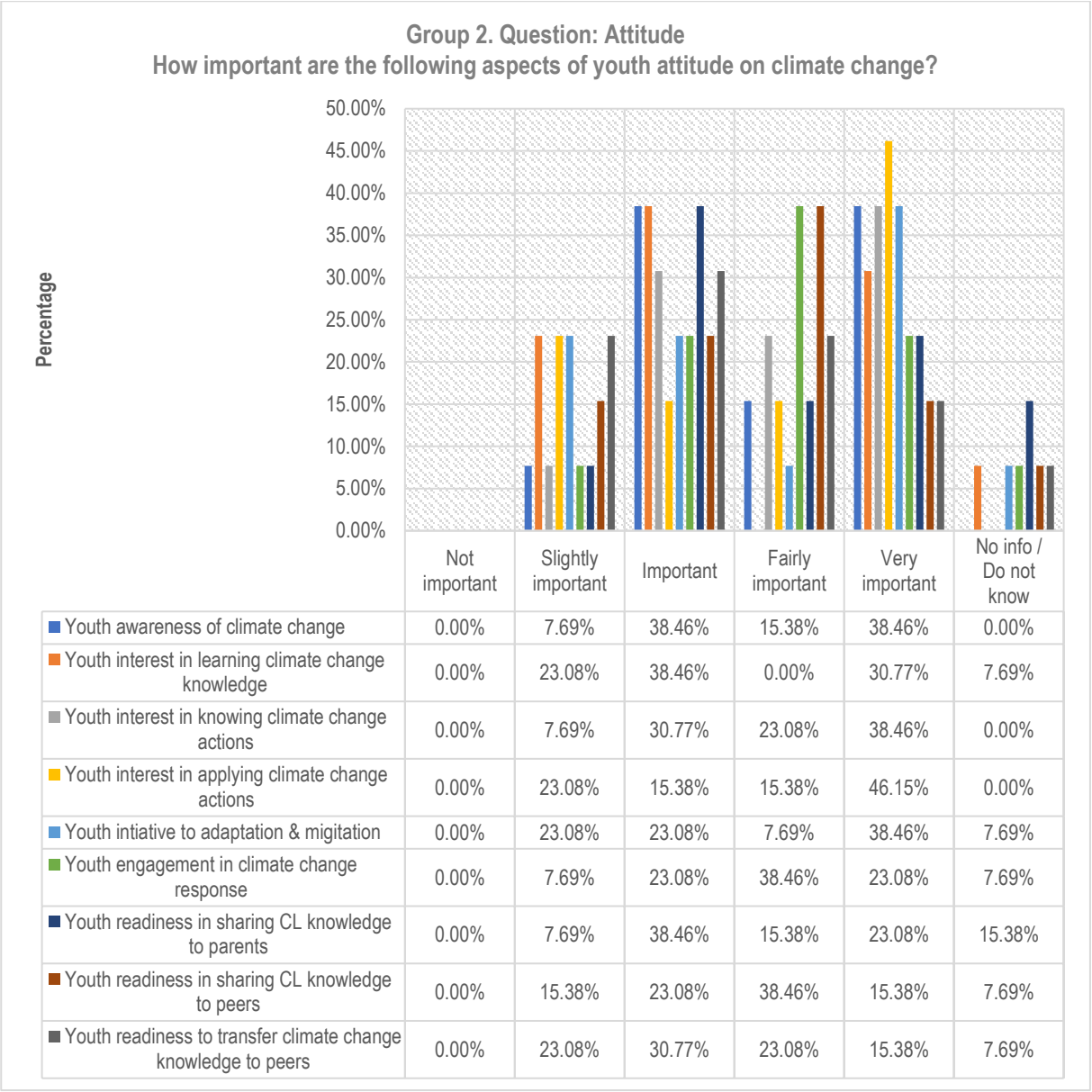
Answers to the questions about the level of importance of youth attitude on climate change from Group 1



	Not important	Slightly important	Important	Fairly important	Very important	No info / Do not know
Youth awareness of climate change	0.00%	0.00%	30.77%	15.38%	38.46%	15.38%
Youth interest in learning climate change knowledge	0.00%	0.00%	23.08%	23.08%	46.15%	7.69%
Youth interest in knowing climate change actions	0.00%	15.38%	7.69%	15.38%	61.54%	0.00%
Youth interest in applying climate change actions	0.00%	0.00%	46.15%	7.69%	46.15%	0.00%
Youth intiative to adaptation & migitation	0.00%	15.38%	23.08%	23.08%	30.77%	7.69%
Youth engagement in climate change response	0.00%	7.69%	23.08%	23.08%	46.15%	0.00%
Youth readiness in sharing CL knowledge to parents	0.00%	0.00%	15.38%	38.46%	38.46%	7.69%
Youth readiness in sharing CL knowledge to peers	0.00%	15.38%	7.69%	30.77%	38.46%	7.69%
Youth readiness to transfer climate change knowledge to peers	0.00%	15.38%	15.38%	38.46%	23.08%	7.69%

Figure 4.16

Answers the questions about the level of importance of youth attitude toward climate change from Group 2



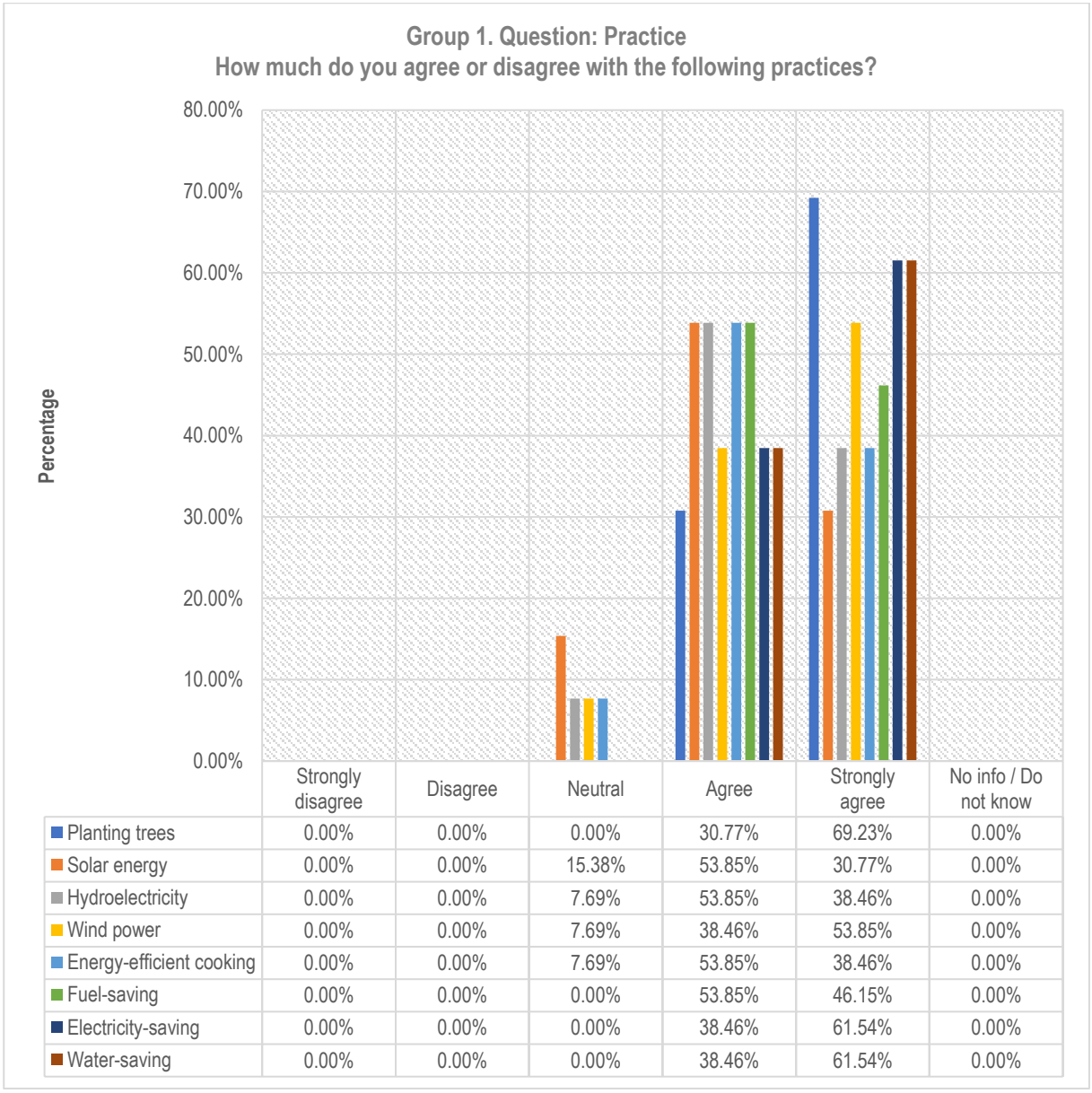
	Not important	Slightly important	Important	Fairly important	Very important	No info / Do not know
Youth awareness of climate change	0.00%	7.69%	38.46%	15.38%	38.46%	0.00%
Youth interest in learning climate change knowledge	0.00%	23.08%	38.46%	0.00%	30.77%	7.69%
Youth interest in knowing climate change actions	0.00%	7.69%	30.77%	23.08%	38.46%	0.00%
Youth interest in applying climate change actions	0.00%	23.08%	15.38%	15.38%	46.15%	0.00%
Youth intiative to adaptation & migitation	0.00%	23.08%	23.08%	7.69%	38.46%	7.69%
Youth engagement in climate change response	0.00%	7.69%	23.08%	38.46%	23.08%	7.69%
Youth readiness in sharing CL knowledge to parents	0.00%	7.69%	38.46%	15.38%	23.08%	15.38%
Youth readiness in sharing CL knowledge to peers	0.00%	15.38%	23.08%	38.46%	15.38%	7.69%
Youth readiness to transfer climate change knowledge to peers	0.00%	23.08%	30.77%	23.08%	15.38%	7.69%

4.5.1.3 Practices toward Climate Change

We presented a list of eight ways of taking action for climate change and asked partakers how much they agreed or disagreed with each piece of information. Figures 4.17 and 4.18 reveal how group 1 and 2 participants agree or disagree with each keyword. 95.19% of participants in group 1 agreed with the ideas about practices to mitigate the effects of climate change, while this rate in group 2 was 75%. The neutrality in responses also differed between group 1 and group 2: the rate in group 1 and group 2 was 4.81% and 16.35%, respectively.

Figure 4.17

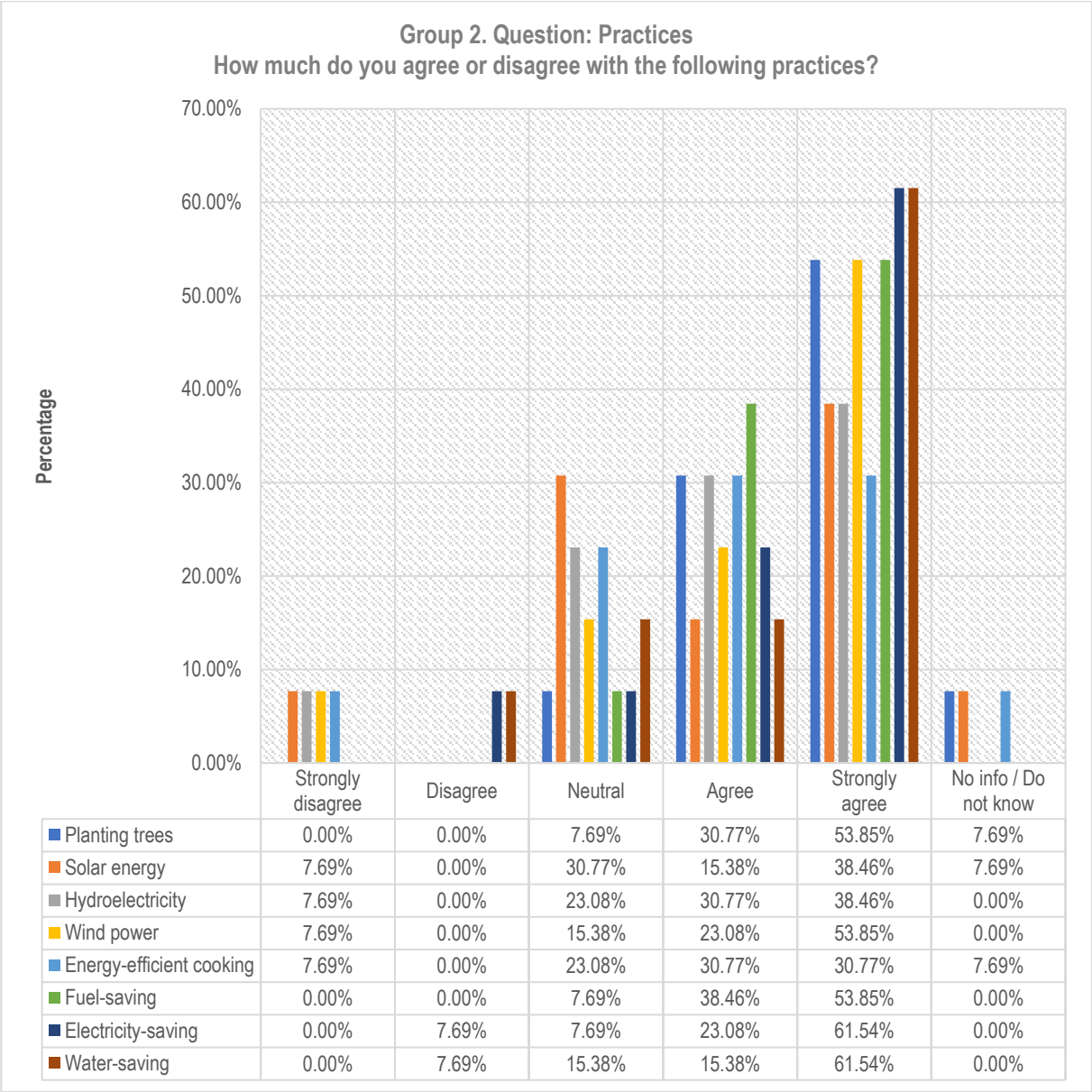
Answers for questions of practices toward climate change from Group 1



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Planting trees	0.00%	0.00%	0.00%	30.77%	69.23%	0.00%
Solar energy	0.00%	0.00%	15.38%	53.85%	30.77%	0.00%
Hydroelectricity	0.00%	0.00%	7.69%	53.85%	38.46%	0.00%
Wind power	0.00%	0.00%	7.69%	38.46%	53.85%	0.00%
Energy-efficient cooking	0.00%	0.00%	7.69%	53.85%	38.46%	0.00%
Fuel-saving	0.00%	0.00%	0.00%	53.85%	46.15%	0.00%
Electricity-saving	0.00%	0.00%	0.00%	38.46%	61.54%	0.00%
Water-saving	0.00%	0.00%	0.00%	38.46%	61.54%	0.00%

Figure 4.18

Answers for questions of practices toward climate change from Group 1



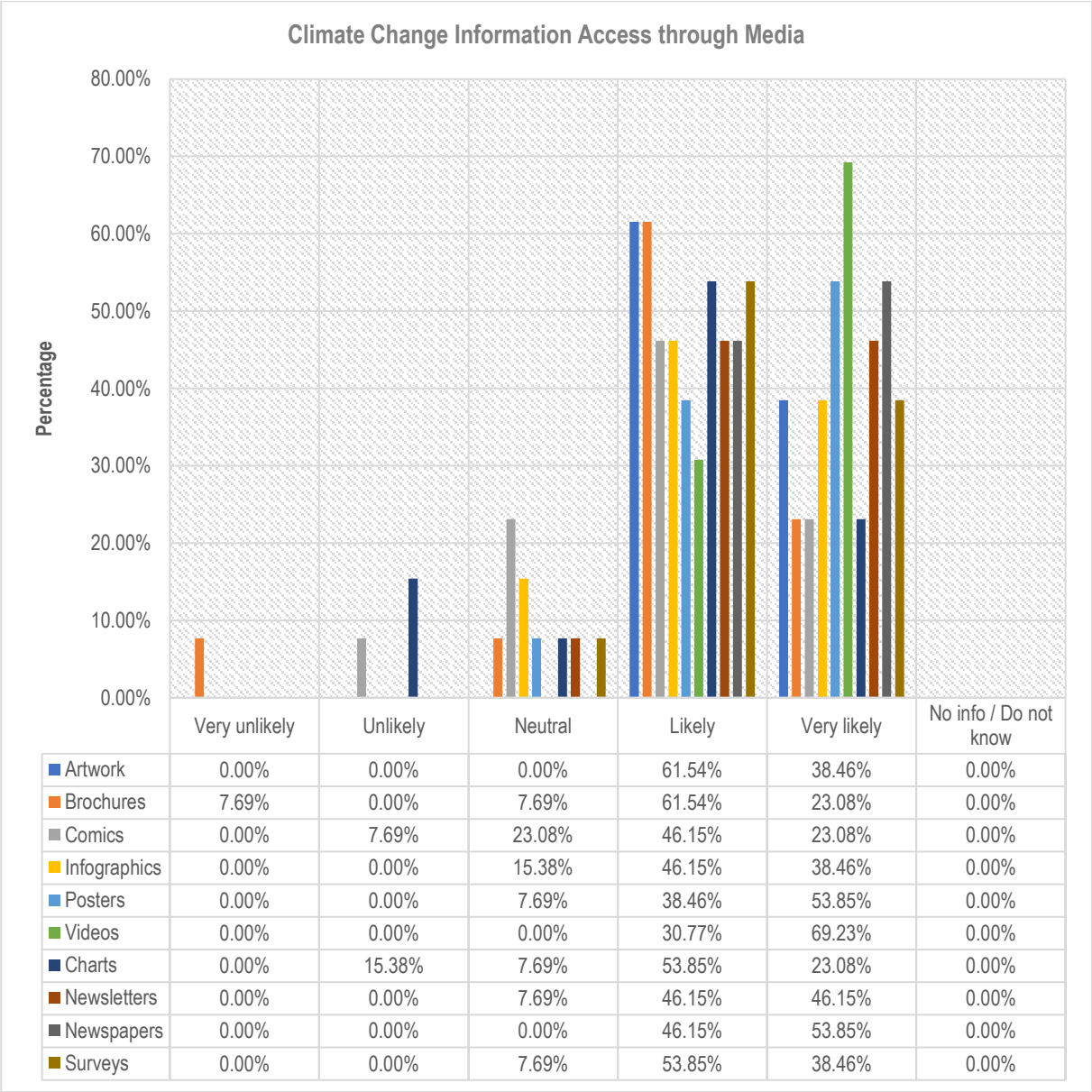
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No info / Do not know
Planting trees	0.00%	0.00%	7.69%	30.77%	53.85%	7.69%
Solar energy	7.69%	0.00%	30.77%	15.38%	38.46%	7.69%
Hydroelectricity	7.69%	0.00%	23.08%	30.77%	38.46%	0.00%
Wind power	7.69%	0.00%	15.38%	23.08%	53.85%	0.00%
Energy-efficient cooking	7.69%	0.00%	23.08%	30.77%	30.77%	7.69%
Fuel-saving	0.00%	0.00%	7.69%	38.46%	53.85%	0.00%
Electricity-saving	0.00%	7.69%	7.69%	23.08%	61.54%	0.00%
Water-saving	0.00%	7.69%	15.38%	15.38%	61.54%	0.00%

4.5.1.4 Climate Change information access through Media

We presented a list of ten approaches to learning climate change information and asked participants how much they agreed or disagreed with each piece of information. Figures 4.19 and 4.20 reveal how group 1 and group 2 participants show how likely they think the approach suits them.

Figure 4.19

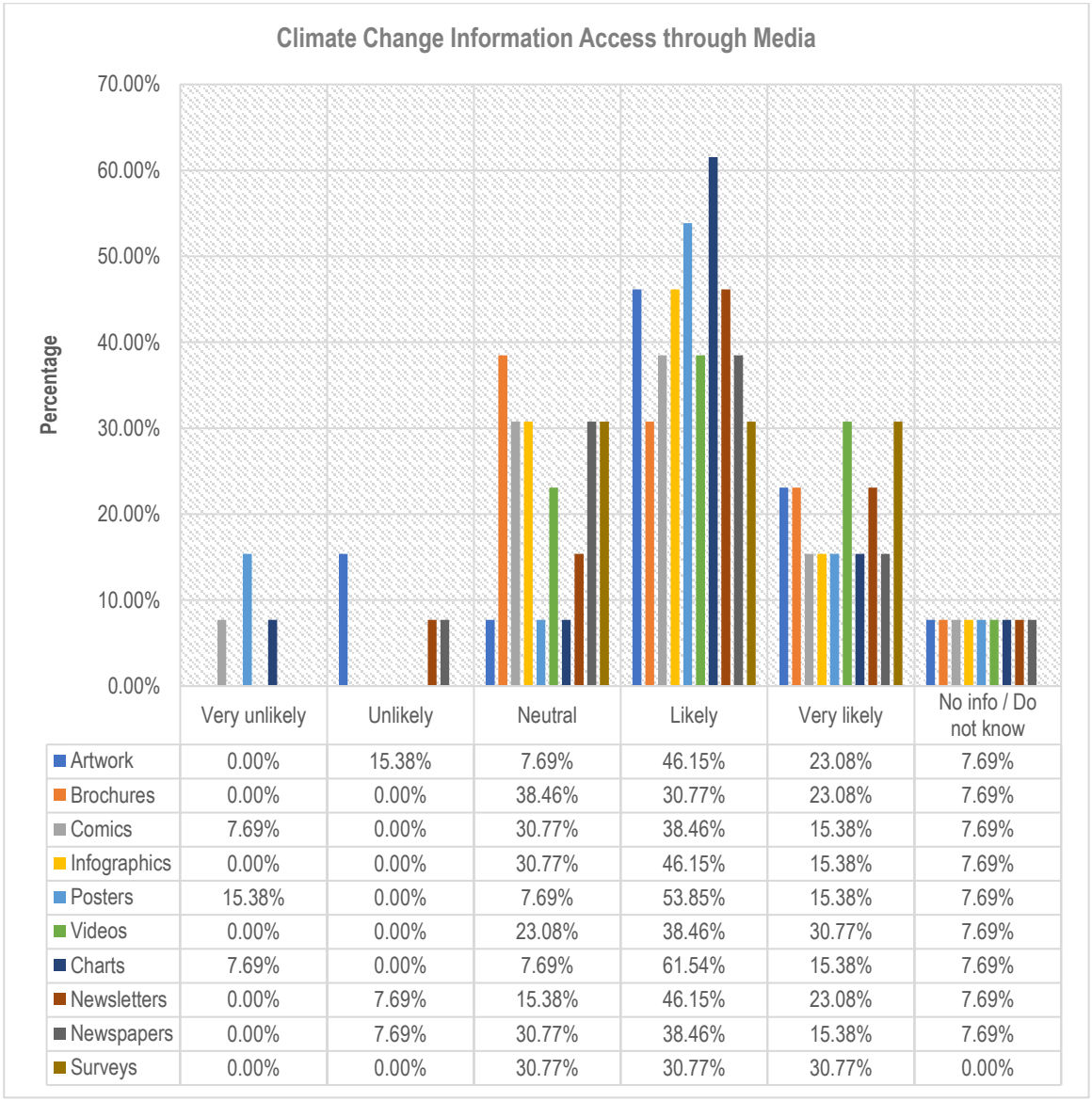
Answers to the questions of climate change information access through media from Group 1



	Very unlikely	Unlikely	Neutral	Likely	Very likely	No info / Do not know
Artwork	0.00%	0.00%	0.00%	61.54%	38.46%	0.00%
Brochures	7.69%	0.00%	7.69%	61.54%	23.08%	0.00%
Comics	0.00%	7.69%	23.08%	46.15%	23.08%	0.00%
Infographics	0.00%	0.00%	15.38%	46.15%	38.46%	0.00%
Posters	0.00%	0.00%	7.69%	38.46%	53.85%	0.00%
Videos	0.00%	0.00%	0.00%	30.77%	69.23%	0.00%
Charts	0.00%	15.38%	7.69%	53.85%	23.08%	0.00%
Newsletters	0.00%	0.00%	7.69%	46.15%	46.15%	0.00%
Newspapers	0.00%	0.00%	0.00%	46.15%	53.85%	0.00%
Surveys	0.00%	0.00%	7.69%	53.85%	38.46%	0.00%

Figure 4.20

Answers to the questions of climate change information access through media from Group 2



	Very unlikely	Unlikely	Neutral	Likely	Very likely	No info / Do not know
Artwork	0.00%	15.38%	7.69%	46.15%	23.08%	7.69%
Brochures	0.00%	0.00%	38.46%	30.77%	23.08%	7.69%
Comics	7.69%	0.00%	30.77%	38.46%	15.38%	7.69%
Infographics	0.00%	0.00%	30.77%	46.15%	15.38%	7.69%
Posters	15.38%	0.00%	7.69%	53.85%	15.38%	7.69%
Videos	0.00%	0.00%	23.08%	38.46%	30.77%	7.69%
Charts	7.69%	0.00%	7.69%	61.54%	15.38%	7.69%
Newsletters	0.00%	7.69%	15.38%	46.15%	23.08%	7.69%
Newspapers	0.00%	7.69%	30.77%	38.46%	15.38%	7.69%
Surveys	0.00%	0.00%	30.77%	30.77%	30.77%	0.00%

4.5.2 FINDINGS FROM THE QUALITATIVE DATA

4.5.2.1 Length of the text

As mentioned above, the first difference between groups 1 and 2 and between groups 3 and 4 comes from the length of the text given by each participant joining the interview. Eight interview questions were asked of all participants from four groups. Participants from groups 1 and 3 who attended art-integrated learning sessions gave longer and more insightful answers than others from groups 2 and 4. By calculating the number of words given in the text of each answer from 46 participants from four groups and then calculating the average number of words per answer in each question of each group, Table 4.12 highlights our calculation of the average length of the text per interview question occurring in each group.

Table 4.12

Average Number of Words per Answer per Interview Questions

Average Number of Words per Answer per Interview Question								
Group	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
Group 1	**26.00**	**25.31**	**20.69**	**35.31**	**48.62**	**58.54**	**34.46**	**36.85**
Group 2	**13.92**	**20.15**	**16.69**	**16.85**	**28.38**	**22.77**	**12.92**	**23.92**
Group 3	**26.22**	**21.33**	**20.56**	**19.78**	**35.22**	**37.56**	**15.67**	**33.11**
Group 4	**14.82**	**16.55**	**15.00**	**18.18**	**22.09**	**23.64**	**14.55**	**33.09**

As seen in Table 4.12, the average number of words in all answers for eight interview questions from Group 1 and Group 3 is much higher than the two controlled groups (2 and 4). By attending art-informed learning sessions, participants in two experimental groups were introduced to knowledge about climate change and given chances to express their ideas, interest and concerns about climate change through art-expressed activities. On the other hand, respondents from two controlled groups were selected not to receive the learning sessions about climate change through art, showing that their answers during the interview were not as long as the other groups. Figures 4.21 and 4.23 depict a more straightforward overview of these differences in the text length between groups 1 and 2 and groups 3 and 4.

Figure 4.21

The average number of words per question of Groups 1 and 2

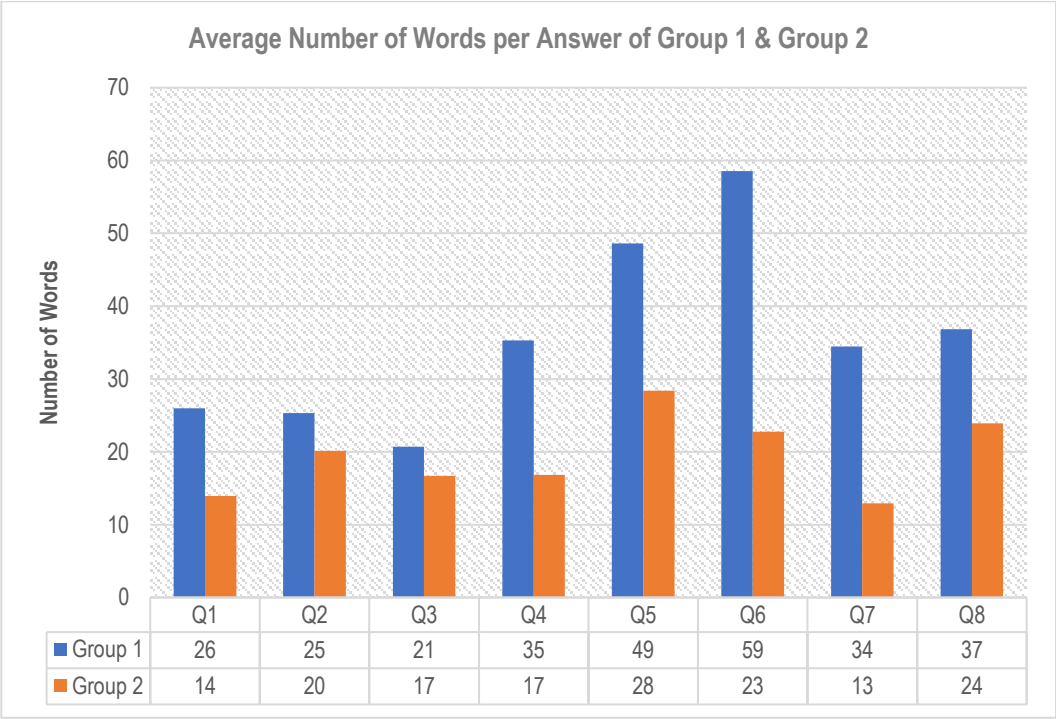
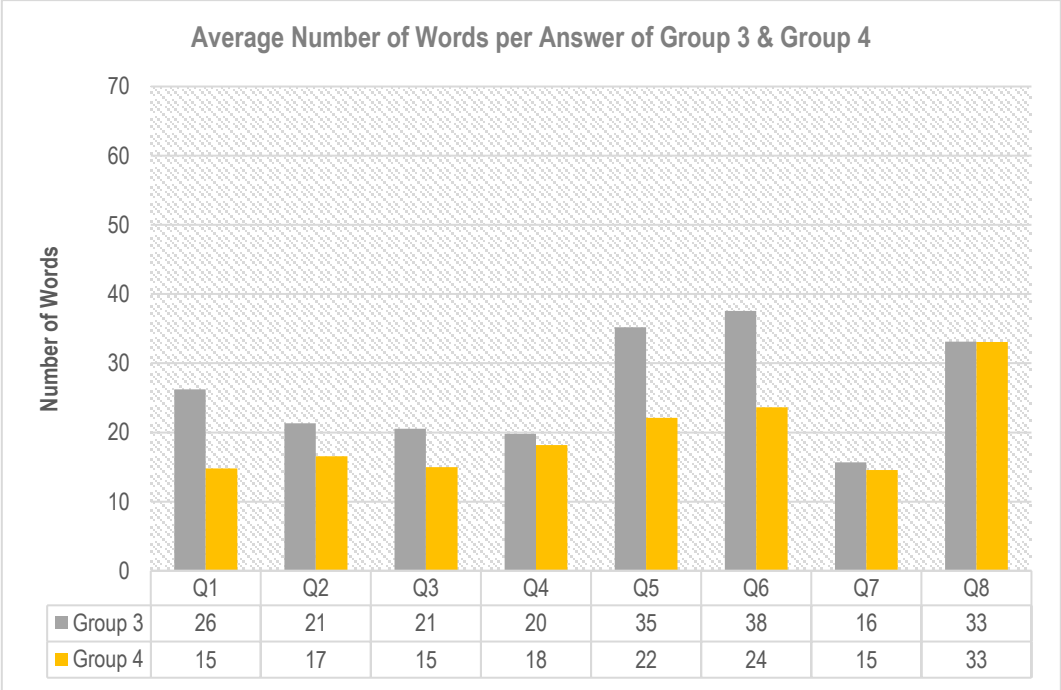


Figure 4.22

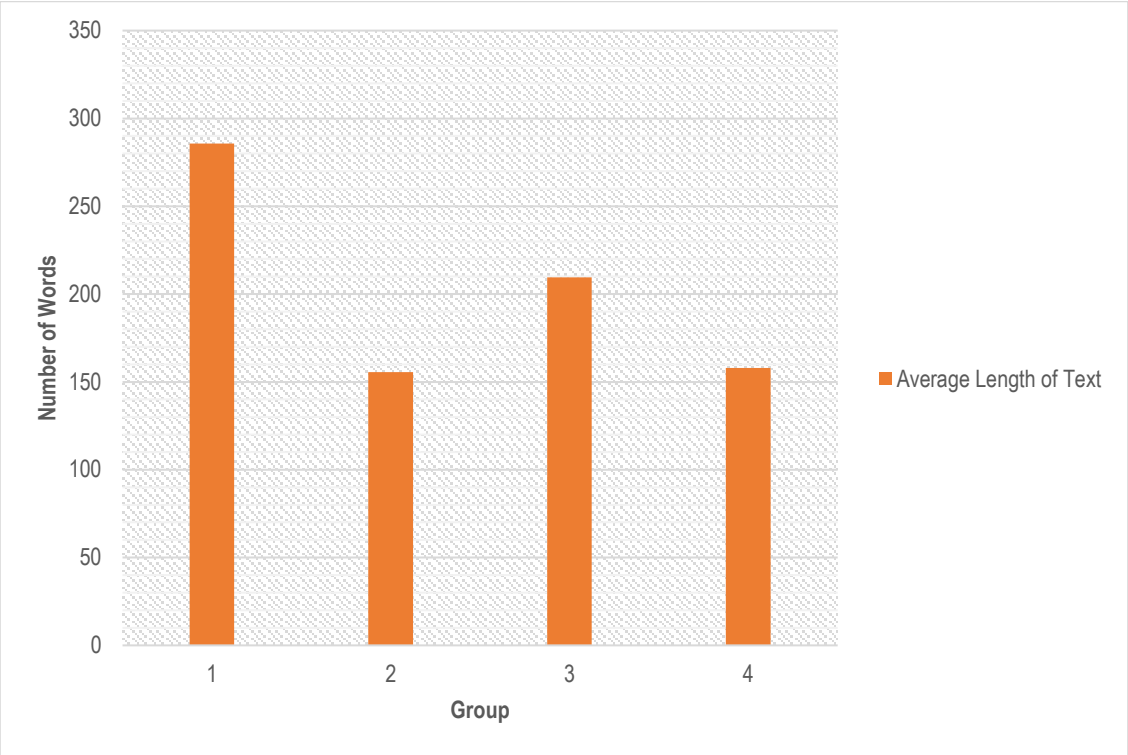
The average number of words per question of Groups 3 and 4



We calculated the average length in the text of all interview answers from four groups. Figure 4.5.15 shows that experimental groups gave a longer text in answers than the control groups.

Figure 4.23

The average length of the text in four groups



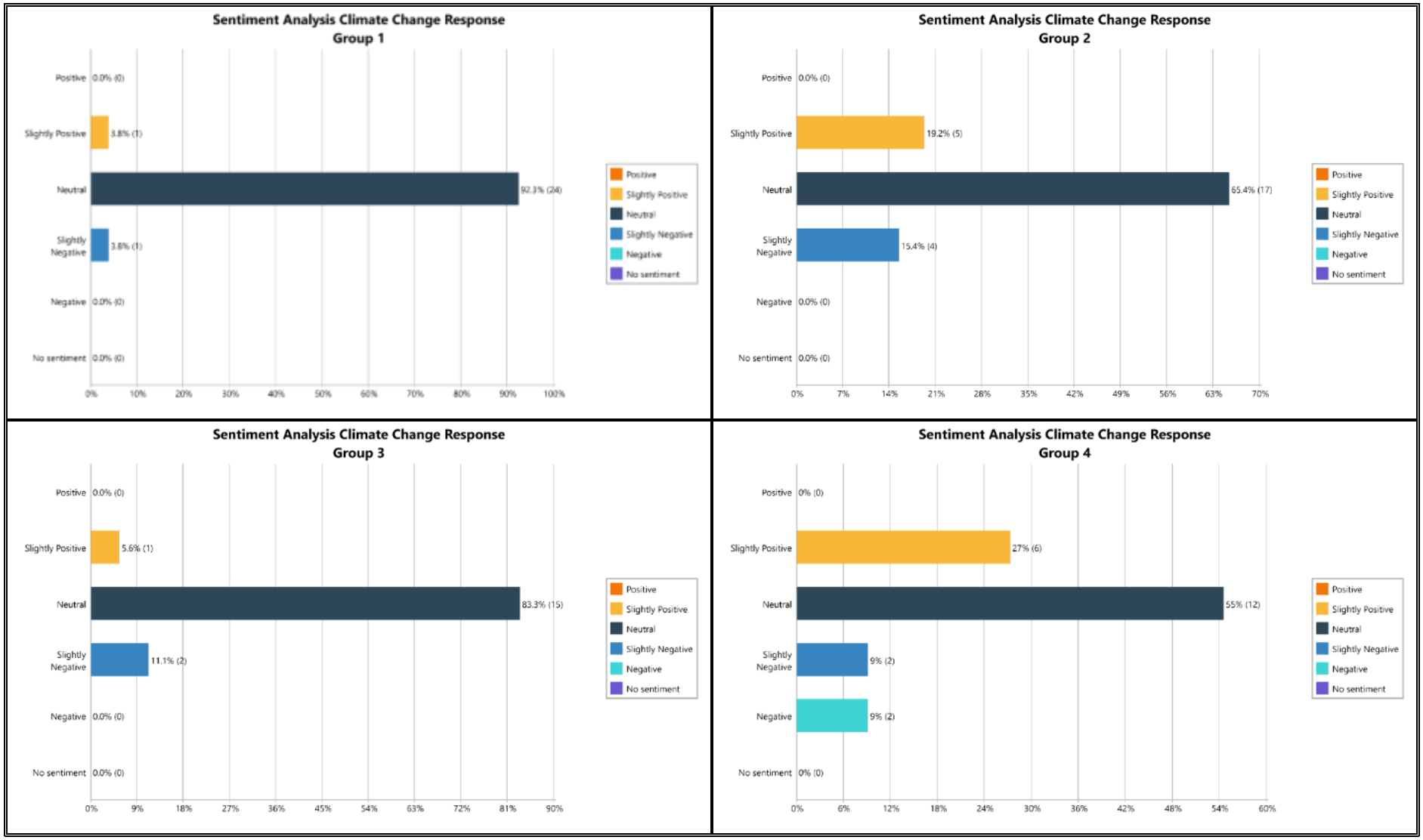
4.5.2.2 Sentiment Analysis

4.5.2.2.1 Sentiment Analysis of Climate Change Response

With documents from four groups, we present in Table 4.13 the sentiment analysis of the first parent code: Climate Change Response, which was conducted based on the creative coding tool of MAXQDA. Table 4.13. show five scales of the sentiment analysis, including negative, slightly negative, neutral, slightly positive and positive. In this assessment, neutral assessments prevail based on the above scale, and the neutral rate is higher in the experimental group than in the control group. Meanwhile, the proportion of "slightly positive" interviews in the control group was higher than in the experimental group.

Table 4.13

Sentiment analysis of climate change response in four groups

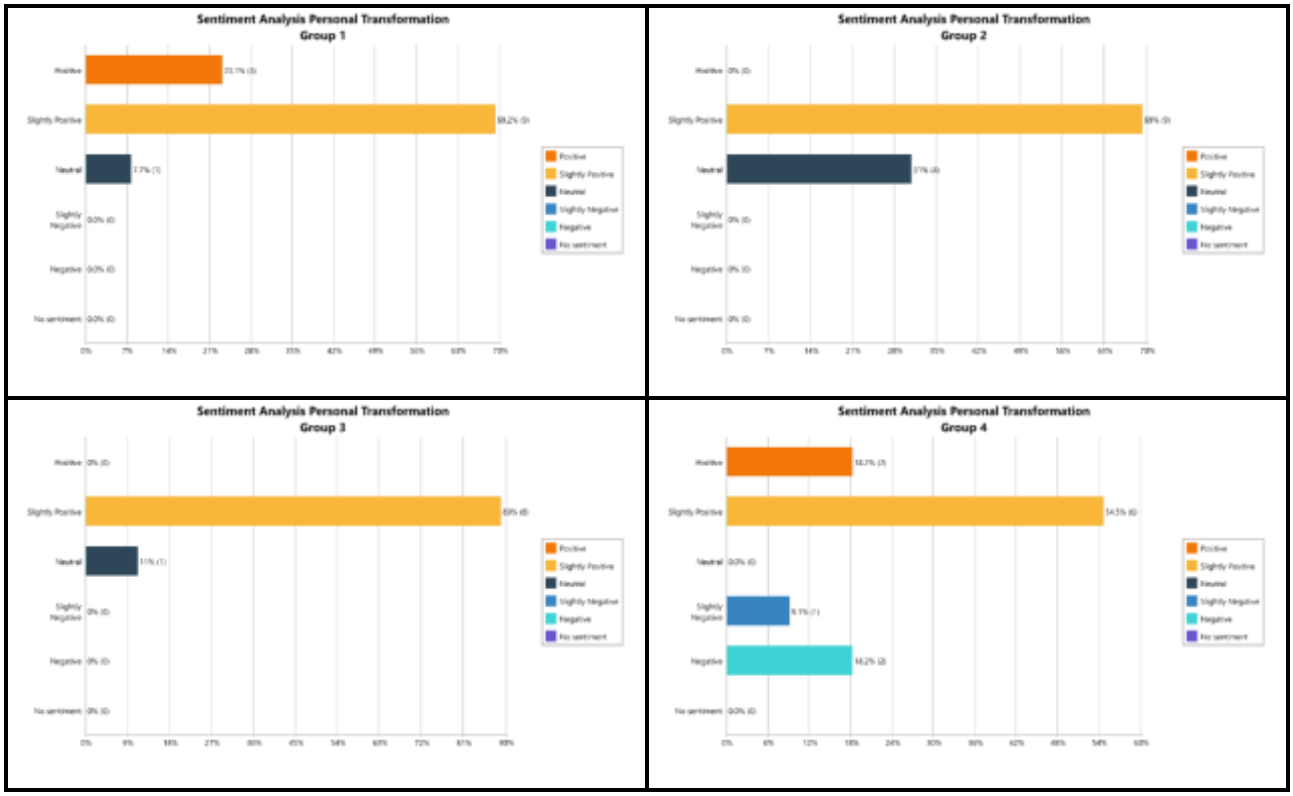


4.5.2.2.2 Sentiment Analysis of Personal Transformation

With documents from four groups, we present in Table 4.14 the sentiment analysis of the second parent code: Personal transformation, which was conducted based on the creative coding tool of MAXQDA. The results from Table 4.5.3. show five scales of the sentiment analysis, including negative, slightly negative, neutral, slightly positive and positive. This analysis showed that “slightly positive” analysis is dominant in four groups, 69.2%, 69%, 89% and 54.5%, respectively, from group 1 to group 4. However, comparing each pair of experimental and control groups, specifically group 1 and group 2, the results showed no difference in “slightly positive” analysis. It was not repeated in groups 3 and 4 when the analysis results showed that the “slightly positive” analysis rate in group 3 was one and a half times higher than in group 4.

Table 4.14

Sentiment analysis of personal transformation in four groups

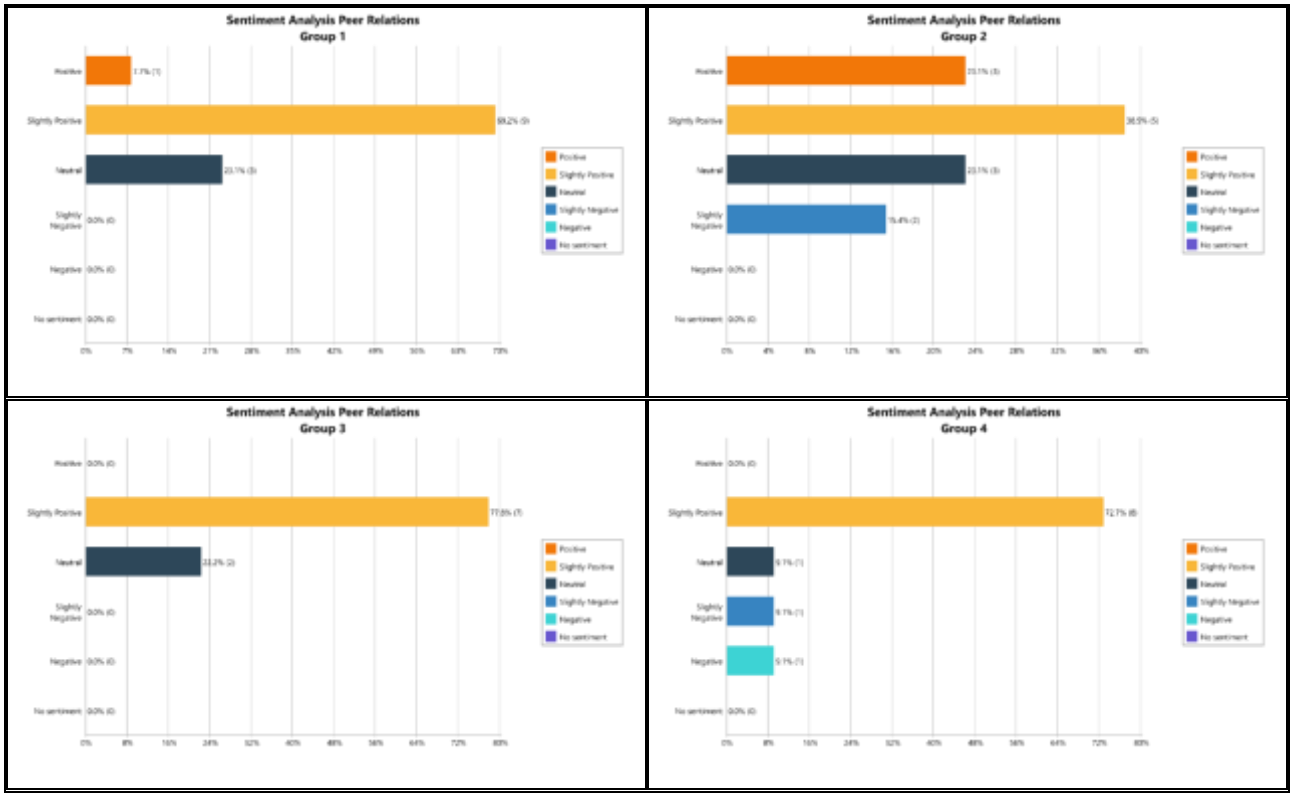


4.5.2.2.3 Sentiment Analysis of Peer Relations

In this section, we repeated the results of the sentiment analysis of the last parent code, “peer relations”, in four groups. The results from Table 4.15 show five scales of the sentiment analysis, including negative, slightly negative, neutral, slightly positive and positive. The sentiment analysis played a dominant part in the four groups was “slightly positive”, 69.2%, 38.5%, 77.8% and 72.7%, respectively, from group 1 to group 4. Taking a closer look at the “slightly positive analysis”, it was dominant in group 1, and the rate of analysis in group 1 was 1.7 times higher than that of group 2. However, there was no difference in this sentiment analysis in group 3 and group 4 when the proportions seemed to be approximately the same. On the other hand, the diversity in this analysis is more evident in the two control groups, group 2 and group 4, when expressing 4/5 of the evaluation values of the analytical scale. While this is shown in two experimental groups, 1 and 3, it is only 2/5 and 3/5, respectively.

Table 4.15

Sentiment analysis of peer relations in four groups



4.5.2.3 Category One: Research Question 1

The parent code of category one is “Climate Change Response”, which includes five sub-codes:

1. Reality awareness
2. Climate change responsibility
3. Human-climate connectedness
4. Climate co-empowerment
5. Knowledge adaption

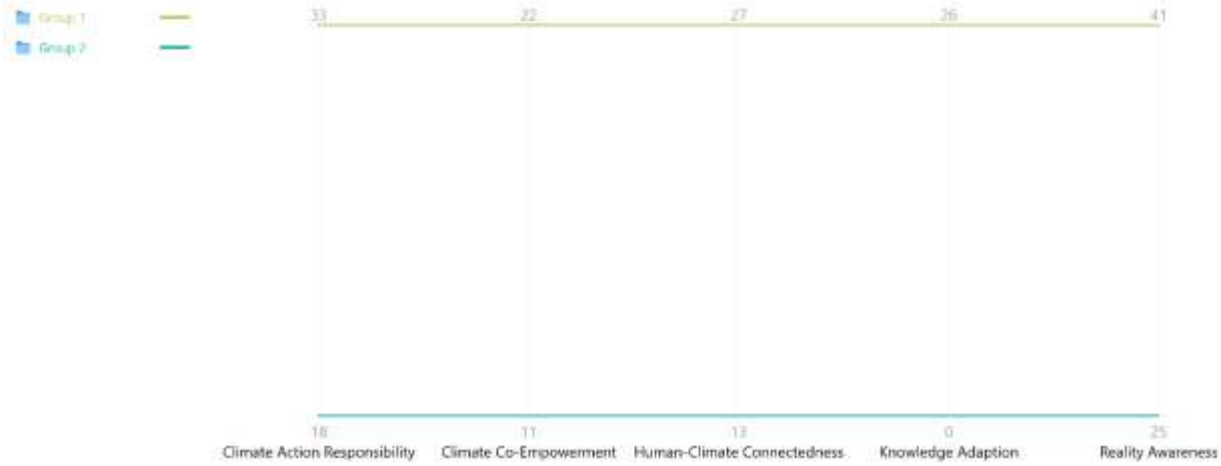
4.5.2.3.1 Profile comparison

The Visual Tool Profile Comparison Chart in MAXQDA allows us to compare cases in their code frequencies. Using this tool, we can identify similarities and differences between cases in assigned groups regarding code assignments. Crucial differences in frequency between groups 1 and 2, groups 3 and 4 at five sub-codes (reality awareness, knowledge adaption, human-climate connectedness, climate co-empowerment and climate action responsibility) of the first parent code, "Climate Change Response", are presented in Figures 4.24 and 4.25. We named the first main differences between experimental and control groups by counting sub-codes frequencies. The results collected from the profile comparison between groups show the role of art-informed science learning toward participants’ understanding and climate change response.

Results from Figure 4.24 show a profound difference between the experimental and control groups 1 and 2. When comparing the frequency of each sub-code, experimental group 1 showed the advantage in all four codes, including reality awareness, human-climate connectedness, climate co-empowerment and climate action responsibility, when all these four codes showed twice the high frequency in interview documents compared to control group 2. In the sub-code “knowledge adaption”, there is no indication that this code is repeated in control group 2, while this number in experimental group 1 is 26 times.

Figure 4.24

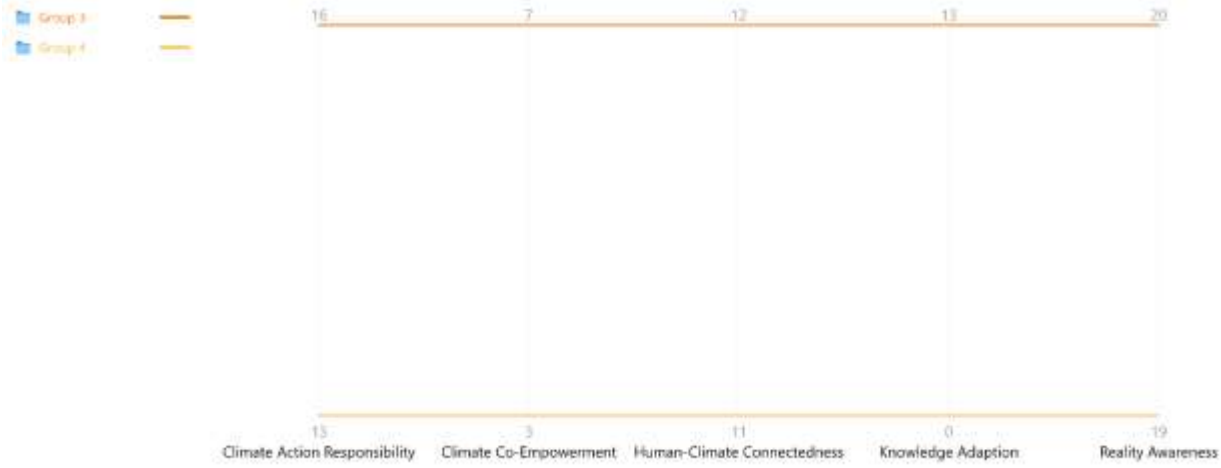
Sub-code frequencies of parent code “Climate Change Response” in groups 1 and 2



The difference was also shown in the study's other two experimental and control groups when the same comparison system was established in Figure 4.25. The difference in sub-codes frequency in groups 3 and 4 is not as sharp as in groups 1 and 2, except for the sub-code “climate co-empowerment”. One common point that should be mentioned in this analysis is that the sub-code “knowledge adaption” has no definite value in the control group 4, while this code is repeated in experimental group 3 13 times.

Figure 4.25

Sub-code frequencies of parent code “Climate Change Response” in groups 3 and 4



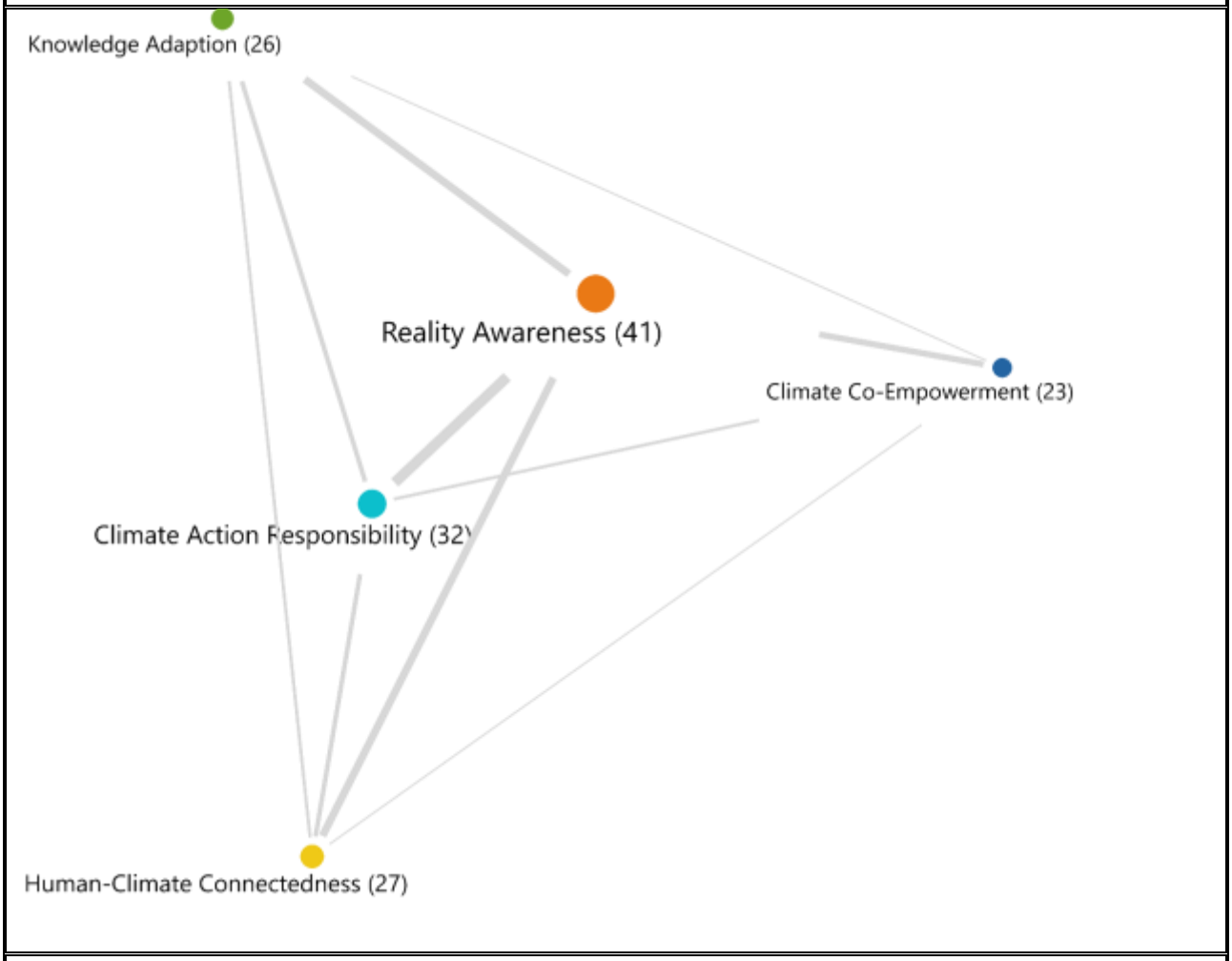
4.5.2.3.2 Code Map

By using MAXQDA, the tool "Code Map" calculated the "Proximity of codes in the same document". We aimed to count the times two codes were assigned at a definable distance in the same document. Each circle symbolises a code, with the distances between two codes representing how similarly the codes have been applied in the data material. In addition, connecting lines between the codes were activated, which indicated which codes overlap or co-occur. The thicker the connection lines are exhibited, the more coincidences between the two codes. Tables 4.16 and 4.17 present the code maps of four groups, including five sub-codes of the first parent code, “climate change response”.

Table 4.16

"Climate change response" code map of groups 1 and 2

Group 1: 5 clusters



Group 2: 4 clusters

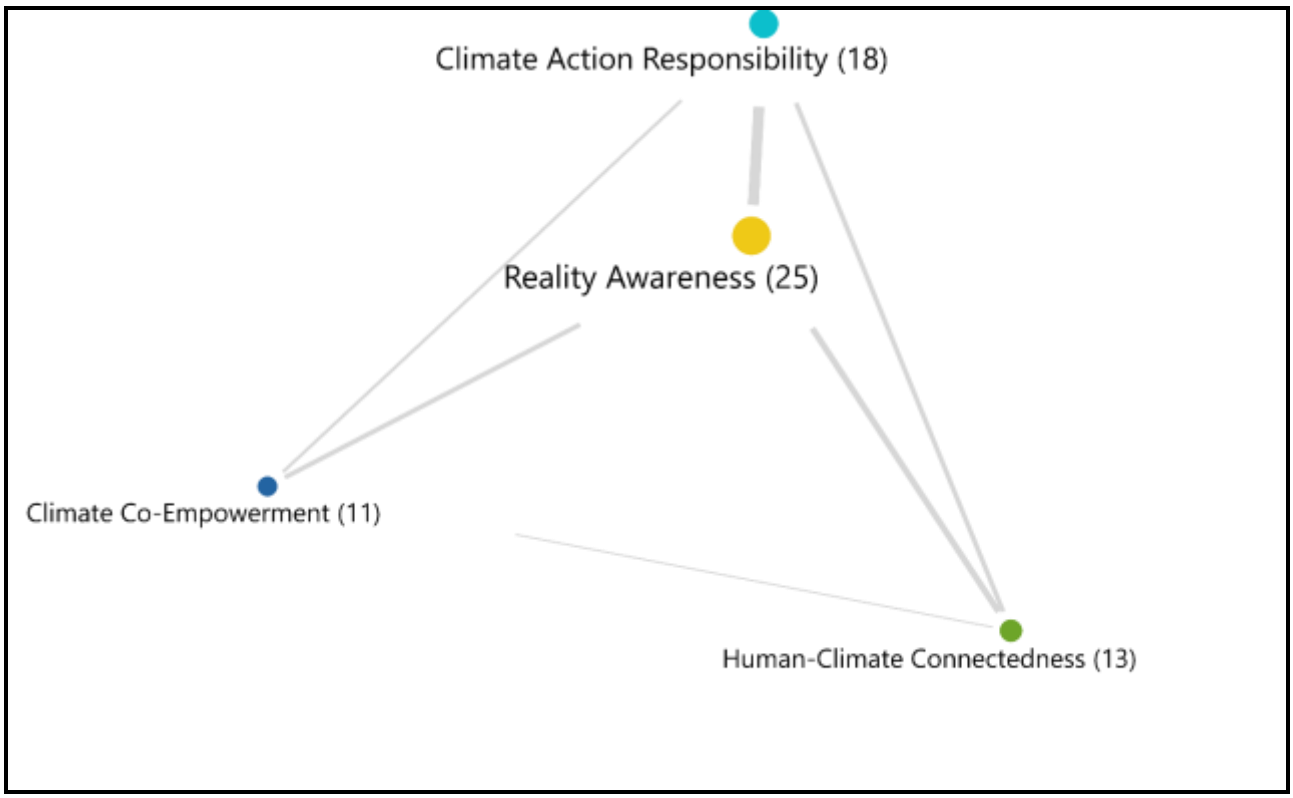
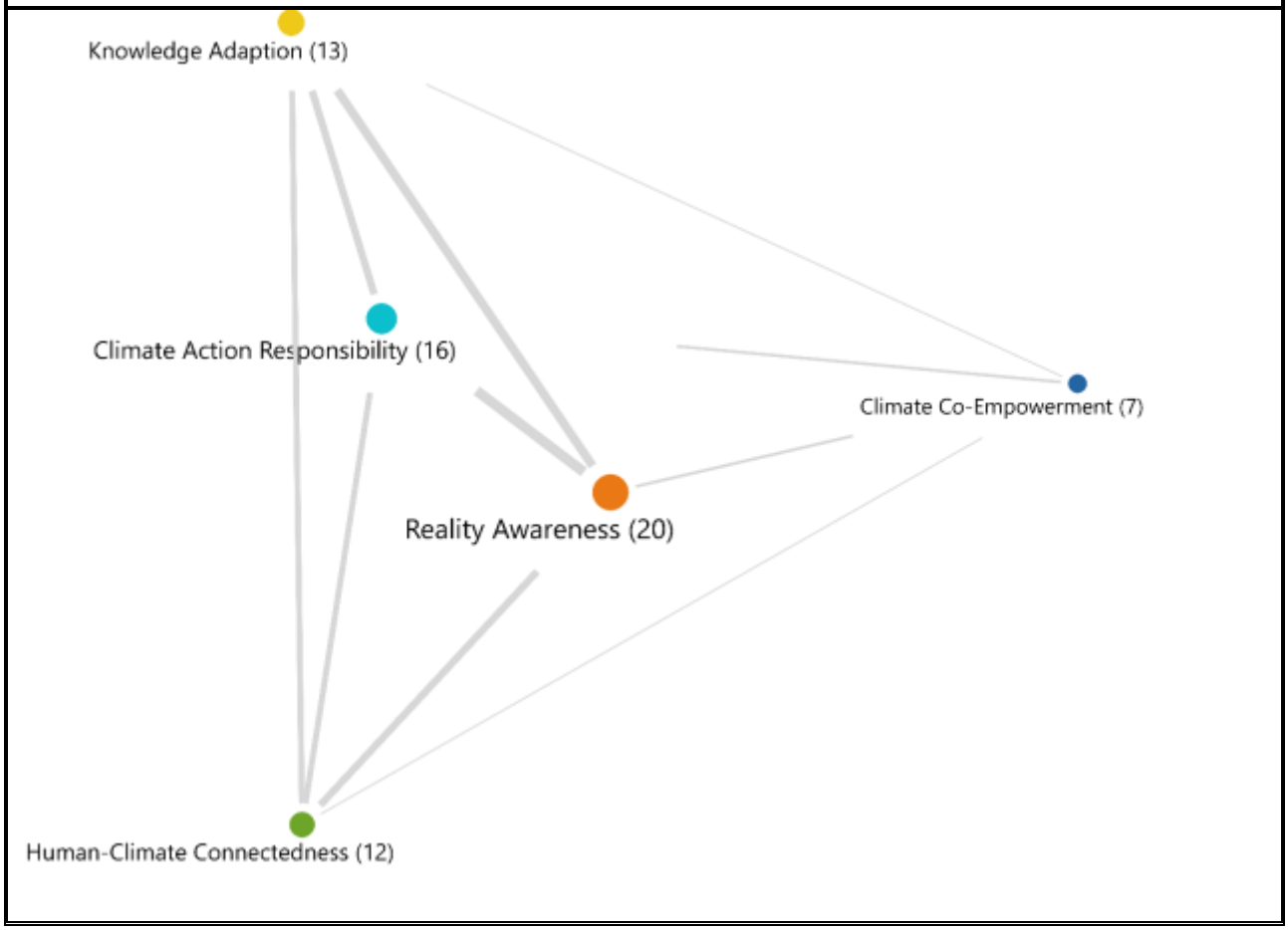


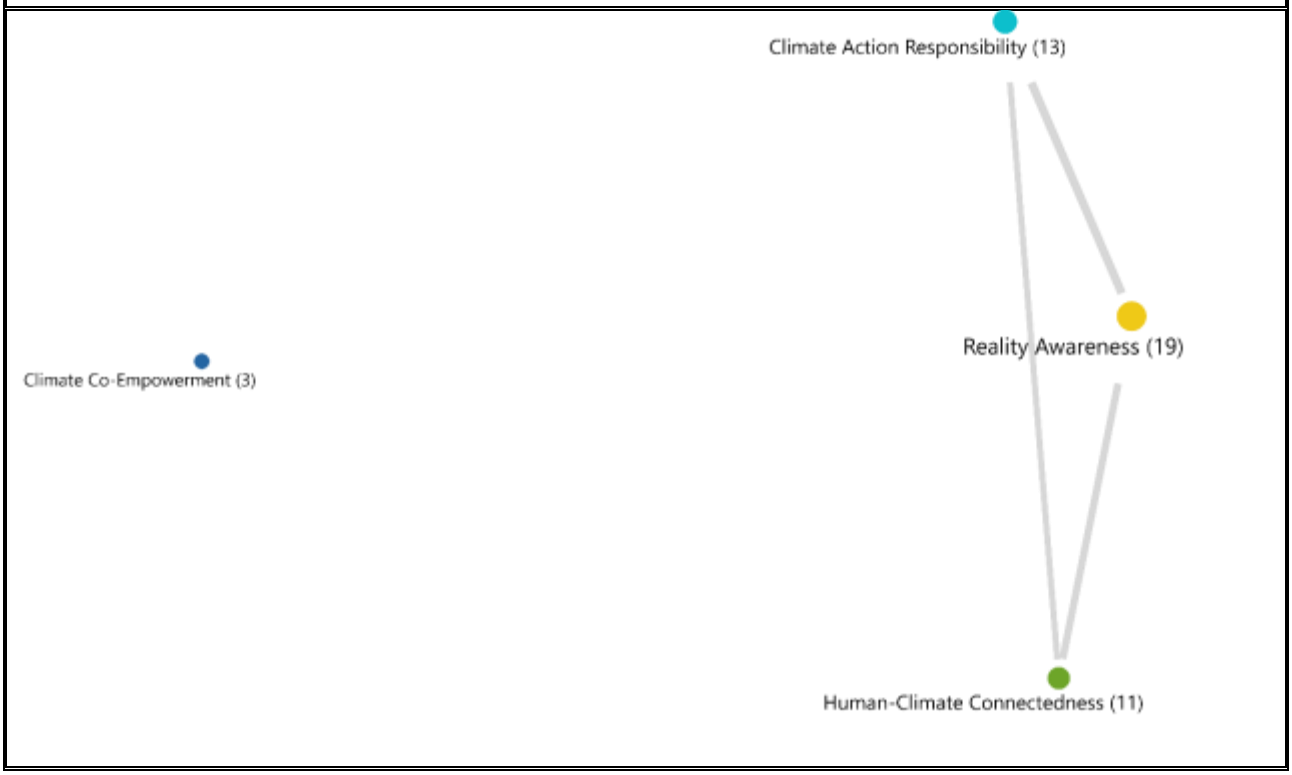
Table 4.17

"Climate change response" code map of groups 3 and 4

Group 3: 5 clusters



Group 4: 3 clusters



The code map presents the findings of research question 1. In this code map, we found the following differences:

1. The results of the comparison between the experimental and control groups showed that in the experimental groups, there was a complete appearance of five sub-codes, or called in another name, "five clusters". Meanwhile, only four clusters were detected in the control groups.
2. When comparing experimental group 1 and control group 2, there is a difference in the association between clusters. Specifically, all five clusters have a correlation connection, and “Reality Awareness” and “Climate Action Responsibility” connect the centre with the rest of the clusters on the map. This shows that these two clusters are central in forming coherence relative to the remaining clusters. However, on the code map of group 2, only four clusters of the first parent code appear, and there is no appearance of the cluster “Knowledge Adaption”.
3. Continuing to compare the code map of experimental group 3 and control group 4, the connection of clusters in these two groups is very different. Precisely similar to the code map results of experimental group 1, experimental group 3 shows a close association between clusters when there are all five clusters. The “Reality Awareness” and “Climate Action Responsibility” clusters stand at the code map's centre. This means these two clusters are central in forming links with the remaining clusters. On the contrary, in the code map of control group 4, the connection between clusters is very loose when only the correlation triangle between three clusters is formed - “Reality Awareness”, “Climate Action Responsibility”, and “Human-Climate Connectedness”. The remaining cluster, “Climate Co-Empowerment”, has no connection with the other three medium clusters mentioned previously.

The detection results in the code map of each group showed the difference between the experimental and control groups. The explanation for this difference lies in the participation of the experimental groups in the art-informed science learning setting. In response to research question #1, full participation in the study's learning sessions is effective in the climate change response of participants.

4.5.2.4 Category Two: Research Question 2

The parent code of category two is "Personal Transformation through Art", which includes four sub-codes:

1. Individual understanding of the world
2. Individual imagination
3. Future actions
4. Ambassador / Agency

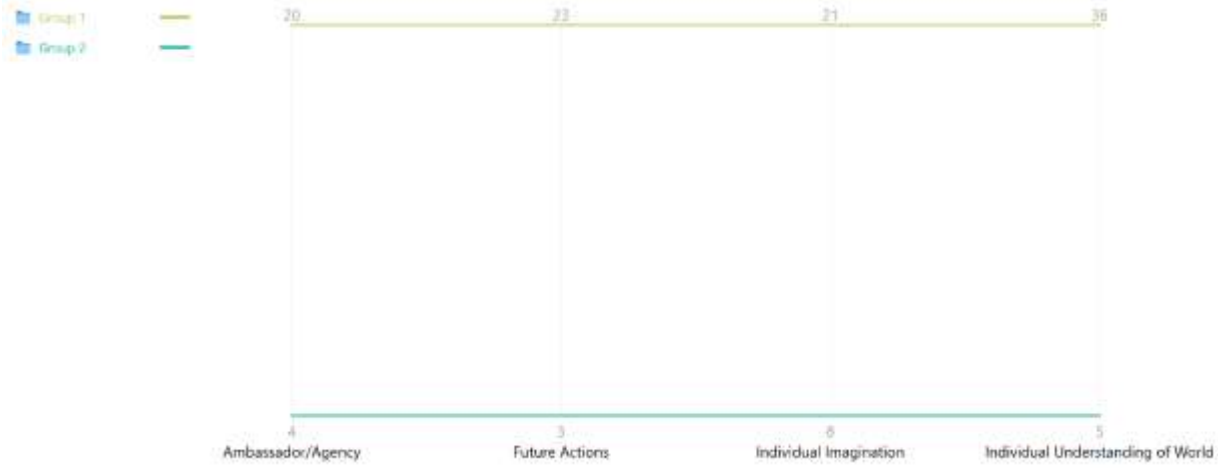
4.5.2.4.1 Profile comparison

The Visual Tool Profile Comparison Chart in MAXQDA allows us to compare cases in their code frequencies. Using this tool, we can identify similarities and differences between cases in assigned groups regarding code assignments. Crucial differences in frequency between groups 1 and 2, groups 3 and 4 at four sub-codes (individual understanding of world, individual imagination, future actions and ambassador/agency) of the second parent code, "Personal Transformation through Art", are presented in Figures 4.26 and 4.27. By counting sub-codes frequencies, we named the first main differences between experimental and control groups in the second theme of personal transformation through art. The results collected from the profile comparison between groups show the role of art-informed science learning in participants' transformation and their transformative experiences in climate change.

Results from Figure 4.26 show a significant difference between the experimental group 1 and the control group 2. When comparing the frequency of each sub-code, experimental group 1 showed the advantage in all four codes, including the individual understanding of the world, imagination, future actions and ambassador/agency. Significantly, the sub-codes "individual understanding of the world" and future actions in experimental group 1 show seven times as high frequency in interview documents compared to control group 2. The other two sub-codes of group 1, "Individual imagination" and "Ambassador/agency", show over 2.5 times and five times, respectively, as high frequency compared to group 2.

Figure 4.26

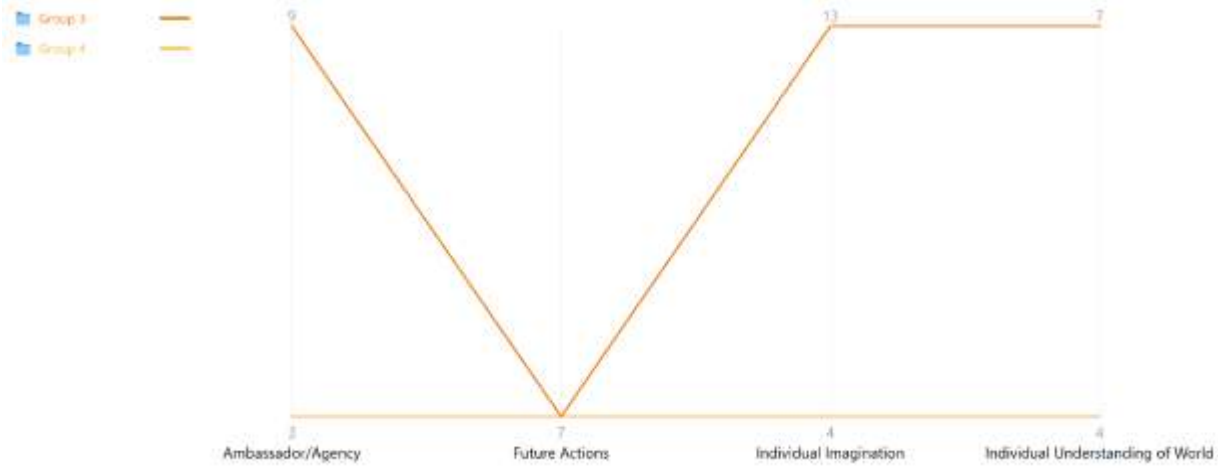
Sub-code frequencies of parent code "Personal Transformation through Art" in groups 1 and 2



However, in Figure 4.27, participants in groups 3 and 4 share one similarity in the sub-code "Future Actions, " repeated seven times in both groups. The other three sub-codes, “Individual understanding of world”, “Individual imagination”, and “Ambassador/agency”, share the same circumstances when compared between groups 3 and 4. Notably, experimental group 3 experienced higher frequencies than control group 4.

Figure 4.27

Sub-code frequencies of parent code “Personal Transformation through Art” in groups 3 and 4



4.5.2.4.2 Code Map

Similar to the code map of question #1, we used the tool "Code Map" to calculate the "Proximity of codes in the same document". Tables 4.18 and 4.19 present the code maps of four groups, including four sub-codes of the second parent code, “personal transformation through art”.

The code map presents the findings of research question 1. In this code map, we found the following differences:

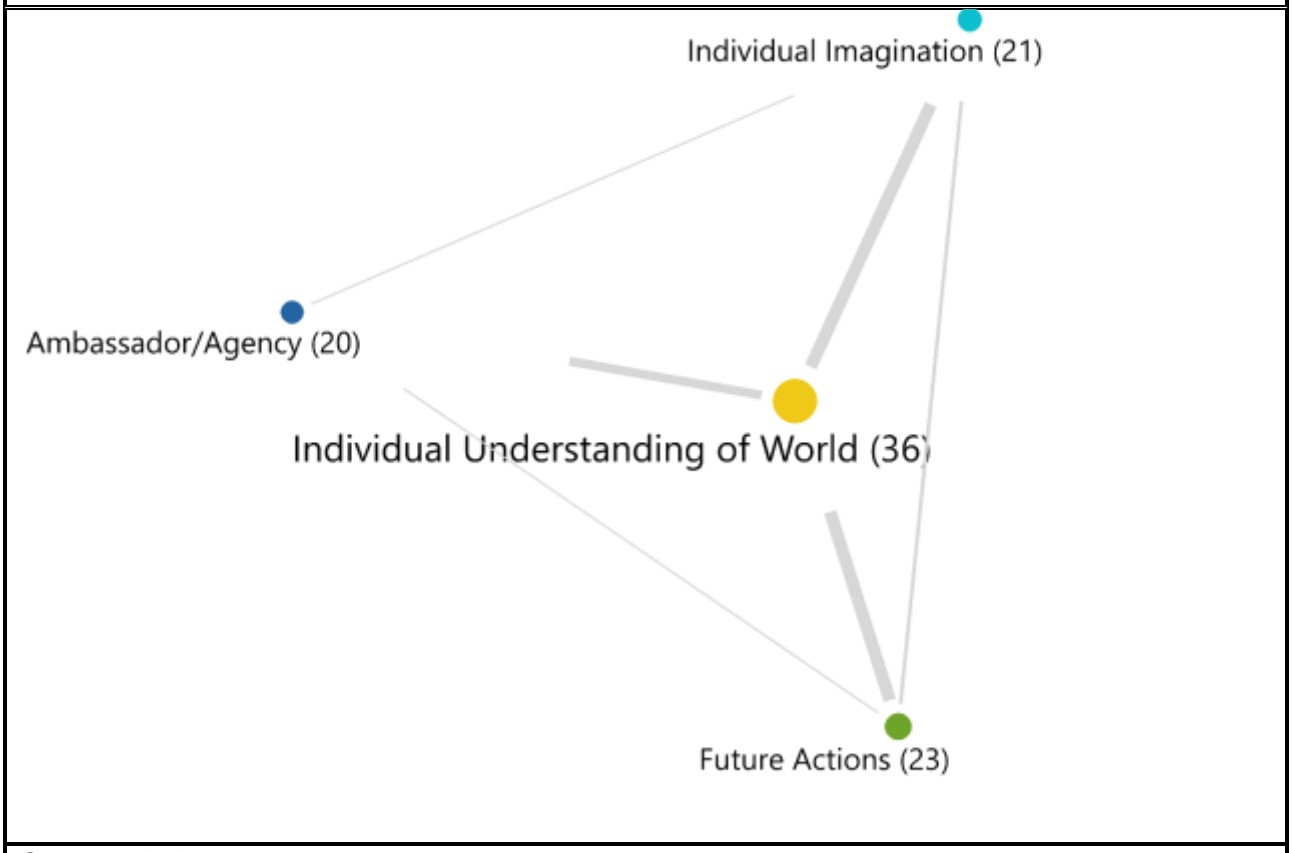
1. The comparison between the experimental and control groups showed that in the experimental groups, only group 1 shows a wholly connected map of all four sub-codes, or called by another name, "four clusters". Meanwhile, in the code map of the remaining experimental group - group 3, there is only a triangle of three sub-codes, including individual imagination, ambassador/agency and future actions. In contrast, the last sub-code, “individual understanding of world”, is only connected with the sub-code “individual imagination”. A different picture is shown in two control groups, 2 and 4, that there is no connection between the four sub-codes of these groups.
2. When comparing experimental group 1 and control group 2, besides the first difference is the discreteness in group 2 and the close connection between the sub-codes of group 1, an easy point to see is the frequency of repetition of the sub-codes in the two groups. Specifically, the proportions of each sub-code in group 1 and group 2 are as follows: Individual understanding of the world (7.8:1); individual imagination (2.6:1); future actions (5.75:1) and ambassador/agency (6.67:1). This can explain the effectiveness of applying art to science learning activities, specifically the topic of climate change. This combined application provides participants with distinctly personal transformational experiences, encourages active and active participation, increases the experience, and helps to better visualize and shape the future actions that the participants want to perform in the future.
3. Continuing to compare the code map of experimental group 3 and control group 4, the connection of clusters in these two groups is very different. Similar to the code map results of experimental group 1, experimental group 3 shows a close association between four clusters. Only cluster “individual imagination” connects with the remaining clusters and establishes a triangle with two clusters, “ambassador/agency” and future actions. In comparison, there is no correlation between cluster “individual understanding of world” with the two clusters, “ambassador/agency”, and future actions. On the contrary, in the code map of control group 4, the connection between four clusters does not happen.

The detection results in the code map of each group showed the disparity between the experimental and control groups. The explanation for this difference lies in the participation of the experimental groups in the art-informed science learning setting. In response to research question #2, full participation in the study’s learning sessions is effective in personal transformation through art.

Table 4.18

"Personal Transformation through Art" code map of groups 1 and 2

Group 1: 4 clusters



Group 2: 4 clusters

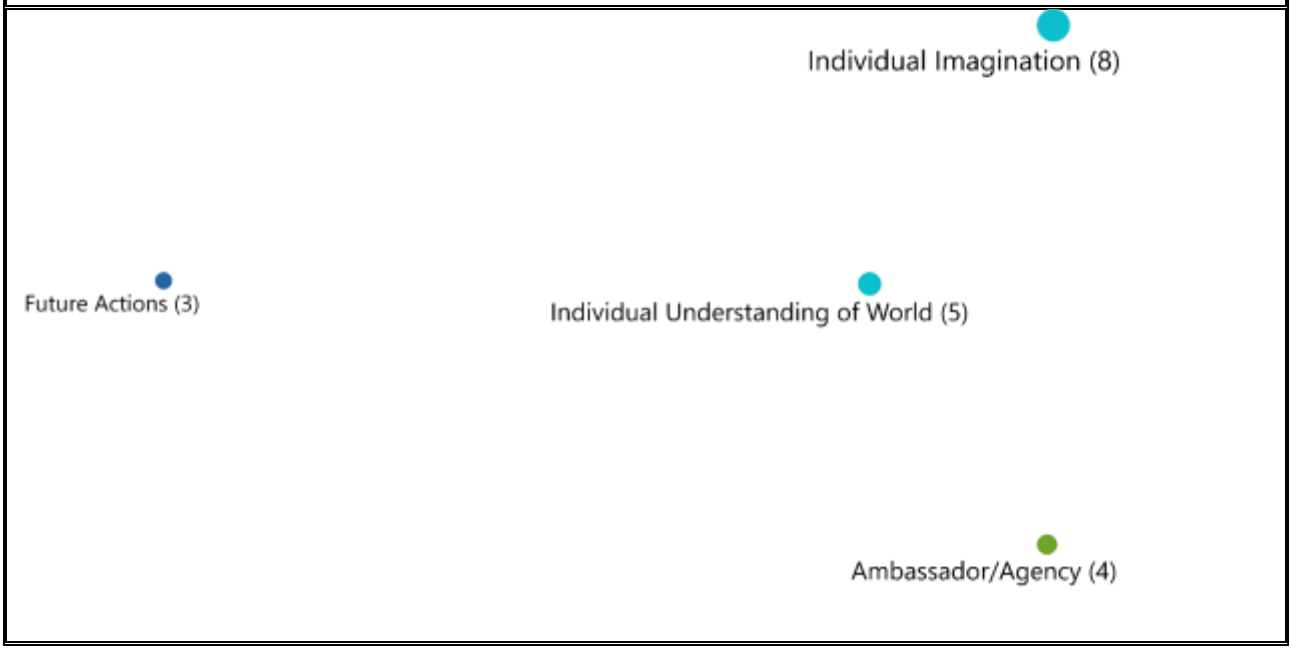
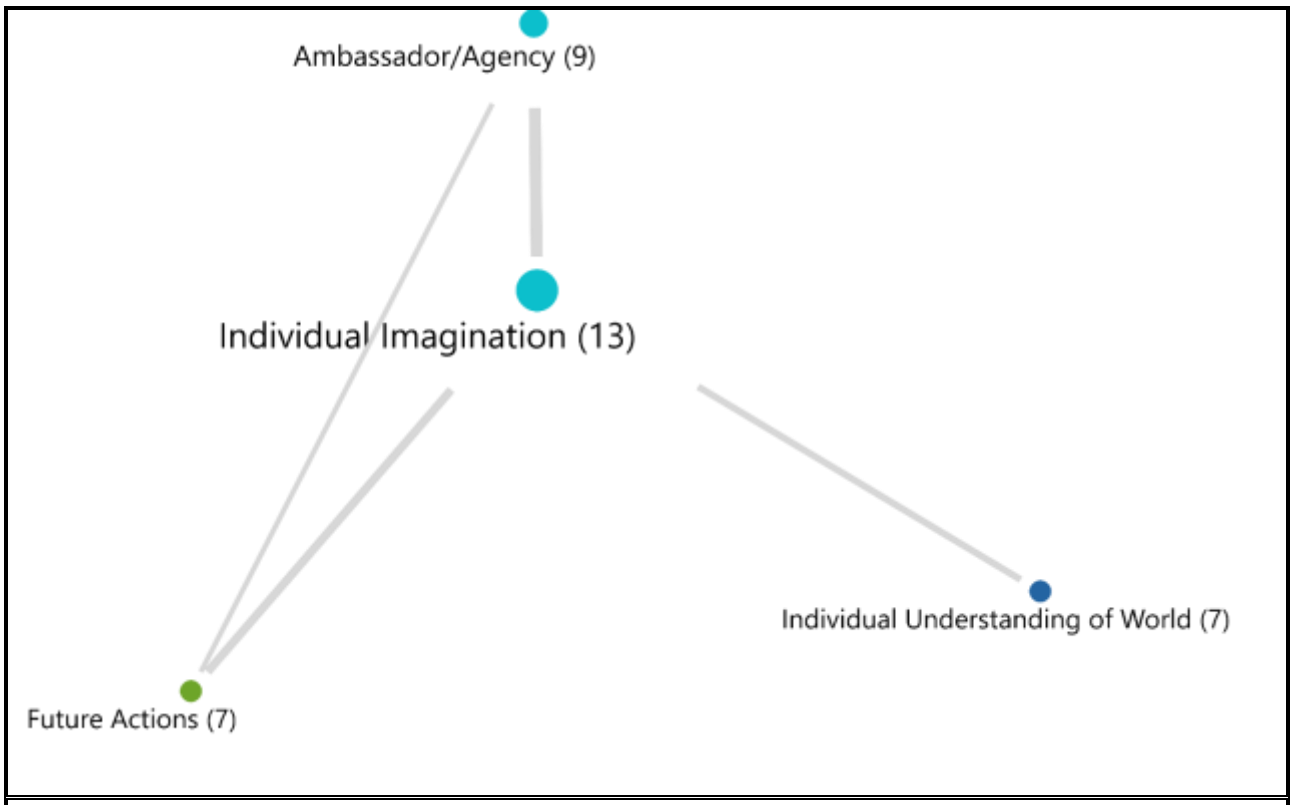


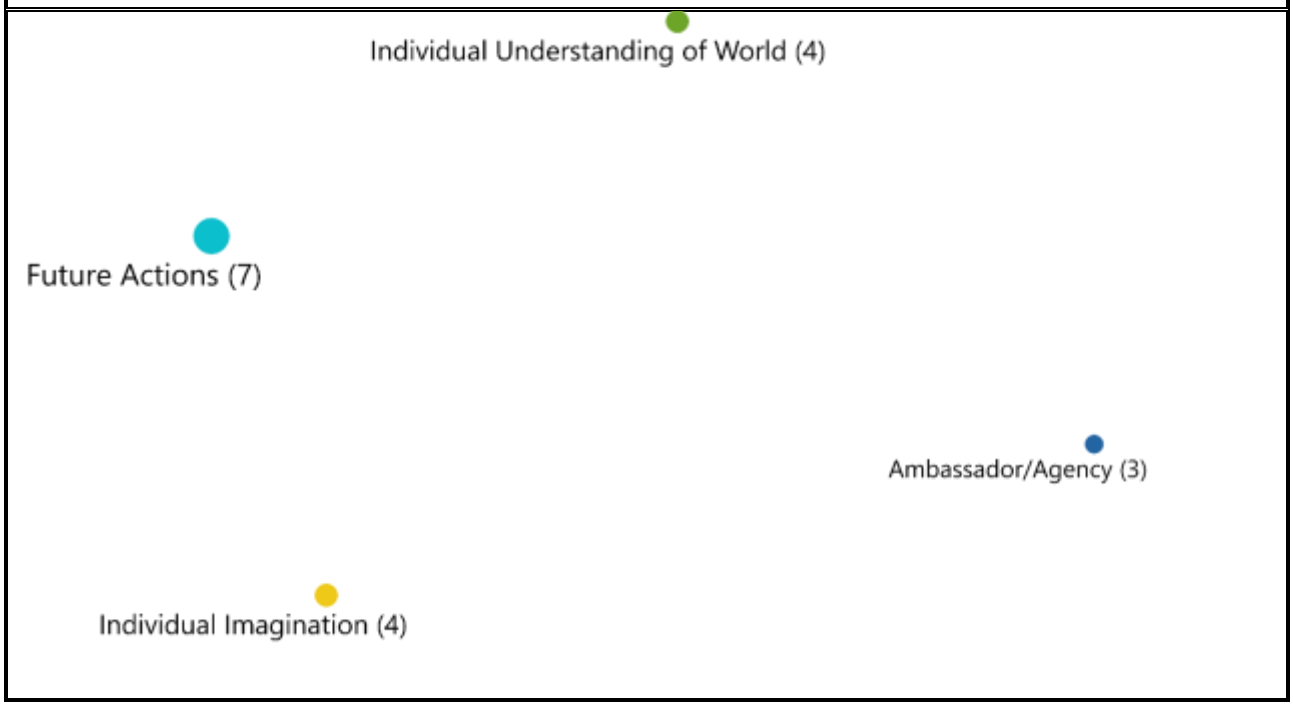
Table 4.19

"Personal transformation through Art" code map of groups 3 and 4

Group 3: 4 clusters



Group 4: 4 clusters



4.5.2.5 Category Three: Research Question 3

The parent code of category three is “Peer relations through Art”, which includes two sub-codes at level 1 and three sub-codes at level 2:

1. Peer acceptance
2. Peer interactions with three sub-codes: perspective-taking, teamwork and communication

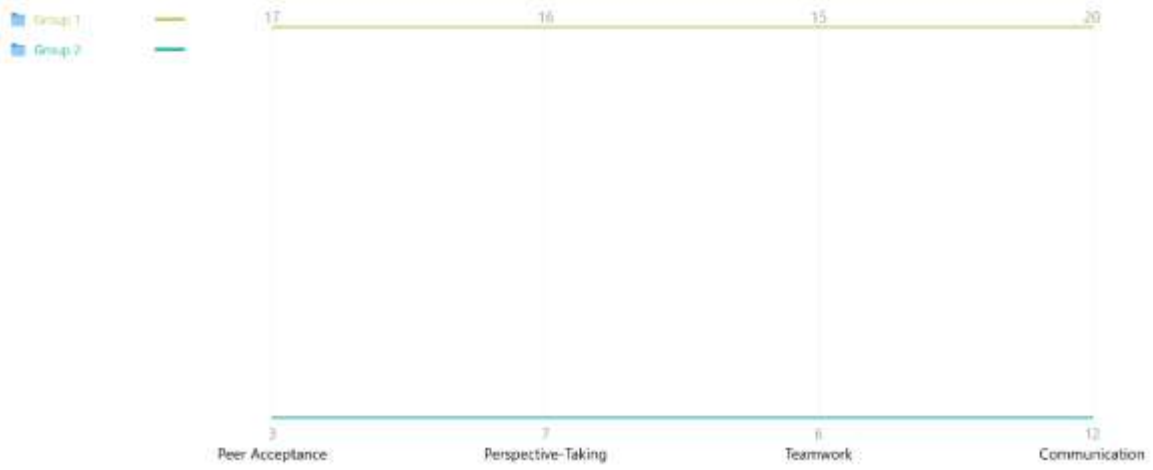
4.5.2.5.1 Profile comparison

The Visual Tool Profile Comparison Chart in MAXQDA allows us to compare cases in their code frequencies. Using this tool, we can identify similarities and differences between cases in assigned groups regarding code assignments. Crucial differences in frequency between groups 1 and 2, groups 3 and 4 at all sub-codes (peer acceptance and peer interactions with three sub-codes: perspective-taking, teamwork and communication) of the last parent code, “peer relations through art”, are presented in Figures 4.28 and 4.29. By counting sub-codes frequencies, we named the first main dissimilarities between experimental and control groups in the third theme of peer relations through art. The results collected from the profile comparison between groups show the role of art-informed science learning in participants’ peer relations development through their transformative learning experiences in climate change.

Results from Figure 4.28 show a significant difference between the experimental group 1 and the control group 2. When comparing the frequency of each sub-code, experimental group 1 showed the advantage in all sub-codes. Significantly, the sub-codes “perspective-taking” and “peer interactions” in experimental group 1 show 4.3 times as high frequency in interview documents compared to control group 2. The other three sub-codes of group 1, “communication”, “teamwork”, and “peer acceptance”, show over 1.67 times, 2.5 times and 5.67 times, respectively, as high frequency compared to group 2.

Figure 4.28

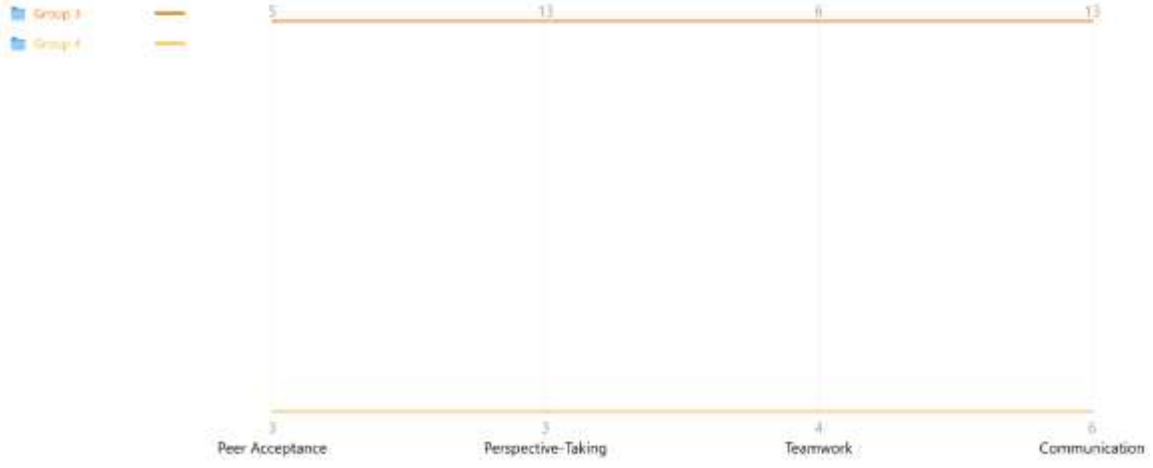
Sub-code frequencies of parent code “Peer Relations through Art” in groups 1 and 2



The difference was also shown in the study's other two experimental and control groups when the same comparison system was established, as presented in Figure 4.29. The difference in sub-codes frequency in groups 3 and 4 is as sharp as in groups 1 and 2. Significantly, the sub-codes “perspective-taking” and “peer interactions” in experimental group 3 show 4.3 times as high frequency in interview documents compared to control group 4. The other three sub-codes of group 3, “communication”, “teamwork”, and “peer acceptance”, show over 2.17 times, 1.5 times and 1.67 times, respectively, as high frequency compared to group 4.

Figure 4.29

Sub-code frequencies of parent code “Peer Relations through Art” in groups 3 and 4



4.5.2.5.2 Code Map

Similar to the code map of questions #1 and #2, we continued using the "Code Map" tool to calculate the "Proximity of codes in the same document". Tables 4.20 and 4.21 present the code maps of four groups, including four sub-codes (at both levels) of the third parent code, “peer relations through art”.

The code map presents the findings of research question 3. In this code map, we found the following differences:

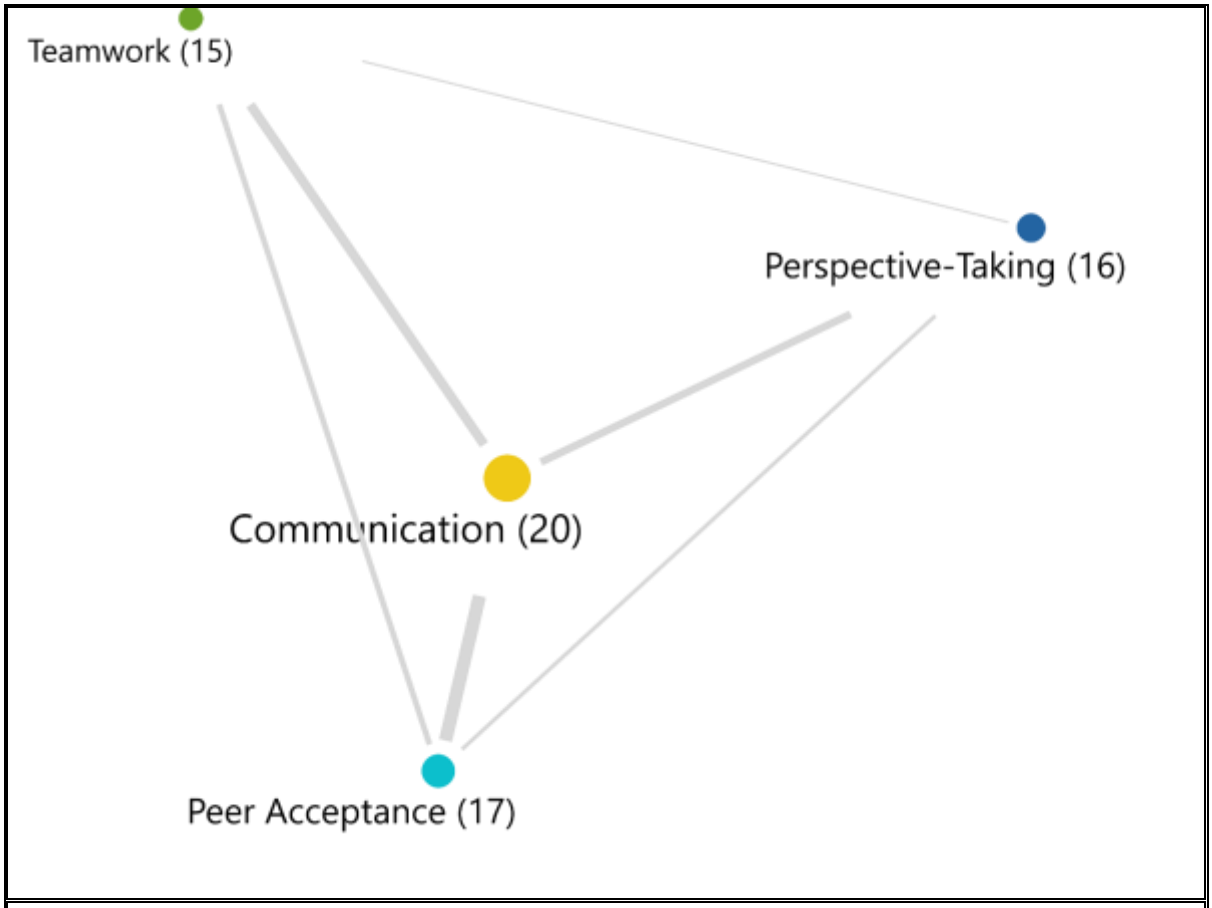
1. The comparison between the experimental and control groups showed that in the experimental groups, only group 1 shows a wholly connected map of all four sub-codes, or called by another name, "four clusters". Meanwhile, in the code map of the remaining experimental group - group 3, there is only one connection between double sub-codes, “perspective-taking” and “communication” and teamwork, while the last sub-code, “peer acceptance”, is separate from the rest of the sub-codes. A different picture is shown in two control groups, 2 and 4, that there is no connection between the four sub-codes of these groups.
2. When comparing experimental group 1 and control group 2, besides the first difference is the discreteness in group 2 and the close connection between the sub-codes of group 1, an easy point to see is the frequency of repetition of the sub-codes in the two groups. Specifically, the proportions of each sub-code in group 1 and group 2 are as follows: communication (1.67:1), teamwork (2.5:1), perspective-taking (2.29:1) and peer acceptance (5.67:1). This can explain the effectiveness of applying art to science learning activities, specifically the topic of climate change. This combined application provides participants with opportunities to present their ideas and artwork, a space to communicate, exchange ideas, and embrace each other's perspectives. Being open in communication and receiving views, sharing, and suggestions from peers helps participants become more confident in presenting their work and motivated to contribute to the development of each individual and their friends.
3. Continuing to compare the code map of experimental group 3 and control group 4, the connection of clusters in these two groups is very different. As mentioned earlier, there is a visible connection between sub-codes in group 3. However, there is a visible distance between the four sub-codes in group 4.

The detection results in the code map of each group showed the variations between the experimental and control groups. The explanation for this difference lies in the participation of the experimental groups in the art-informed science learning setting. In response to research question #3, full participation in the study’s learning sessions is effective in peer relations through art.

Table 4.20

“Peer Relations through Art” code map of groups 1 and 2

Group 1: 4 clusters



Group 2: 4 clusters

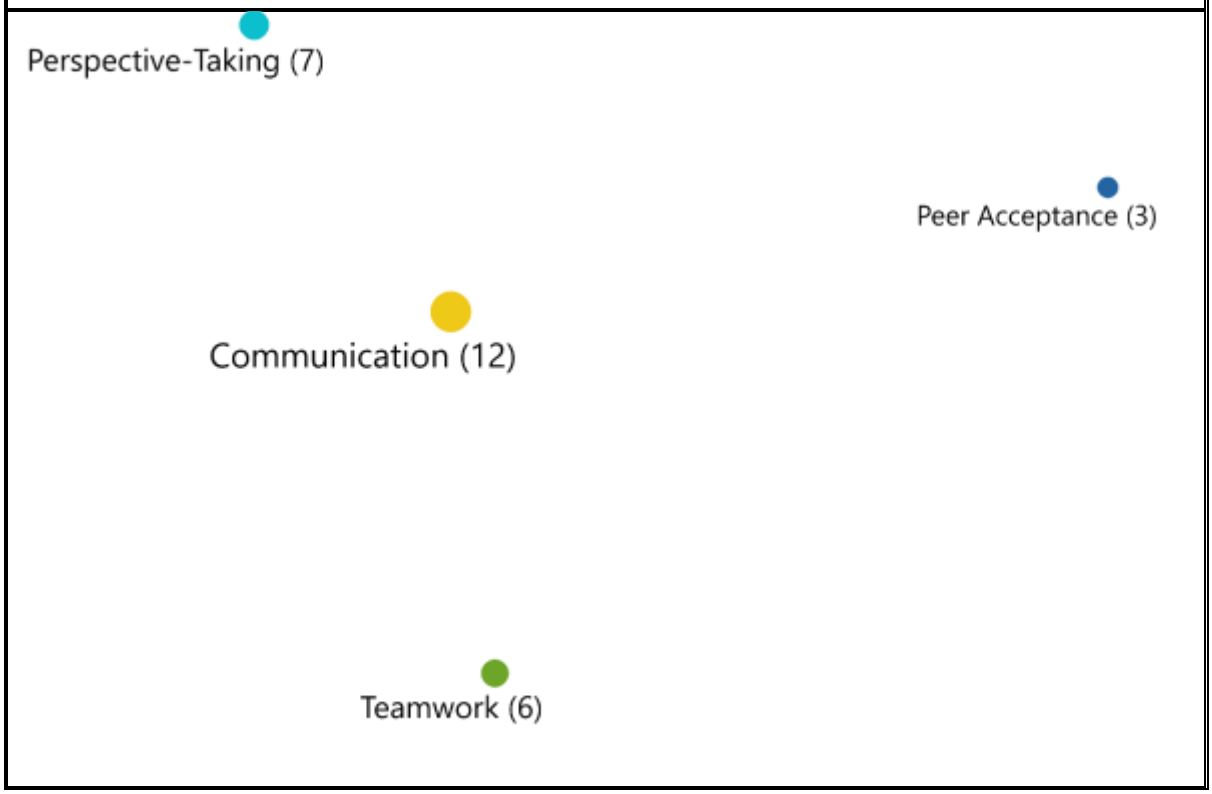
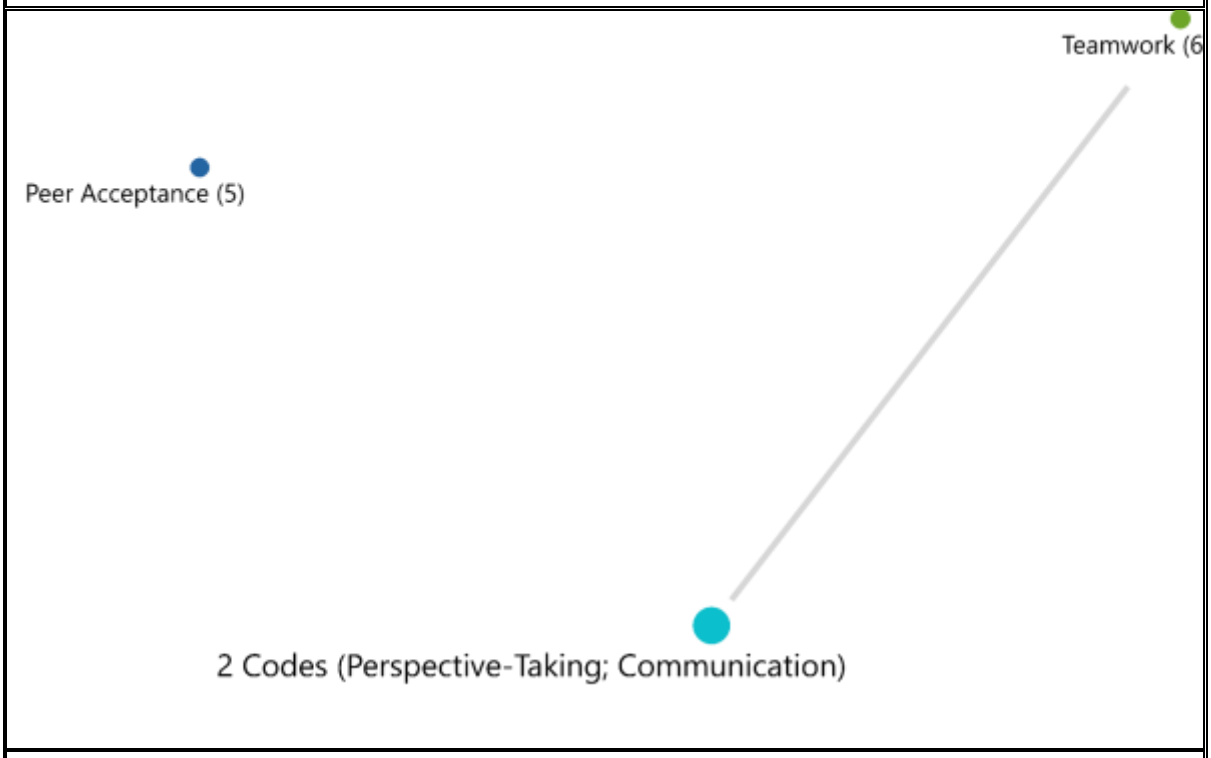


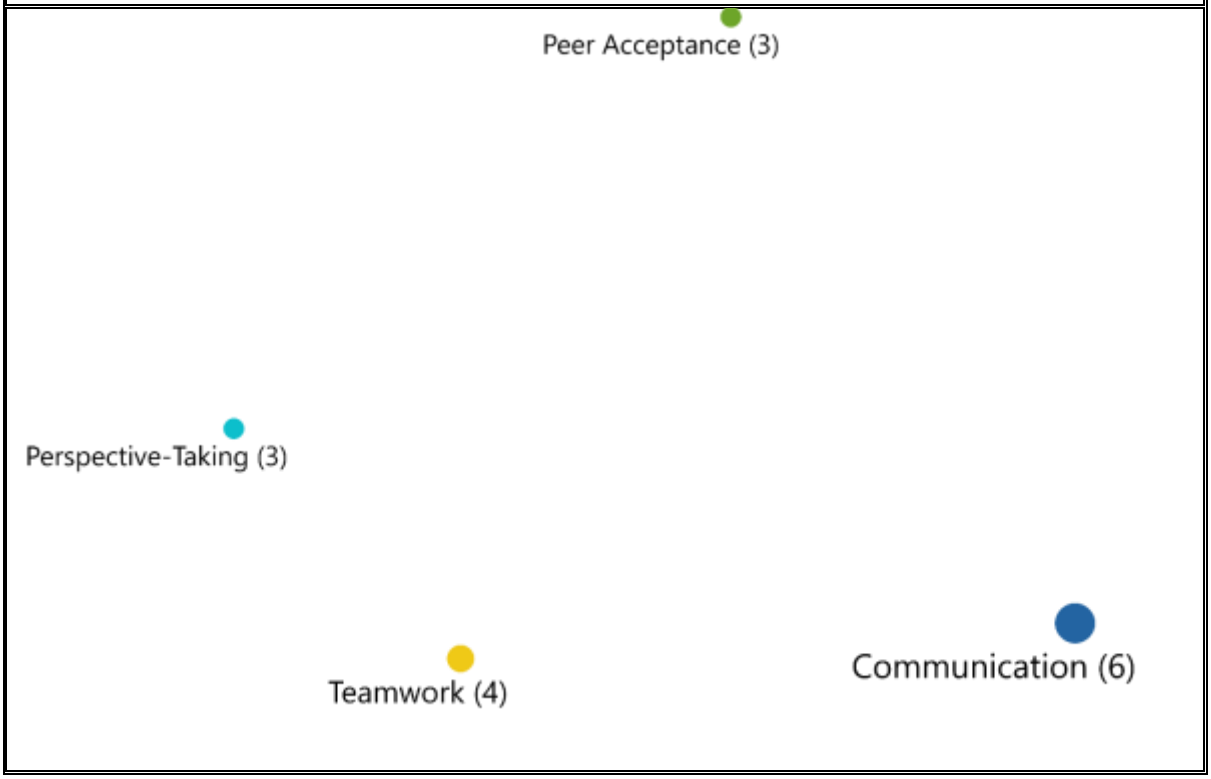
Table 4.21

"Peer Relations through Art" code map of groups 3 and 4

Group 3: 4 clusters



Group 4: 4 clusters



4.5.2.6 Case Study: Collective cases as representative cases

As Chapter 2 of Research Methodology mentions, we present our analysis of four cases in this section. The collective cases offered us more full-scale and insightful investigation for two reasons: (1) it involves worldviews about the given topic of participants whose experiences are different, and (2) each case is thoroughly studied and presented individually. The qualitative case study helps researchers investigate remarkable phenomena within the data-gathering sources. It performs a comprehensive assessment through a variety of lenses in order to reveal multifaceted components of the phenomenon (Baxter & Jack, 2008). Qualitative case study methodology enables researchers to explore complex phenomena in-depth within some specific context (Rashid et al., 2019).

Case study reporting is as important as empirical material collection and interpretation. A case study's quality depends on empirical material collection, analysis, and reporting (Denzin & Lincoln, 1998). A sound report structure and "story-like" writing are crucial to case study reporting. According to Rashid et al. (2019), there are six features should be considered while reporting a case study: (1) case descriptions, (2) participant descriptions, (3) relationship descriptions, (4) detail of field protocols, (5) empirical material interpretation and analysis and (6) conclusion.

Given the specific nature of this study, in which we combine the recommendations of Rashid et al. (2019) and the specificity of the data we collect and process through MAXQDA, our analysis includes the following aspects:

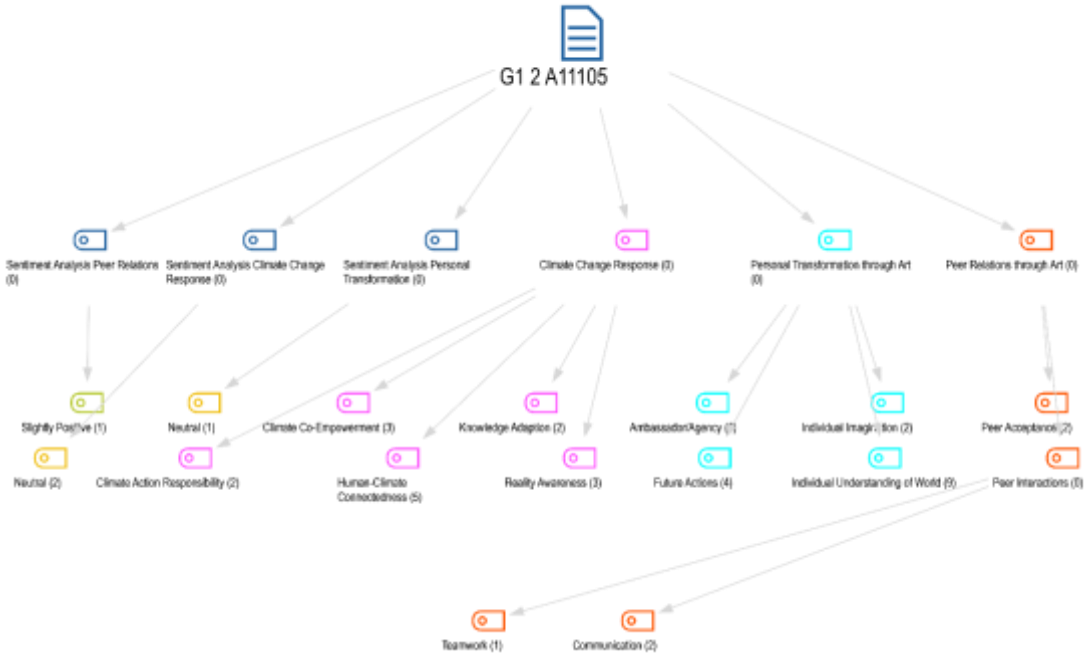
1. Case description
2. Participant description
3. Empirical material interpretation and analysis, including code hierarchy, code cloud, word cloud
4. Conclusion

This section presents our analysis of four cases from experimental group 1. Our detailed explanation and analysis of each case correspond to each aspect mentioned earlier. Tables 4.22 - 4.24 detail the analyses of each case, covering four aspects and, in each respect, the corresponding interpretation.

Table 4.22

A detailed analysis of case study G1 2 A11105

Case study analysis G1 2 A11105				
1. Case Description	Location	Ho Chi Minh City, Vietnam		
	Number of attended activities	KAP survey	Learning sessions	Interview

<table>
<tr><th colspan="5">Case study analysis G1 2 A11105</th></tr>
<tr><td></td><td></td><td>Yes</td><td>Yes (04 sessions)</td><td>Yes</td></tr>
<tr><td rowspan="2">2. Participant Description</td><td>Gender</td><td colspan="3">Male</td></tr>
<tr><td>Age</td><td colspan="3">17 years old</td></tr>
<tr><td colspan="5">3. Empirical material interpretation & analysis</td></tr>
<tr><td>3.1 Code Hierarchy</td><td colspan="4">Single-Case Model G1 2 A11105 (Code Hierarchy)
 

The image shows the presence of the three main code groups and each sub-code branch of this case, in addition to the sentiment analysis, which shows the diversity in the case interviews concerning the interview questions. When considering in detail the interview transcription of this case, for interview question 6, the answer provided by participant G1 2 A11105 code was judged to be very specific, detailed and insightful.

“I observed the apparent changes in two of my friends. At first, these two friends, A11144 and A11120, were bashful when speaking. However, over the past few weeks, I have seen a marked improvement from their side: breezily speaking and expressing their own opinions and drawing out messages to convey to others. I felt better interacting with them and seeing how their progress has improved. By observing their development, I have learned that I am more confident and dare to share my feelings and ideas.” (G1 2 A11105’s answer for interview question #6).</td></tr>
</table>

<table>
<tr><th colspan="2">Case study analysis G1 2 A11105</th></tr>
<tr><td></td><td>Specifically, this participant made a judgment from observing the positive change between his two friends and his own. In general, the participant and the two friends became confident and bold and dared to share their knowledge and actions with others and have ideas to work with others.</td></tr>
<tr><td>3.2 Code Cloud</td><td> 

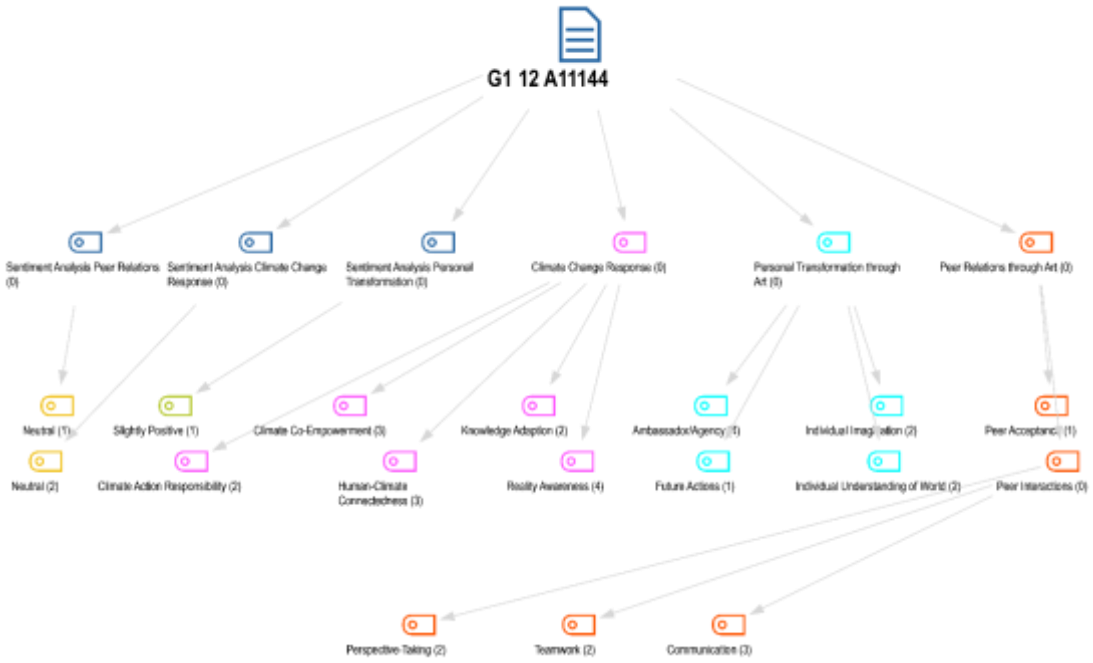
The code cloud of case G1 2 A11105 shows the central role of the code-named “Individual Understanding of World” about the rest of the other sub-codes of the code system in the framework of this study. Accordingly, for this participant, a unique understanding of the world plays a central role in responding to climate change, developing other facets of the personal sphere transformation and peer relations.</td></tr>
<tr><td>3.3 Word cloud</td><td> 
</td></tr>
</table>

Case study analysis G1 2 A11105	
	The word cloud shows that "I" is in the centre position. Using the “interactive word tree” tool, we calculated that there were 18 branches of the word “I” for this case, which is higher than the average of 12.2 branches for the entire group 1. This analysis will be explained in the “discussion” section of this chapter).
4. Conclusion	The peculiarity of this case analysis is that participant G1 2 A11105 witnessed the changes himself and actively observed and presented the positive changes that occurred to their friends. Creating opportunities for participants to actively participate in individual activities, encouraging discussion and communication with others in the group, and creating an atmosphere of frank, goodwill, and constructive exchange is essential in forming these transformative learning experiences. The role of the facilitator in the context of this study lies not only in transmitting scientific knowledge related to the topic of climate change and providing the necessary art supplies for participants to create but also in engaging with students in discussions, taking an active "supportive" role to encourage interpersonal interaction.

Table 4.23

A detailed analysis of case study G1 12 A11144

Case study analysis G1 12 A11144				
1. Case Description	Location	Ho Chi Minh City, Vietnam		
	Number of attended activities	KAP survey	Learning sessions	Interview
		Yes	Yes (04 sessions)	Yes
2. Participant Description	Gender	Female		
	Age	17 years old		
3. Empirical material interpretation & analysis				

Case study analysis G1 12 A11144	
3.1 Code Hierarchy	**Single-Case Model G1 12 A11144 (Code Hierarchy)**  The code hierarchy of participant G1 12 A11144 shows the predominant presence of two sub-codes, “Ambassador/Agency” (parent code: Personal transformation through Art) and “Reality Awareness” (parent code: Climate change response), with the frequency of 4 occurrences for each sub-code. Similar to case study #1, there is an entire presence of sub-codes belonging to all three parent codes. The code cloud of the participant G1 12 A11144 in the next part of this analysis shows how these two sub-codes play a role in their correlation with other sub-codes.

Case study analysis G1 12 A11144	
3.2 Code Cloud	 It is easy to see the correlation of the sub-codes “Ambassador/Agency” and “Reality Awareness” in this participant G1 12 A11144's code cloud, where, as mentioned above, these two sub-codes hold a central position with the remaining sub-codes. It can be concluded that the sub-code “Reality Awareness” plays a vital role in participant G1 12 A11144's formation of specific ideas and actions concerning climate change (parent code: Climate change response), and sub-code “Ambassador/Agency” impacts her personal transformation through art-integrated science learning experiences.

<table>
<tr><th colspan="2">Case study analysis G1 12 A11144</th></tr>
<tr><td>3.3 Word cloud</td><td> 
</td></tr>
</table>

The detail and diversity in the branching of the word "I" (including 25 branches) show the intense perspective of the participant when expressing her viewpoint and sharing her personal transformation journey after participating in four art-combined climate change learning sessions. Specifically, the participant G1 12 A11144 shared the following:

"I remember that I was in the same group as my friends before. I remember that I was the quietest person. I rarely gave my opinion. In most group activities, I did not speak. I just sat there and watched, observed and took notes. Now, through the lessons, I drew and learned with my friends. I boldly gave opinions, shared ideas, listened and consulted, and gave suggestions to other friends more than before. When my classmates gave me some comments and raised questions about my presentation and artwork, I felt happy. I feel more confident when communicating with friends and happy they talked and shared with me. I found it more suited for me to discuss with my friends. After the past lessons, my role has changed from being quiet, taking notes, observing and cleaning up at the end of the class; now, I am more active and confident in group activities." (G1 12 A11144's answer for interview question #6).

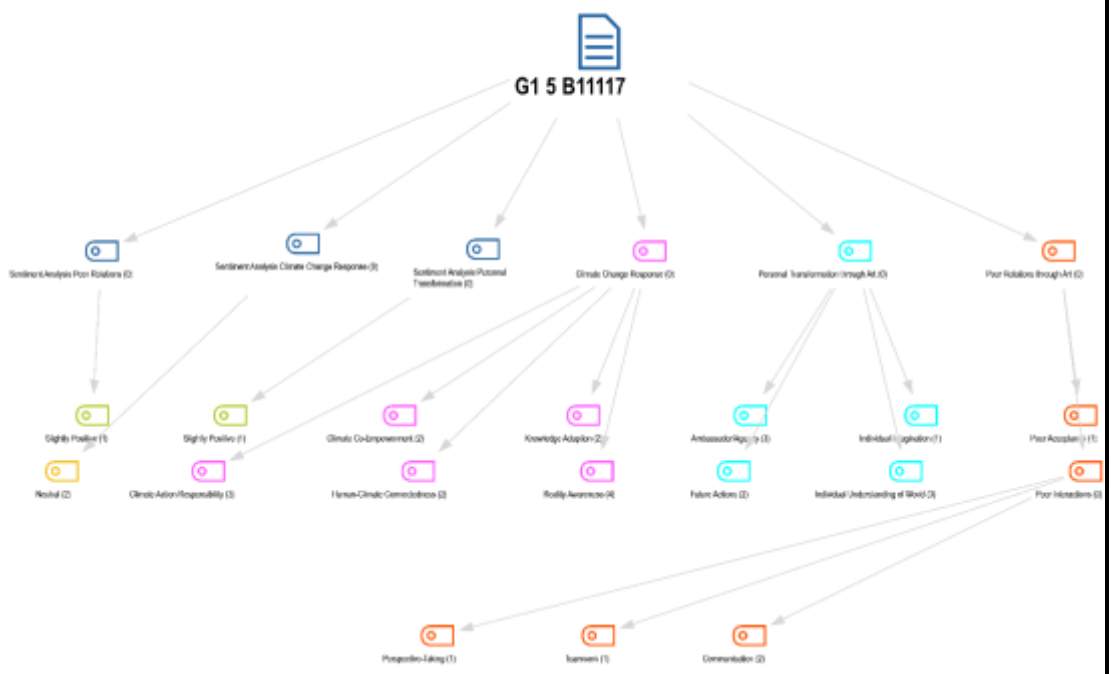
From a member who rarely gave personal opinions, after four experiential learning sessions, she has become more confident in sharing her views and listening to other members' feedback. The transformative learning experiences have created more engaged learning for her.

Case study analysis G1 12 A11144	
4. Conclusion	Case G1 12 A11144's experience of fully participating in the three research activities shows diversity in the descriptive detail of each aspect mentioned above. Acknowledging the participants' evaluations of the individual's experience through each session and her observations with other members helps the researcher better understand the correlation between the students' worldview expression individuals with future actions performed by the individual or in collaboration with other members. The fact that the individuals who share their plans on implementing a project together with other members to convey the message of environmental protection and climate change action with their peers are an example to show the positive impact of the application of art in science communication in this age group. Specifically, the participant G1 12 A11144 shared as below: ***"Learning through art, like the past few weeks, made learning progress more accessible for me to follow and digest. The lessons of the past weeks, such as ecological footprint, comparing the difference of each place over time under the impact of climate change through pictures, and drawing about saving water, I learned more facts and found this way of learning more appropriate to get a grip on climate change. My friends and I had an idea to work together on a successful individual project to communicate knowledge and solutions to protect the environment to others, especially those of my age."*** (G1 12 A11144's answer for interview question #5). These positive transformational experiences, in this case, show the potential for practical application of the learning model and communicating science through the arts.

Table 4.24

A detailed analysis of case study G1 5 B11117

Case study analysis G1 5 B11117				
1. Case Description	Location	Ho Chi Minh City, Vietnam		
	Number of attended activities	KAP survey	Learning sessions	Interview
		Yes	Yes (04 sessions)	Yes
2. Participant Description	Gender	Male		
	Age	16 years old		

Case study analysis G1 5 B11117	
3. Empirical material interpretation & analysis	
3.1 Code Hierarchy	**Single-Case Model G1 5 B11117 (Code Hierarchy)**  Similar to the two cases analyzed above, the code hierarchy of participant G1 5 B11117 shows an entire presence of sub-codes belonging to all three parent codes and the predominant presence of two sub-codes, “Ambassador/Agency” (parent code: Personal transformation through Art) and “Reality Awareness” (parent code: Climate change response), with the frequency of 3 and 4 occurrences, respectively.

Case study analysis G1 5 B11117	
3.2 Code Cloud	 Different from the analysis of case G1 12 A11144, when the central position belongs to "Ambassador/Agency" and "Reality Awareness", it is seen in the detailed analysis of G1 5 B11117's code cloud that the sub-code "Reality Awareness" holds a central position with the remaining sub-codes. It can be concluded that the sub-code "Reality Awareness" plays a vital role in participant G1 5 B11117's formation of specific ideas and initiatives to tackle climate change (parent code: Climate change response), and sub-code "Ambassador/Agency" impacts his personal transformation through art-integrated science learning experiences together with other sub-codes.

Case study analysis G1 5 B11117	
3.3 Word cloud	 The detail and diversity in the branching of the word "I" (including 16 branches) show the intense perspective of the participant when expressing his viewpoint and sharing his personal transformation journey after participating in four art-combined climate change learning sessions. Specifically, the participant G1 5 B11117 shared the following: ***"It was a beautiful learning way when combining art and science. Through art, learning became more colourful, and we enjoyed and learned more than before. I rarely talked to my friends. However, I am more confident in imparting knowledge to my team with the knowledge I have learned through the past sessions. I think through this way, I interacted and talked with my friends better in the past lessons. Those were exciting lessons. I quickly spread my messages through drawings and communicated with my friends."*** (G1 5 B11117's answer for interview question #6). From a member who "rarely talked to" his friends, after fully participating in the activities within the framework of this study, G1 5 B11117 has seen an evident change in himself when he becomes more confident in sharing the knowledge he has learned with others and affirming that learning science through the arts brings excellent experiences to his friends and himself.
4. Conclusion	Case G1 5 B11117's experience of fully participating in the three research activities shows that the perspectives are highly personal in terms of aspects: how G1 5 B11117 envisions and expresses views related to responding to climate change, the impact of classroom design incorporating art into the classroom to learn scientific knowledge for highly converting

Case study analysis G1 5 B11117	
	experiences as well as improved interactions with friends. Specifically, the participant G1 5 B11117 shared as below: ***"The most immediate action I can take is to plant trees and talk to my family about protecting the environment. With my friends, I can talk to them to convey that branches should not be cut and share knowledge with them. Applying art to climate change and the environment is a wonderful thing. At my age, my peers and I are curious. Our curiosity and learning through art help me be more creative in every lesson.."*** (G1 5 B11117's answer for interview question #8). These positive transformational experiences, in this case, show the potential for practical application of the learning model and communicating science through the arts.

4.6 Discussion of findings

4.6.1 Discussions

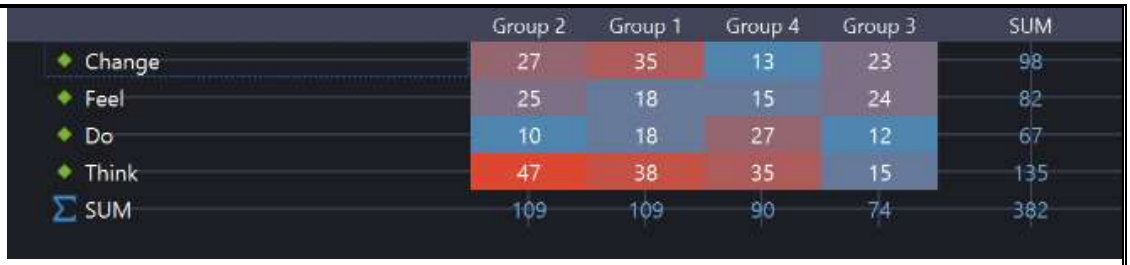
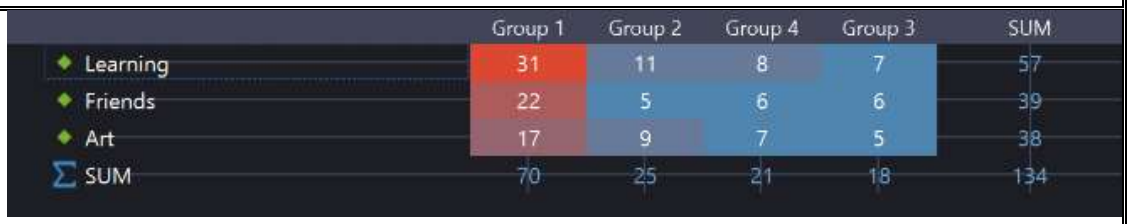
4.6.1.1 Word Matrix Browser

The Word Matrix Browser visualises how frequently words occur in documents. In the rows, selected search words or categories of the dictionary are presented, and document groups form the columns. Based on word frequencies from 46 documents, 9386 words were analysed by MAXQDA. We selected words which appear in more than 50% of documents. In summary, we concluded there are three main sets of words from four groups, including Set No. 1 (I, We, Climate); Set No. 2 (Change, Feel, Do, Think); Set No. 3 (Leaning, Friends, Art). Table 4.25 is a summary of the word matrix browser in four groups.

Table 4.25

Three sets of the most frequent words in interview documents from Four Groups

Set No. 1		Group 1	Group 2	Group 3	Group 4	S...
	I	159	143	112	125	539
	We	12	3	7	2	24
	Climate	4	1	1		6
	SUM	175	147	120	127	569

Set No. 2	
Set No. 3	

The word matrix browser in Set No.1 shows that in comparison between groups 1 and 2, groups 3 and 4, words "I", "We", and "Change" are repeated more frequently in two experimental groups (groups 1 and 3) than two controlled groups (groups 2 and 4). To explain this, we found that participating in science communication classes in the field of climate change through the arts helps participants (1) gain more superior knowledge on this topic than groups that did not participate in learning sessions, (2) express their personal views stronger and more confident after being allowed to express, present and share their views through art products, (3) have more connectedness between oneself and others, particularly with friends in the same group, when discussing climate change impacts and possible actions together.

More importantly, when looking closer at the word matrix browser in Set No. 3, words in this set represent the interviewee's views on learning climate change topics through art and how this learning experience benefits peer relations. It is easy to see that the experimental group shows superiority in the frequency of repetition of words, specifically in the first pair: the experimental group 1 and the controlled group 2. However, experimental group 3 and control group 4 did not show a big difference in the remaining pair. Note that this is just a comparison of the frequency of repetitions of common words in participants' responses. The analysis needs to be more profound when considering the responses' content. This is discussed in the next section of this chapter.

4.6.1.2 Interactive Word Tree

Using the Interactive Word Tree in MAXQDA, words and word combinations from all interviews of each group were discovered and analysed visually in their respective contexts. The more frequently a word or word combination occurs, the more distinctly it appears in the tree. The Word Tree offers two-way interactivity: Firstly, it can be navigated via its individual "branches" to visualise words in their contexts. Secondly, the data is interactively linked to the original texts. Based on the word matrix browser's findings, we present Table 4.26, which shows the number of branches of each word in four groups. Numbers highlighted in red represent the highest value in each matching pair: Groups 1 and 2, Groups 3 and 4.

Table 4.26

The number of branches of the most frequently repeated words in four groups

Words	Group 1	Group 2	Group 3	Group 4
I	**158**	47	47	47
We	**29**	11	13	**14**
Climate	**38**	29	**25**	17
Think	38	**47**	15	**35**
Change	**35**	27	**23**	13
Feel	18	**25**	**24**	15
Do	**18**	10	**12**	6
Learning	**31**	11	7	**8**
Friends	**22**	5	6	6
Art	**17**	9	5	**7**

As seen in Table 4.26, there are 158 branches of "I" in group 1, which makes group 1 have the most branches among the four groups and three times more than group 2. Using an Interactive Word Tree in MAXQDA, we had a better overview of how participants in each group shared their insights about climate change response and level of readiness to take action. The common point in Table 4.26 is that the experimental group shows superior results when comparing the number of branches with the other two control groups. Especially for experimental group 1, in the list of 10 most repeated words in 46 interview documents with participants, group 1 has 8/10 words with the most branches. To see the difference in each pair of experimental and control groups, the figures below show the interactive word tree, the distribution of branches and the profound significance of each branch in detail.

Figures 4.30 - 4.33 summarise the detailed description of branches of the word "I". By presenting branches of the word “I” in each group, we can see how insightful it is in the given answers of each respondent from two experimental groups and two control groups. When establishing the subject of the address communication with the researcher, the participants used the personal pronoun "I" to express their views on the interview questions. For two experimental groups, 1 and 3, using “I” shows a clear, coherent and detailed expression expressing thoughts, perceptions, actions, responsibilities, feelings and

emotions associated with climate change and its correlation with nature. In contrast, these assessments did not appear dense (expressed in the number of word branches) for the two control groups, 2 and 4.

Figure 4.30

158 Branches of the word "I" in group 1

Figure 4.31

47 Branches of the word "I" in group 2

Figure 4.32

47 Branches of the word "I" in group 3

Figure 4.33

47 Branches of the word "I" in group 4

Another example is given to the words "Climate", "Art", and "Friends". Since this study focuses on the role of art involvement in science communication activities with adolescents in three aspects: climate change response, personal transformation and peer relations, the word "Art" plays a central position in order to discover how participants perceive the idea of involving art into climate change communication campaigns.

Figures 4.34 - 4.37 show the fact that when it comes to "Climate", respondents from groups attending the learning sessions (1 and 3) provide answers that demonstrate interest, understanding of the topic, and responsibility and thinking about how climate change affects individual lives and the communities around them. More importantly, answers from groups 1 and 3 show that participants' perceptions of how implementing climate change adaptation actions will affect their future.

Figure 4.34

38 Branches of the word "Climate" in group 1

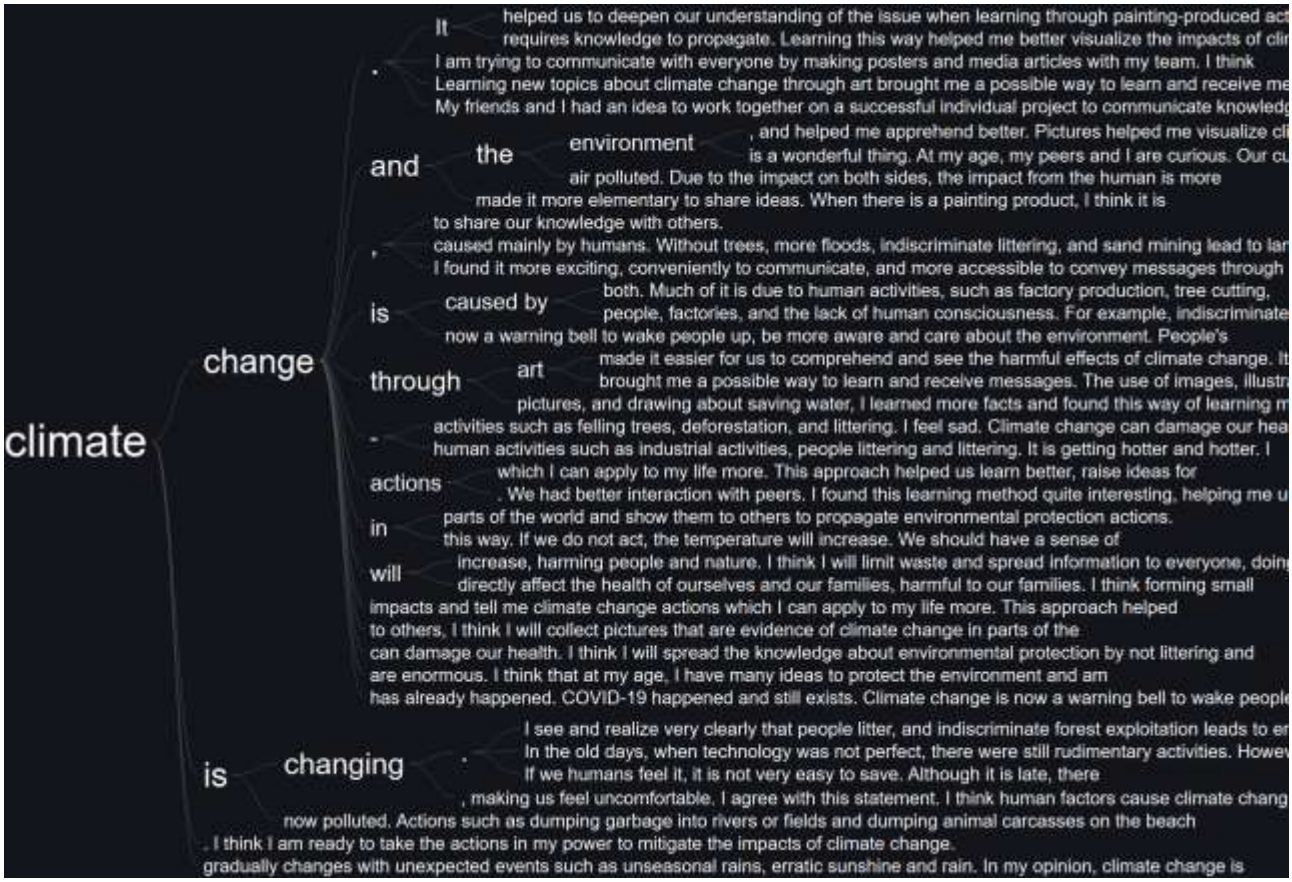


Figure 4.35

29 Branches of the word "Climate" in group 2

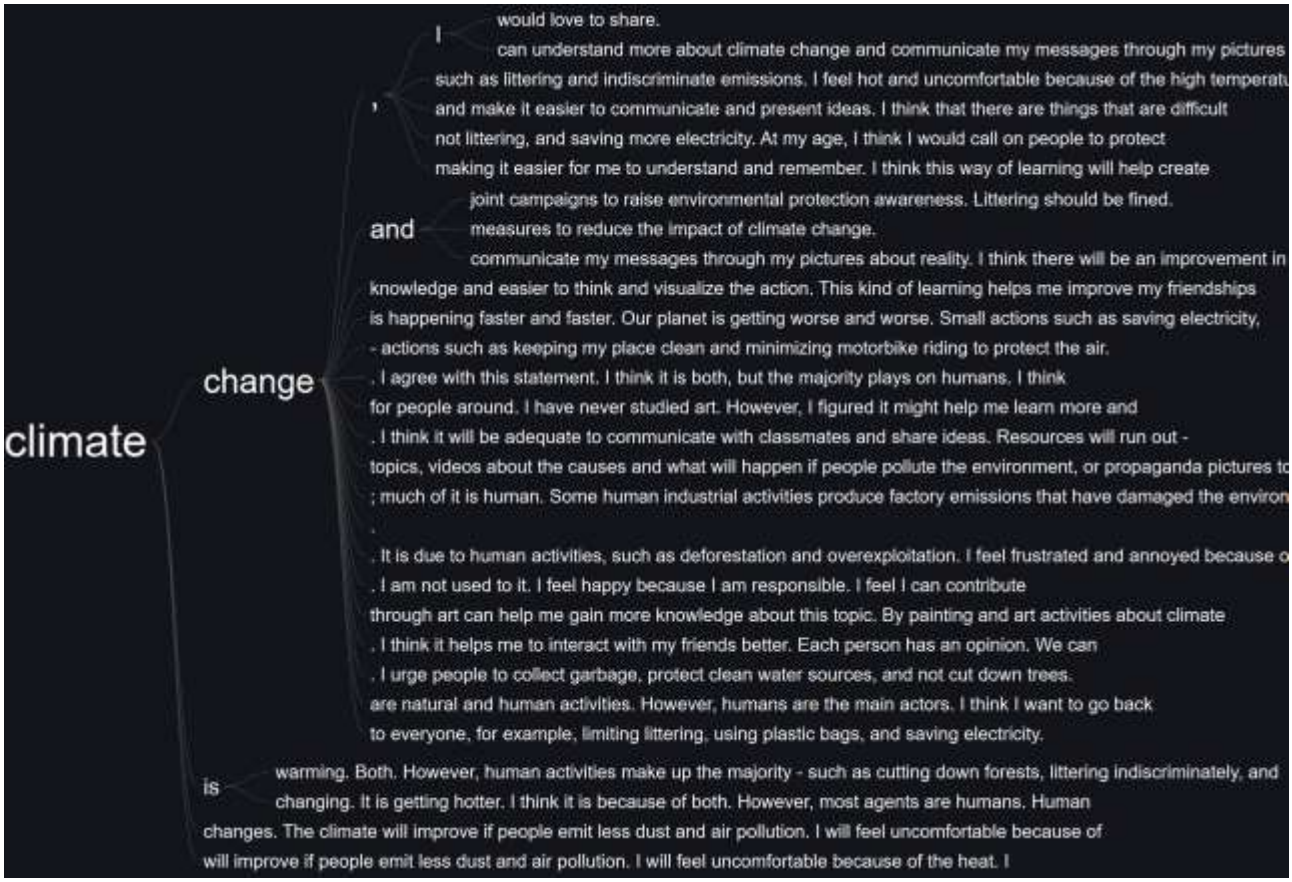


Figure 4.36

25 Branches of the word "Climate" in group 3

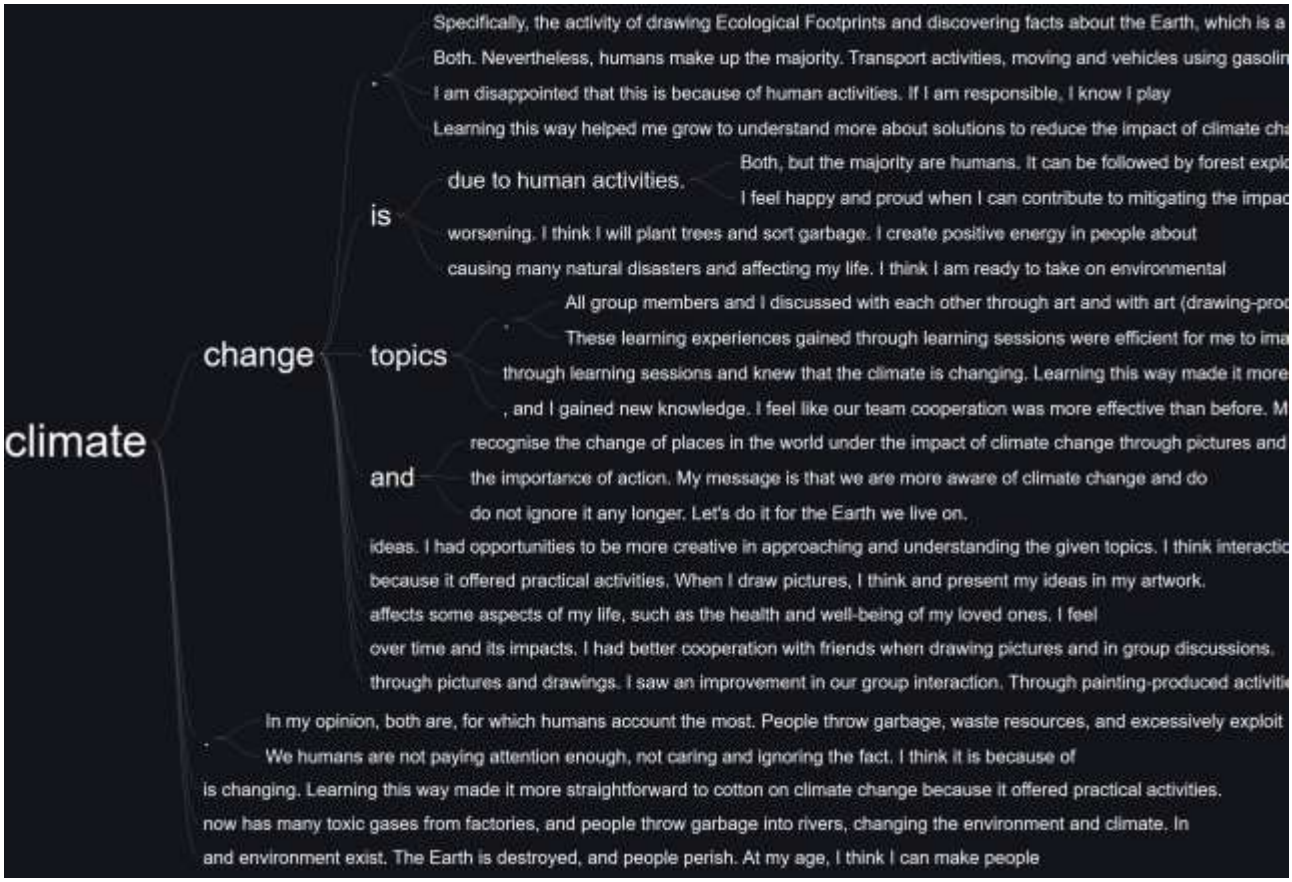
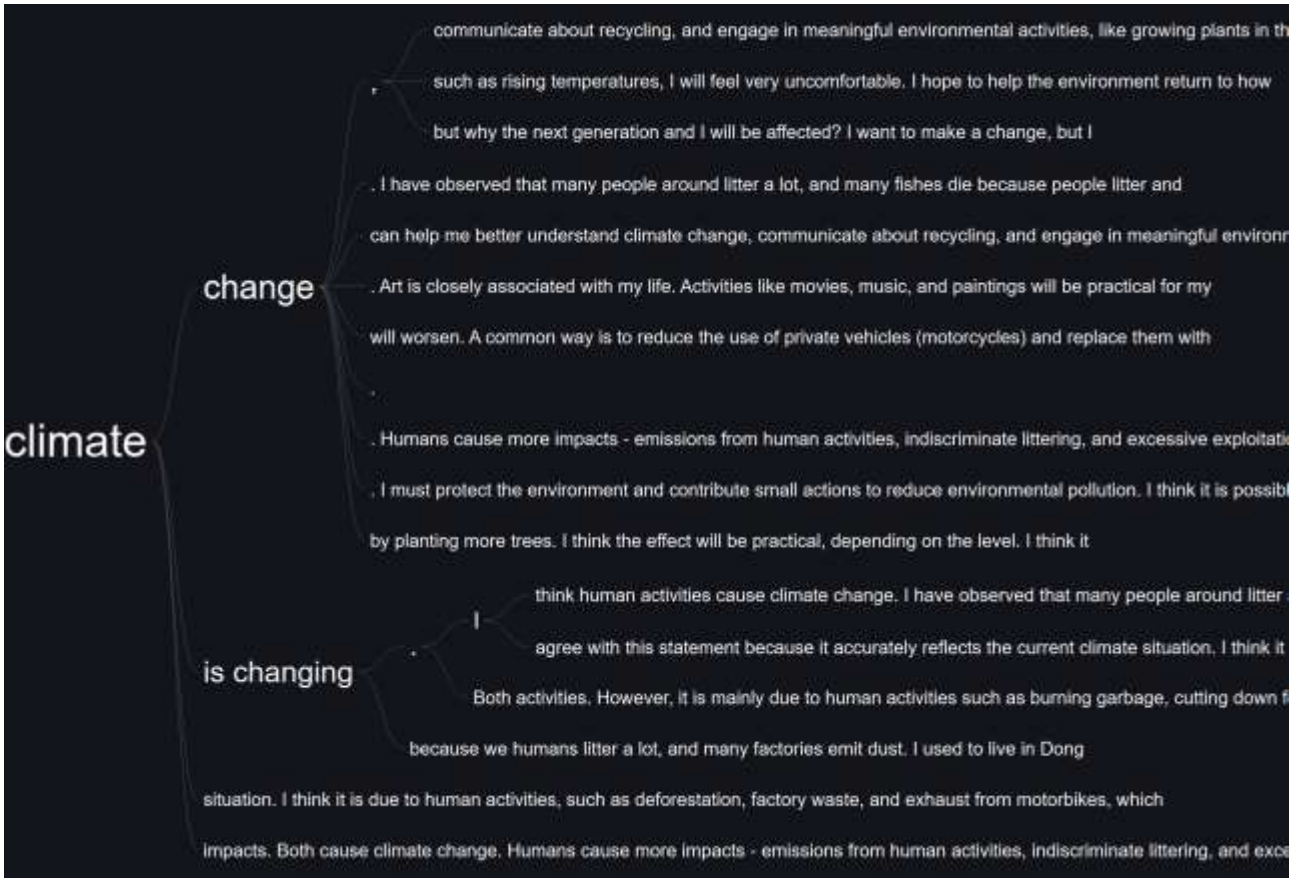


Figure 4.37

17 Branches of the word "Climate" in group 4



It was evident to analyse the branches of the word shown in Figures 4.38 - 4.41 that the group that fully participated in the three processes of taking the survey, attending the class, and participating in the interview showed more insightful responses when asked and developing a peer-to-peer interaction through art-integrated learning. The branches in group 1 showed a markedly positive change in the friendship relationship between group members. Specifically, there was a development in communication, teamwork and acceptance of group members' views. In addition, some individuals exhibit definite differences, which have been presented and analysed in the "Case Study" section before.

Figure 4.38

22 Branches of the word "Friends" in group 1

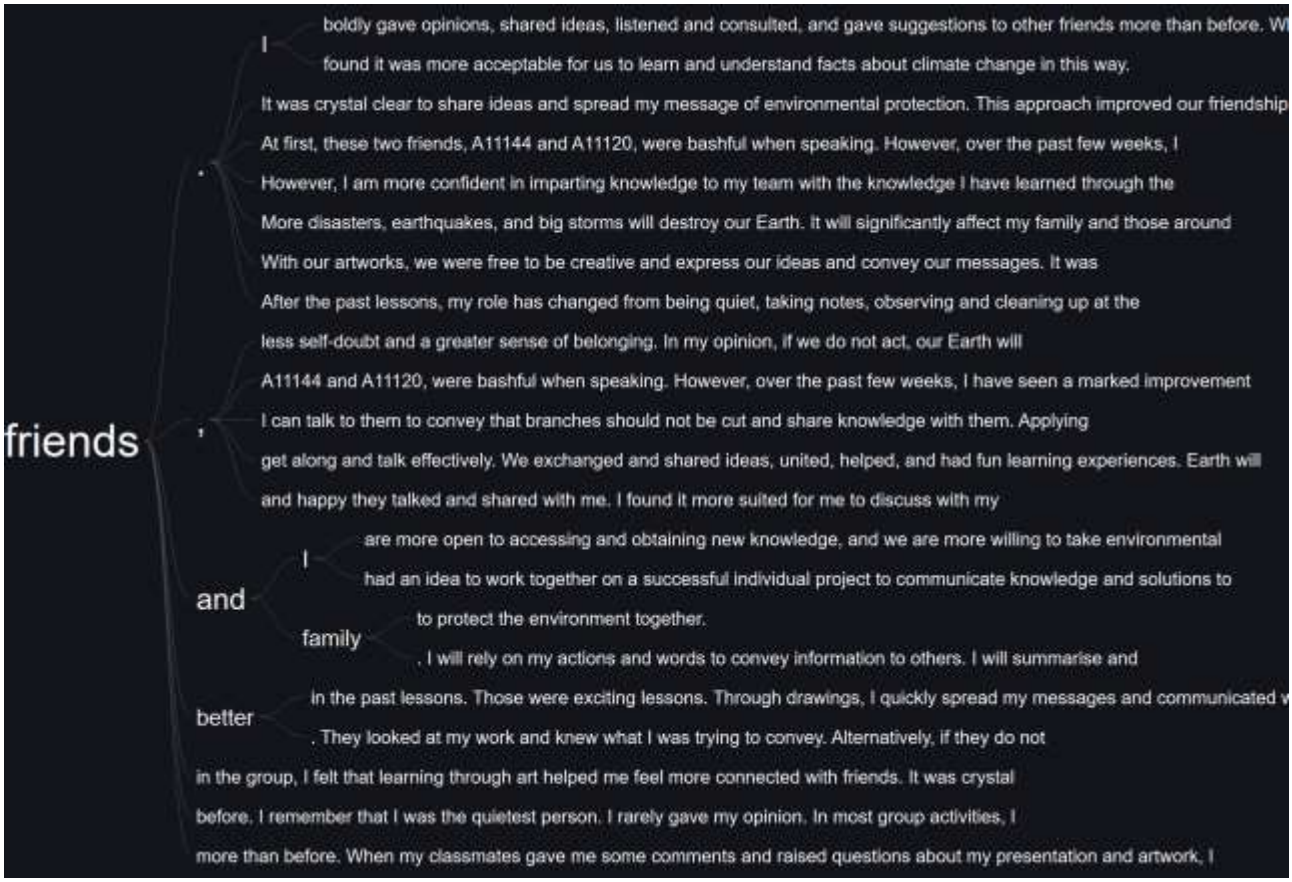


Figure 4.39

5 Branches of the word "Friends" in group 2

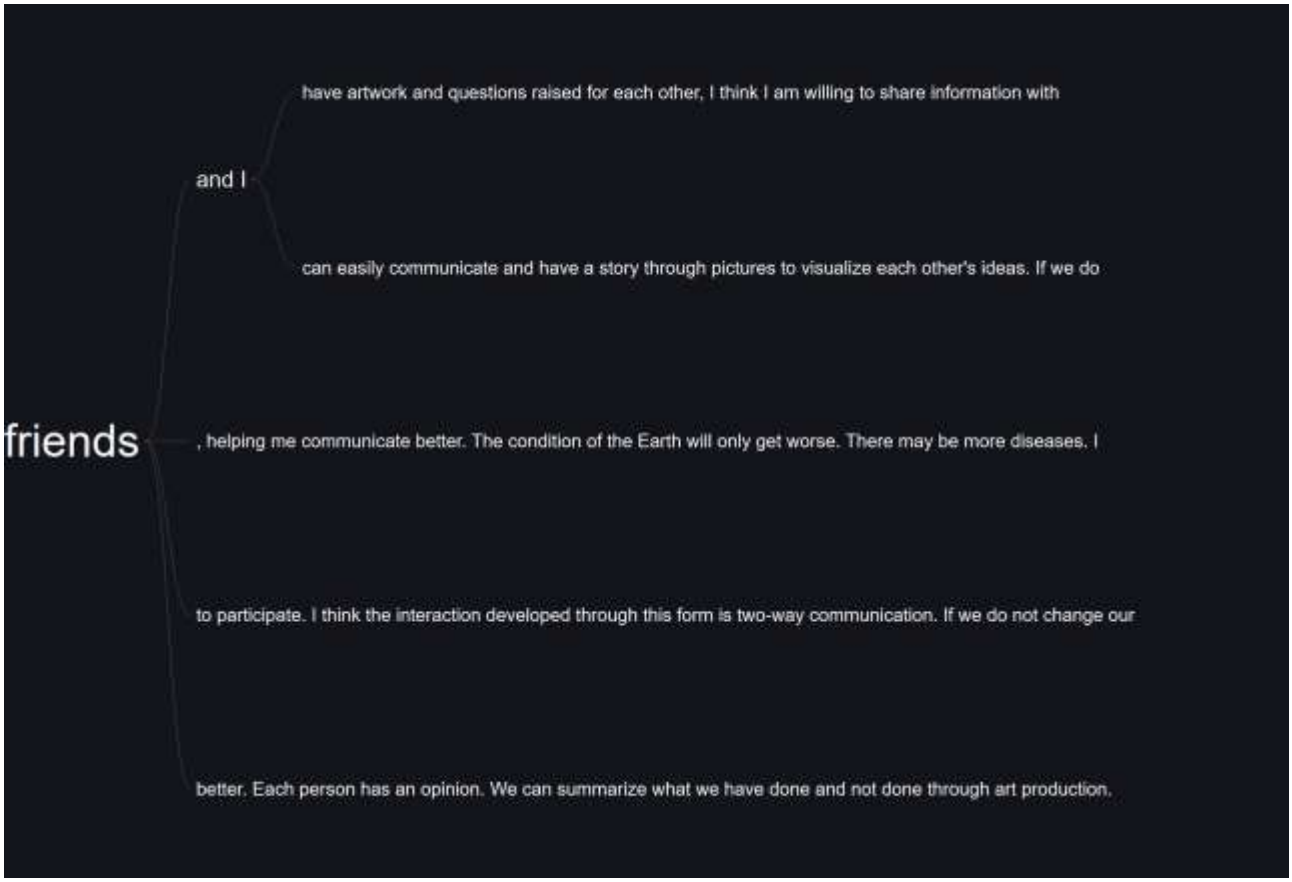


Figure 4.40

6 Branches of the word "Friends" in group 3

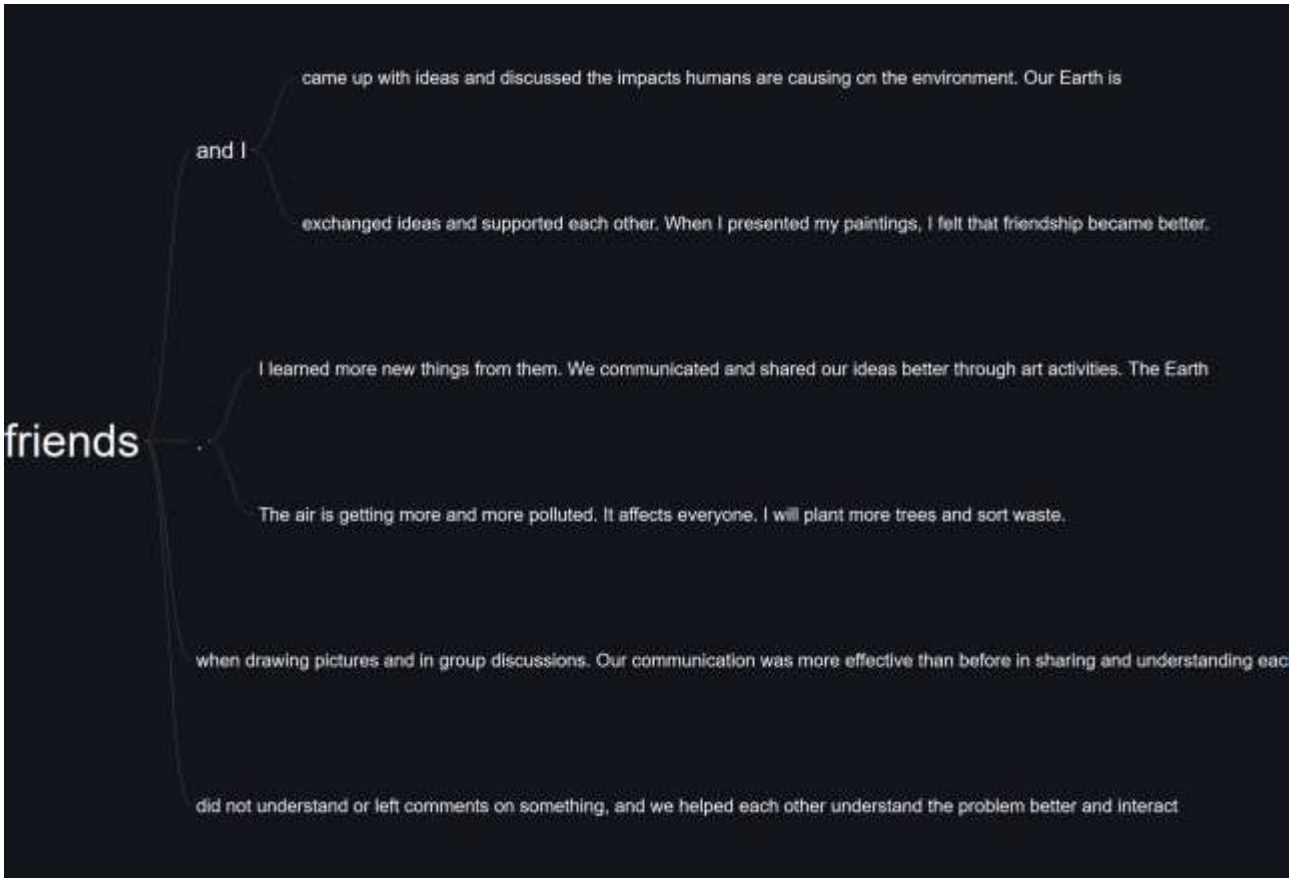


Figure 4.41

6 Branches of the word "Friends" in group 4

Last but not least, when it comes to art, the focus in this study is that participants attending learning sessions gave positive feedback about the role art can play in helping them understand climate change better, express their personal views without feeling criticised, and receive other sharing among peers shares in the group peacefully, flexibly and with goodwill. In addition, through art, individuals have a deeper connection with their thoughts and inspirations and express that to the outside world through painting products, seeking out new experiences and agreements with other friends, and seeing different perspectives when comparing, contrasting and receiving others' sharing within the group. It shows that learning experiences in an art-integrated setting help individuals better understand the topic introduced in each session, share knowledge, and present ideas to respond to climate change. Figures 4.42 - 4.45 present the word “Art” in four groups.

Figure 4.42

17 Branches of the word "Art" in group 1

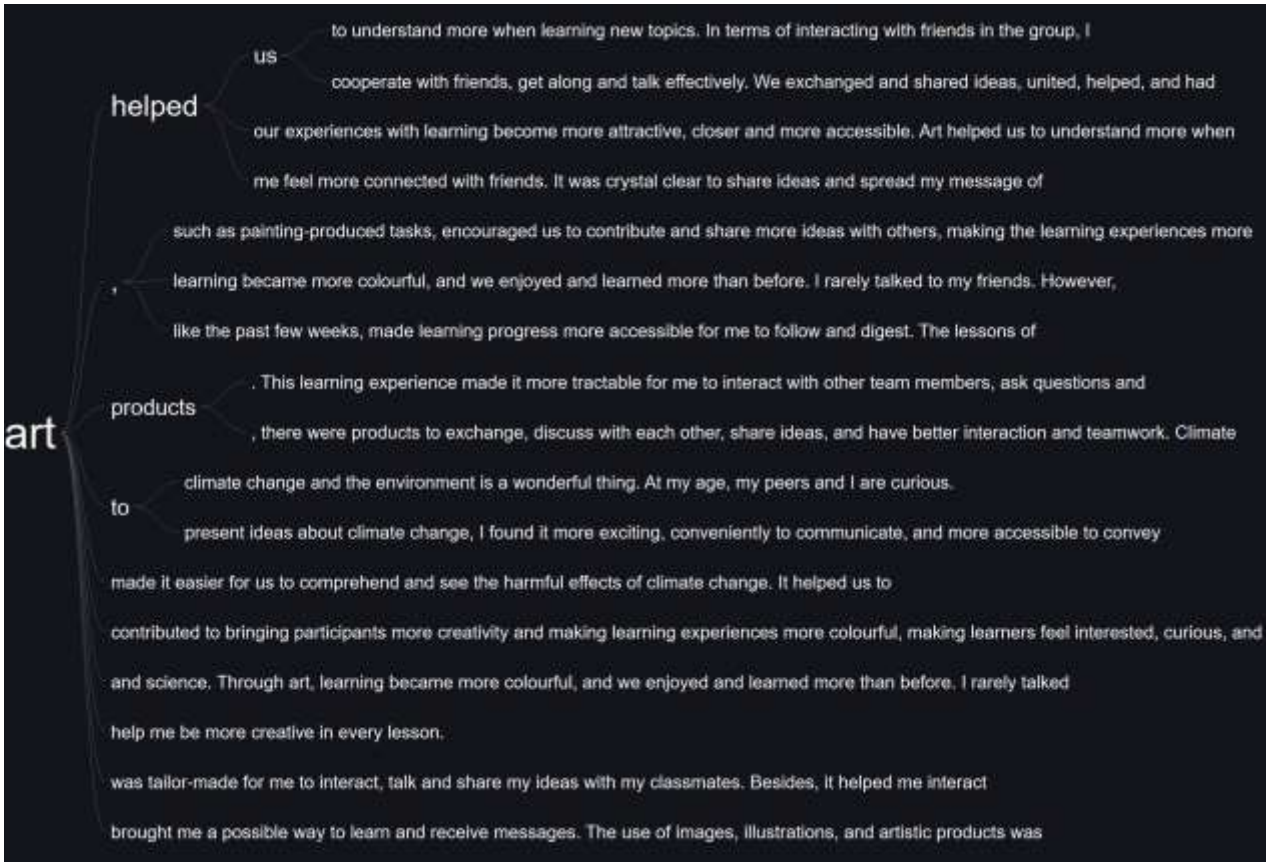


Figure 4.43

9 Branches of the word "Art" in group 2

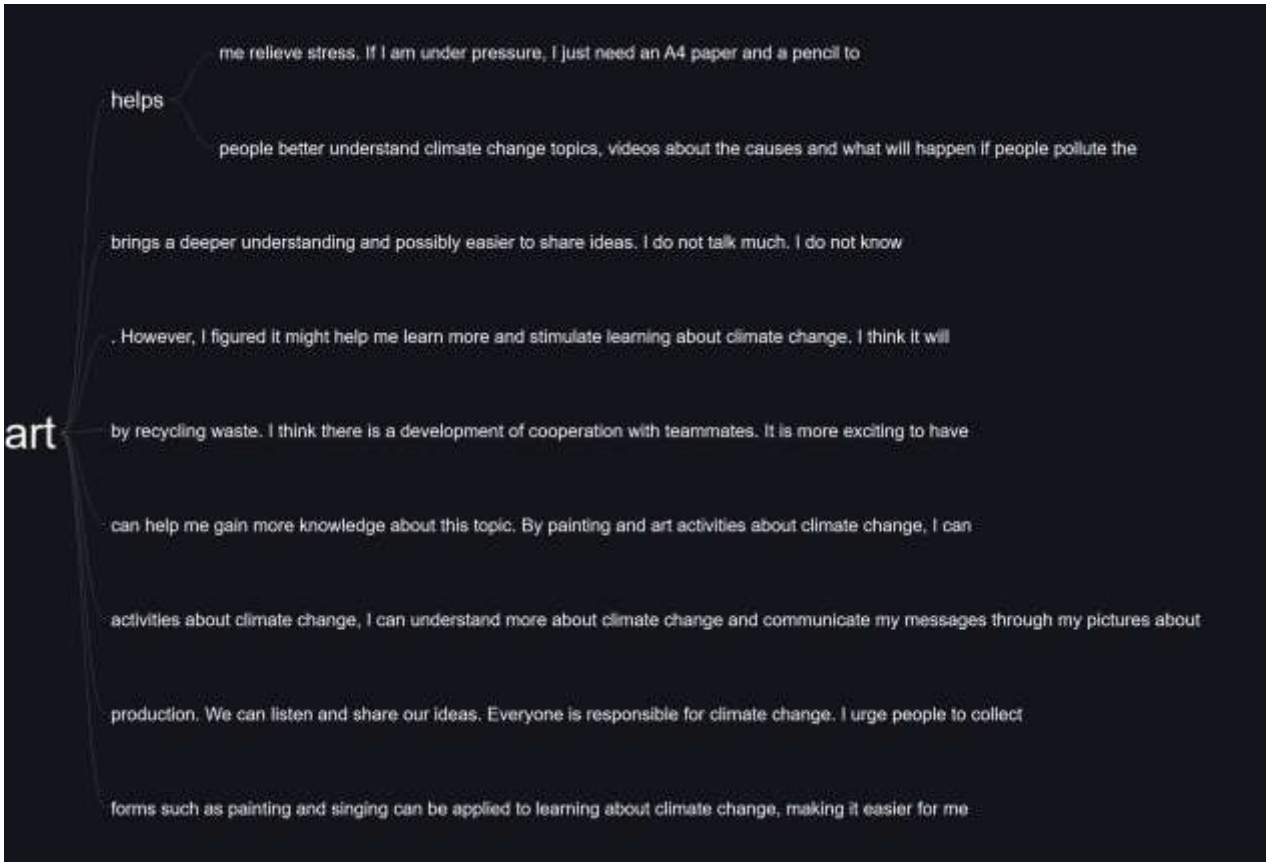


Figure 4.44

5 Branches of the word "Art" in group 3

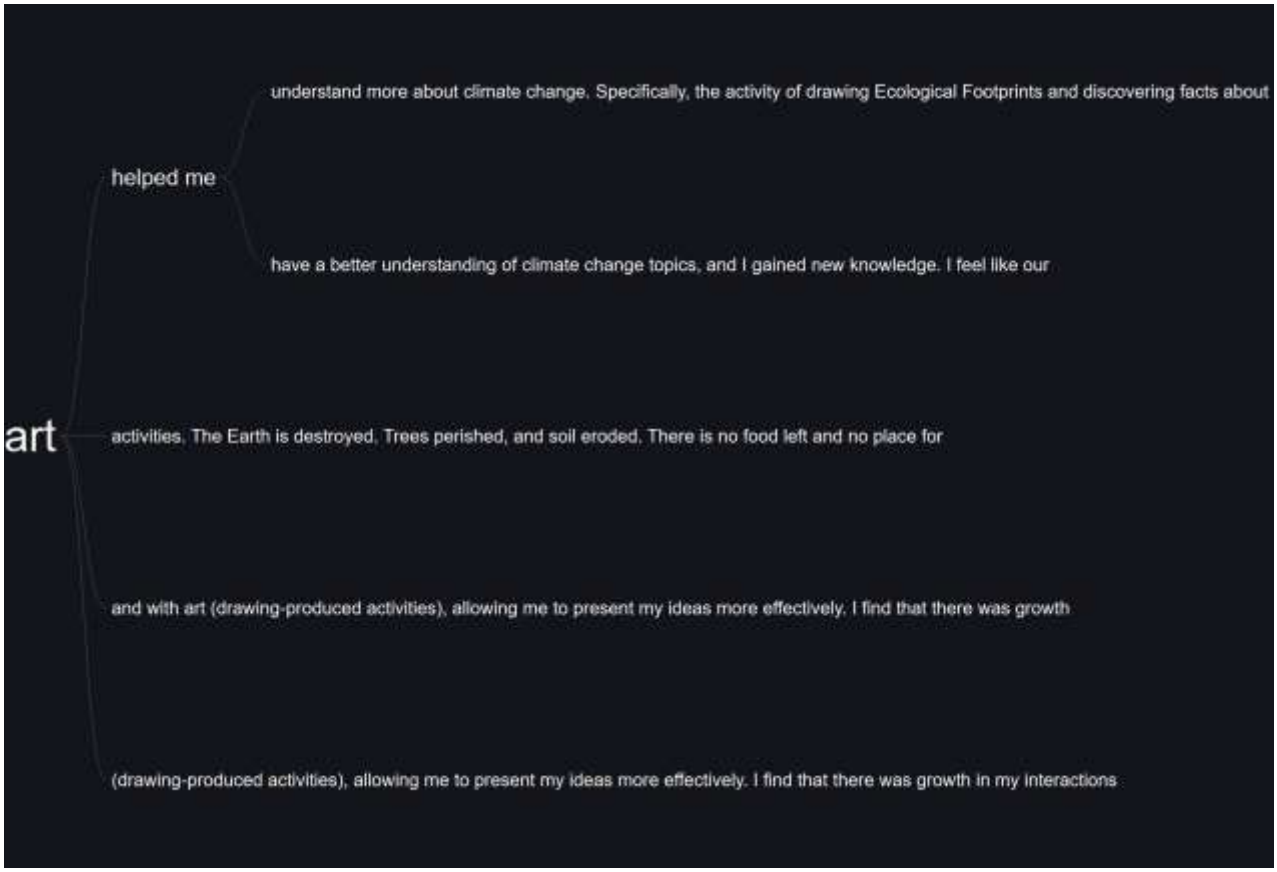
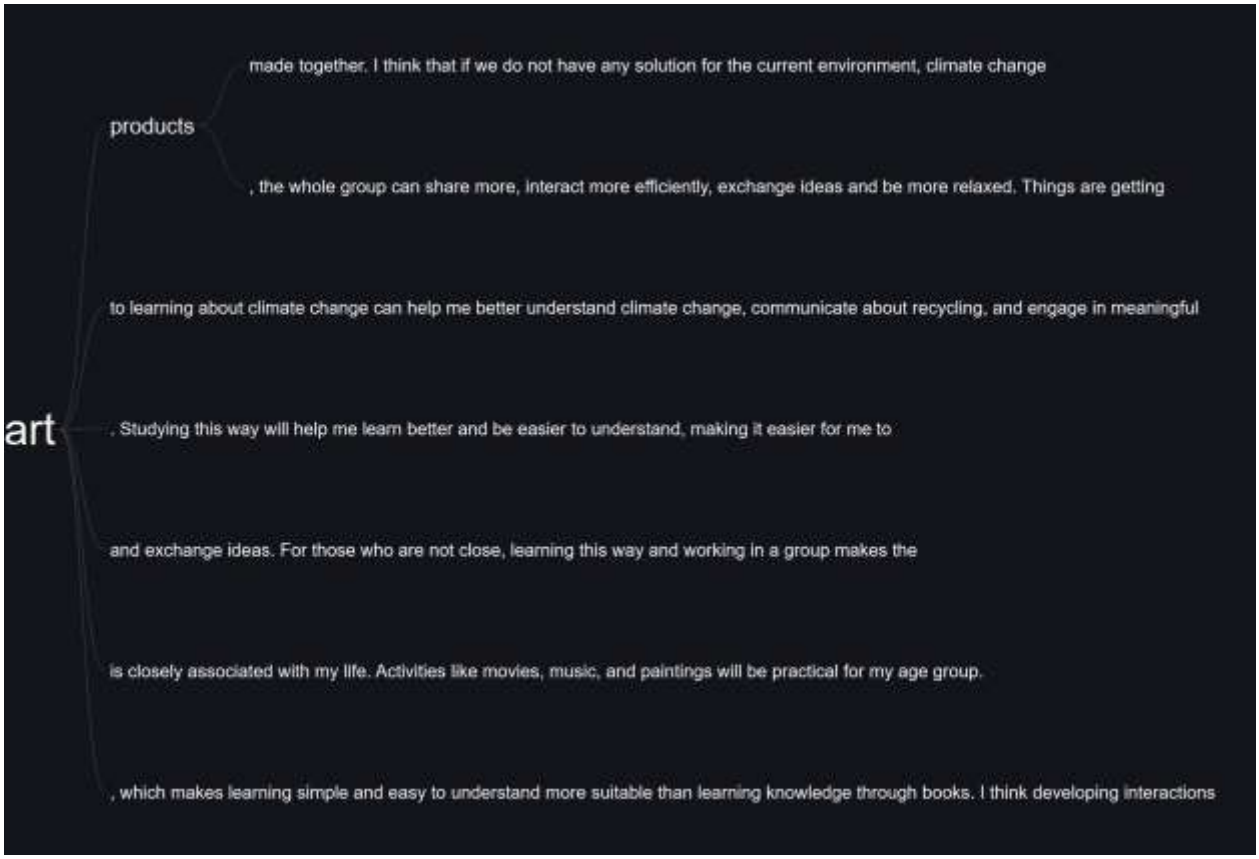


Figure 4.45

7 Branches of the word "Art" in group 4

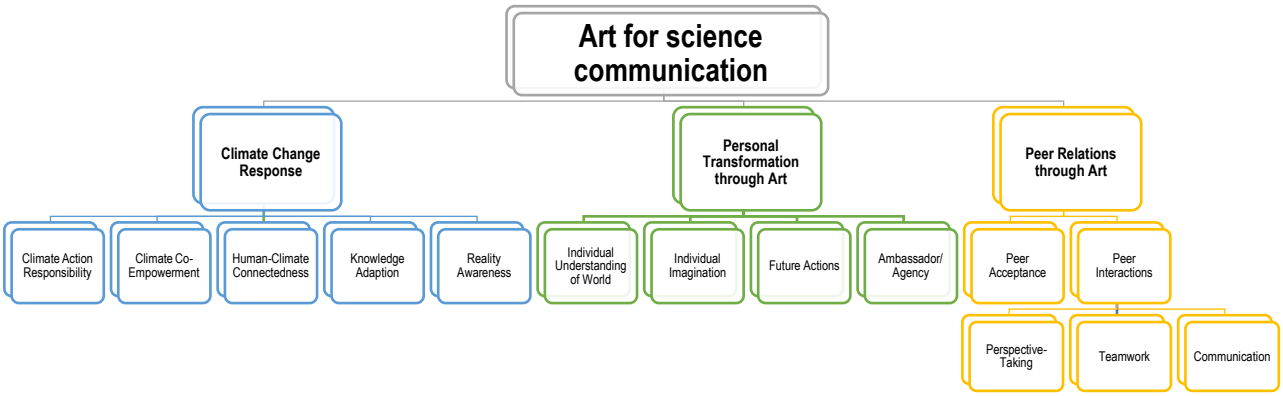


4.6.2 Summary of Research Questions and Findings

The thematic analysis of interviews allowed us to construct three main focus areas in the participants' perspectives about their acceptance and openness to climate change communication sessions as a topic in science communication that rely on art-integrated approaches. The three parent codes, or "the three main themes" of the findings in this study, are linked by an overarching theme of "art for science communication". The first theme is how art influences respondents' climate change responses. The second theme focuses on the personal transformation of each individual when being invited to experience an art-informed science communication activity. The final theme highlights the peer relations that may develop through art-collaborated science communication settings. Figure 4.46 summarises the research questions and their respective results of three main themes.

Figure 4.46

Summary of study findings



This study has anatomised respondents' perspectives on their learning experiences in learning sessions provided by the researcher that integrate the art-informed approach. Findings demonstrate the actual and potential impacts of enhancing climate change contents or, at a broader level, other science topics with art-informed integration into science education, especially in the theme of personal transformation sphere. We have argued in this study that providing a space where participants feel free to connect, share, talk, ask, present their initiatives and do something by touching, acting, and performing with art materials does enhance not only a sense of being connected with themselves but also a greater connection with the outside world, namely peers and surroundings. Moreover, by seeing and reflecting on their viewpoint in other people's opinions, in this study, we witness how adolescents see their feasible and potential sense of cooperation and being an agency for change-making in their communities. Last but not least, this sense of being involved shows how they can be aware of the world they are living in, that they can relate to environmental issues and bring to bear on their current or future practice.

5 CHAPTER 5: CONCLUSION

The findings from the qualitative interviews of this study have presented an empirically driven analysis, increasing the understanding and practical ways of art-informed science communication with groups of adolescents in the context of environment-related societal challenges in Vietnam. This study focused on the role of art-informed science communication in participants' climate change response, personal transformation sphere and peer relations for Vietnamese adolescent samples. It also presented how transformative experiences through an art-informed science learning approach affected participants' personal transformation of thoughts, feelings and future actions toward climate change. The use of art in scientific communication activities brings about effective communication between scientists and the lay society. Set in Vietnamese society, where art has not been brought close to the people, the climate crisis is still a vague concept that the public needs to pay more attention to. Incorporating art into sharing information about climate change and providing opportunities for participants to articulate their thoughts and ideas successfully demonstrates the combination of science and art.

5.1 Study contributions

5.1.1 Implementation of Computer-Assisted Qualitative Data Analysis

In the context of research methodology, this study is one of the pioneering ones in deploying MAXQDA in qualitative data analysis to analyse the constructs of an art-integrated approach, climate change and personal transformation. Applying MAXQDA to qualitative research helps scientists save time in assigning parent codes and sub-codes to the text part instead of doing it mechanically. Moreover, this application is highly effective in building code maps and systems in a more intuitive and accessible way.

Through analysis, researchers can create progress by starting with an initial description of raw data and then disaggregating the data into smaller parts (Gray, 2004) as described in this study, text parts and assign codes for each by using MAXQDA to see how these connect to new concepts and findings. This lengthy process provides researchers with the basis for their new view of the data collected. According to Miles and Huberman (1994), qualitative analysis is "more likely to be suggestive than conclusive", and the main focus of qualitative research is to comprehend how people act and interpret data in multiple aspects. The role of qualitative researchers is to "gain a holistic or integrated overview of the study", including participants' perceptions.

5.1.2 Implications to society: Using art-informed approaches in science communication practice

There is an emergent body of literature related to art-based and art-informed practice and research, such as in social work (Collins, 2020), but very little has been written about the transformative experiences of participants in science communication practice. Participants' experience and understanding of what an arts-informed approach to learning science, as found in this study, was naturally varied and diverse. Four

learning sessions offered in this study for two groups of participants were highly reflective, constructive and participatory, demonstrating an interactive rapport between learners and the science facilitator. By inviting participants to get into an open conversation, we could confirm the assumptions behind the three research questions of this study: that art is feasible to improve the quality of science learning, contribute positively to participants' climate change response and play as a great connector of developing peer friendship and personal transformation sphere of the individual. The investigative study's findings can only indeed apply to the participants involved. For example, the creative and self-reflective process happened to each participant during each session, and the shared co-production among participants was unique. It is explained the similarities and differences in giving insights and sharing experiences in the interview. Moreover, those unique experiences and the encouraging relationship between learners and the facilitator have set a robust connection for trust building and expressing interest in learning about other science topics.

As a science communicator, while giving learning sessions to participants, a great discovery we experienced in this study is the subjective background of participants' replies and their willingness to see other teammates' artwork and show their respect toward innovative products made by others. To explain their subjective responses, each participant responded based on their perceptions, belief systems, life experience, and, most importantly, their transformative experiences through an art-informed approach to learning science. However, this was coordinated by the group discussion through open conversation, critical thinking and active listening to others' sharing. Approaching the discourse among participants has brought a significant involvement in showing surprise at what they discovered about others' creative identities. The science communication practice is about communicating science topics to the public, building trust, and creating a space where everyone involved feels comfortable sharing ideas and aspects of their identities (Collins, 2020).

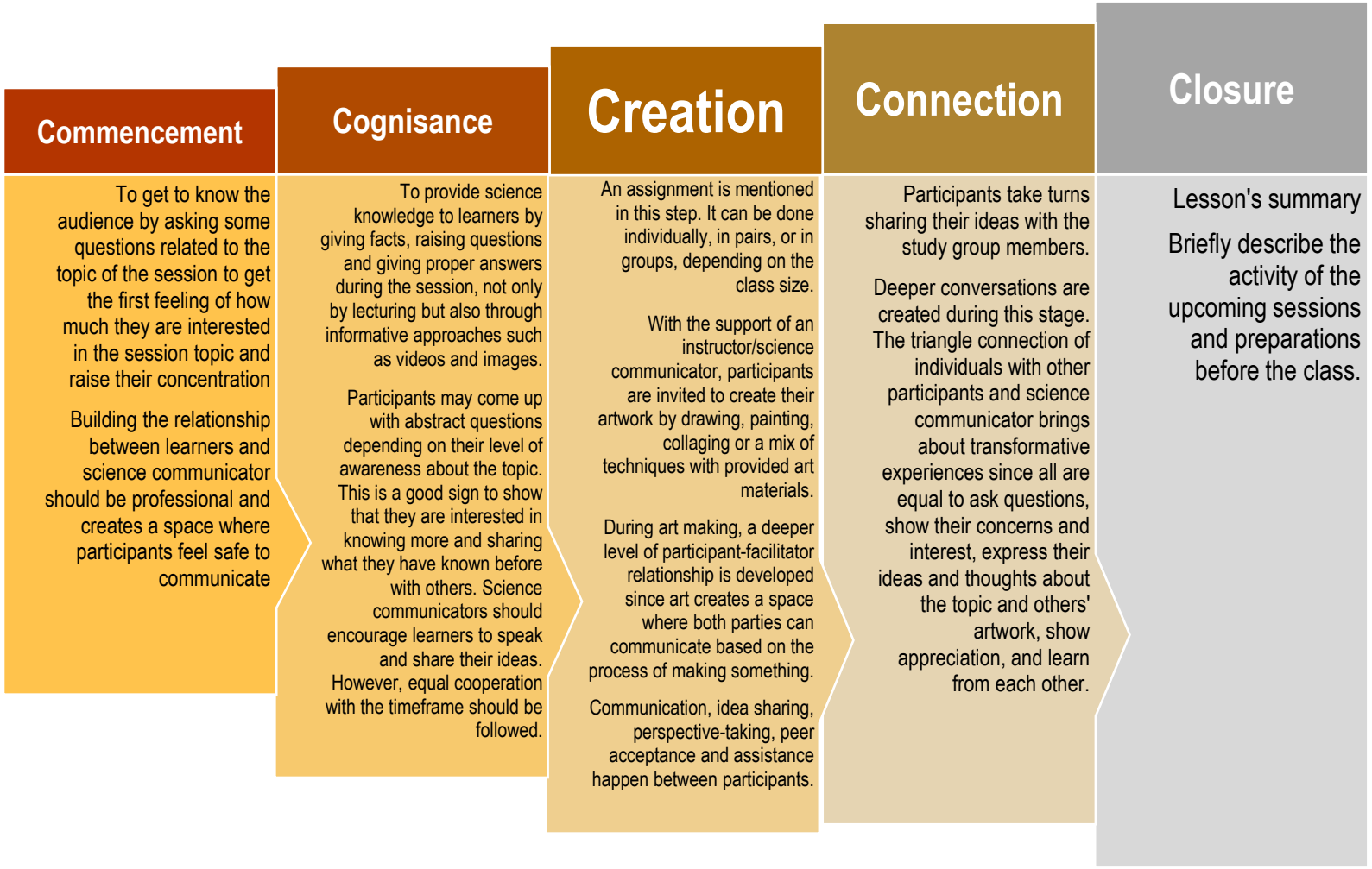
More importantly, this study supports the statement of El-Lahib and colleagues (2022) that the use of arts-informed approaches helps enhance students' interactions with their teammates, bring their social concerns and reality awareness to the table in a way they can talk about at ease and have a meaningful education experience. This may be explained by the fact that the art-integrated approaches invite students to "engage in reflective and reflexive practices through a process of collectively creating and sharing artistic work". Sharing the same viewpoint with El-Lahib and the team (2022), the use of art in an educational setting offers a certain openness and flexibility to sharing and learning from each other where the process of learning and experiencing things together is "dialogical, reciprocal and mutual between the students and the instructor". Especially in this study, we discovered the process of peer relations between the participants and their peers. The experiences gained through art-informed science

communication activities bring participants to an artistic environment where artistic abilities or talents are not mentioned but for co-creating and sharing meaning, expressing and communicating their understanding of the world with others and seeing how others perceive things, expanding their transformative experiences and trying on someone else's shoes.

Last but not least, this study revealed how successful a framework of how to conduct a learning session of science communication with art involvement was. The 5C framework designed and implemented within this study was adequate to bring new knowledge to participants and enhance their participation in art-science activities. 5C stands for Commencement, Cognisance, Creation, Connection and Closure. Figure 5.1 presents our 5C framework, which we designed and applied in our study for the practical implication of art-integrated science communication.

Figure 5.1

The 5Cs framework of art-integrated science communication practice



5.2 Study limitations

Having said that, however, since we worked on this study from the beginning, we know it deeply and see it from the viewpoint of someone creating it initially. It can be more fruitful to develop a deeper understanding of this study's findings or any other parts of this thesis to learn and know more other ways of seeing qualitative data collected in an art-informed science communication approach. Lastly, an interpretation of the findings obtained was provided, along with why the findings were relevant to the research with comparisons to other existing research. In this section, we discuss this study's limitations, including participant profiles and participation and the multi-faced nature of factors affecting the personal transformation of individuals.

5.2.1 The participant profiles and participation

Male and female participants in this study are between the ages of 16 to 18 years old, live or attend the Centres occasionally, and have different life experiences, family backgrounds and socioeconomic statuses. Their participation was voluntary, and they decided to join the study alone. We did our best to recruit participants who wanted to and were able to commit to this research project. However, we experienced few participants bringing their discomfort to the interview. As a result, it took more time for us to discover more insights from their response by asking the questions again and repeating their answers to seek confirmation. Therefore, these respondents had an "incomplete" data set compared to other group participants. While this has impacted the findings, they are believed to be minor and do not cause any concerns.

In addition, research with adolescents aged 16 to 18 shows adaptation in approaching scientific topics at a higher cognitive level. Specifically, abstract questions focus on individuals' perceptions of their future assumptions if they and those around them are unaware of how the global climate is changing, the importance of protecting the environment and thinking about future actions. Their opinions are insightful, and they share their identity and express the need to connect with other objects, such as friends and the community in which the participant lives. Therefore, the observation and collection of data on participants' actions and changes is time-consuming and is a suggestion for future new studies. Not only focusing on the survey, science learning sessions with an art-informed approach and interview, but also at the later stage of individual actions taken three months, six months after participating in the class with art integration. In addition, this also helps the individual to evaluate the effectiveness of the plans they share during the interview, which have brought about positive changes for himself, his friends and the community.

5.2.2 Factors affecting the personal transformation of participants

As stated previously in other sections, since participants are from different sites in one location (Ho Chi Minh City), it is acknowledged that the outcomes of this study are exploratory. This study focused only

on the relationship between the art-informed approach to climate change and the personal transformation of participants. Considering the multi-faced nature of how individuals transform themselves after being involved in an art-integrated science communication activity, the possibility of factors playing a role in their future actions toward climate change over a more extended period should be considered. This study utilises qualitative-driven research methodology with the application of MAXQDA for qualitative data analysis. Based on the experience of this study, the elements of interviewing should be consistently present in future studies, as they shape the structure of code sets, analysis and interpretation of the findings. We highlight which factors affect the individual's personal transformative experiences in participating in art-rounded science learning sessions. Defining reasons helps researchers to find the most appropriate implications for scientific communication with the public through an art-informed approach.

When researching teaching information and communication theories through arts, Ibekwe (2020) argued that anxiety and stress might happen during the implementation of the art project. In this study, we witnessed that to reduce stressful and anxious experiences, building trust and assurances to the learners is essential for a science communicator. All information connected with participants' identities is confidential, and they are not being judged on their artwork and art talents by the facilitator and other participants. During implementing the activities, we strongly addressed that the art-informed science learning process focused on how informants used art to express their thoughts, ideas and science messages and present them to others. We realised their potential stress of being judged, receiving negative comments from others, and consolidating the grounded rule of the activity that all ideas were welcome and free to be discussed. Positive words were used to encourage learners' motivation and readiness to get involved in group discussion and share their climate change messages at the end of the activity with phrases, such as: "*What a great idea!*", "*Incredible to see how you presented your climate action in such a beautiful way! Very informative!*", "*How thoughtful you are to think about our future actions toward our environment!*" "*Such a creative idea!*". We realised that by picking fine details in their artwork and discussing that one, as well as inviting other members to raise questions and share their ideas and thoughts about their peers' products, a circle of being connected with other great ideas from the network and feel supported by others have been developed. Another feature that reduced the fear of being judged and of failure was that participants in two groups attending learning sessions knew each other too well since they attended occasionally or lived in their Centre together for years and years.

Working together on the same project, they also anticipated the questions, such as: *What should I do if I see myself being more active than usual? Shall I step out of my comfort zone?* As stated above, there are no judgements or nasty comments during each activity. All felt welcome and appreciated. In this

study, we minimised the potential resistance of participants by building a solid connection between the instructor and informants, trust and respect. The science communicators maintain the activity implementation's harmony and invite participants' breakthrough ideas.

According to Ibekwe (2020), "anxiety and fear of failure are felt not only by the learners. Instructors may also experience anxiety about not being able to "pull off" the project". In this study, the facilitator experienced a fair amount of anxiety and apprehension about integrating an art-combined science collaboration activity with the unpredictable situation of COVID-19. Since all physical activities must follow strict rules for protecting all individuals involved against COVID-19, the instructor was aware of the fact that negative situations and developments may occur, such as a participant or science communication facilitator being infected with COVID-19 or a re-emergence of the disease, affecting the implementation progress of project activities. If either of the above situations occurs, operation disruption is likely. This affects the student's ongoing experience and the researcher's observation and performance efforts. Personal experience through science and art learning activities should be a continuous process, without interruption, and further limit the objective impacts on activities such as weather, epidemics, and transportation issues. In the context of the ongoing COVID-19 epidemic with controlled developments, researchers still experience anxiety and stress when imagining a possible COVID-related incident- 19. These experiences of anxiety and suspense should be controlled to ensure that the classroom activity is seamless and that the experience provided to participants is not interrupted and affected by this feeling.

5.3 Study significance

5.3.1 Raising awareness of the Sustainable Development Goals

A novel positive outcome of this study is that it shows the reflections on the Sustainable Development Goals introduced by the United Nations by introducing the content of science communication with art-informed integration to the young generation in creative educational contexts. This approach plays a crucial role in further practice, management, and research, as well as highlighting the educational gains to participants, personal sphere development and how policymakers could benefit from the study to include more art communication for science, particularly science communication. Sustainable development goals have been achieved in this study, including:

- *Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*, and *Goal 10: Reduce inequality within and among countries*. In this study, we introduced and provided art-informed science education to adolescents from low-income families. Through four learning sessions with art integration into science communication, these participants were given opportunities to express their opinions and future actions toward climate change with creative approaches. More than that, these learning sessions offered them a great

space to reduce inequalities in extra education access, empower them to take action for their environment, spread their knowledge with others regardless of their background, and foster ownership.

- *Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable Half of the world's population live in cities*. Throughout all learning sessions provided in this study, participants in two experimental groups knew and were given examples of how to live green and more sustainable, such as using more public transport instead of private cars and motorbikes, creating more green spaces within their communities by planting more trees and taking care of their little garden at home, improving their environment quality by less littering and plastic bags, more reducing and using more personal cups and bottles.
- *Goal 13: Take urgent action to combat climate change and its impacts*. The outcomes of this research have contributed significantly to Goal 13 of the SGG by the United Nations. Based on these outcomes, it may inspire other researchers and educators to promote more art-integrated climate change activities with the young audience for the public's awareness of taking action toward climate emergency and navigating practitioners and professionals to produce research and initiatives with impact leads to science perception communication and science-based environmental behaviours. This can take interdisciplinary approaches from environmental fields to social sciences and can be influenced by promoting more cooperative and transformative strategies in participatory ways.

5.3.2 Empirical evidence to reinforce understanding

As practical implications, this study provides empirical evidence in the field and fresh perspectives for the current literature regarding the role of art in science communication as a mediator and moderator. In addition, the qualitative analysis added to the body of knowledge by demonstrating art as a critical connector that could impact meaningful work towards personal transformation and peer relations and the climate change response of respondents in a more active and cooperative engagement. Like earlier studies, art builds connections for the individual to feel creative to complete tasks. The differentiating point is where this study proceeded a step further by showing that art-informed science communication activities can encourage transformative learning experiences, activating personal motivation to know more about science.

Moreover, communicating science through an art-based approach encourages participants to think actively and critically about science, be eager learners and effective communicators with other people about other science topics, and be open to various perspectives and willing to learn from others. The learning sessions set within this study have shown that adolescents feel more integrated into their

community, responsible, self-confident, and communicative. They see themselves in different roles, from listening to content creators, activists and communicators with peers and family. Enhanced interaction between participants and their peers and community with the partnership of science and art activities may provide stability and sustainability to science communication at larger scales. The results of this study may be utilised when developing more effective forms of collaboration among scientists, science communicators and educators for more innovative teaching methods and future research projects on the transformative experiences of teachers and learners.

5.3.3 Deployment of MAXQDA as a digital qualitative analytic tool

Three research questions were examined through a qualitative approach using MAXQDA in interviews and solved critically. We applied the interview stages of Ritchie and Lewis (2003), qualitative data analysis of Pope and Mays (2006) and MAXQDA in establishing the code system and code map and aligned strongly with the literature review and research questions. We have minimised our bias in analysing data collected from interviews and presenting the study findings. We worked on the study interviews responded by participants by working side-by-side together through our lens of analysis and interpretation of data. The use of interviews allowed us to have more in-depth insight into participants' personal experiences from both experimental groups and to discover differences between experimental and control groups. The qualitative interview study presented an empirically driven analysis, increasing the understanding of participants' transformative experiences in art-combined science communication activities, particularly from the viewpoints of researchers concerning previous research. It made the interpretation and analysis of the findings more meaningful. Therefore, we could view, understand, analyse and present the story of the data collected from more than one perspective.

Moreover, the MAXQDA approach in analysing qualitative data minimised the researcher's subjectivity when assigning code values to the text. As mentioned, a code value must be defined by the background literature review, objectives and research question to establish a code value's necessary properties (sub-codes). Therefore, the MAXQDA application improves the results reporting, which has become increasingly important in social science research. Besides, building a correlation model between parent code and sub-codes by applying MAXQDA or qualitative analysis processing software helps researchers visualise their research results, thereby serving as a foundation for further studies.

5.4 Recommendations for future research: Practical and policy makers' implications

Future research is needed for further conceptualisations of art-informed science communication on different age groups (children to experienced adults) from different backgrounds of culture in other countries. Deepening the understanding of the challenges in the collaboration between science communication researchers, experts, and the lay society in building a solid network of communicating

science would contribute to the research and practice of our field. The network established through art activities allows researchers and experts to get to know more about their audiences, to see what they think about what science is and what science is not, and how they perceive art as a medium for them to know more about their surroundings and encourage them to feel free to talk about science without having any judgement. As science communicators, we must be sensible in communicating effectively with the lay society and bringing science closer to daily life.

The following areas are suggested for future research as below:

- A study needs to be conducted with a more significant number of participants.
- An area for further research is to see if there are any significant differences between males and females for any of the three main themes of climate change response, personal transformation and peer development through art.
- A study should compare personal transformation and level of perception between Vietnamese participants and participants from other countries.

The findings of this research are relevant to the broader study of science communication practices through art-science collaboration to discover how art and science can collaborate and encourage participants to experience and express what they think about science and what they believe and do not believe in science. This study highlighted that the participants from two experimental groups felt the impact of art-informed approaches, and their impact was noticeably different between participants. It shows how art can be flexible in scientific communication to the public and bring different experiences among participants. Among the many challenges of promoting a creative science communication space and researching participants' experiences, this study has contributed to the urgent needs.

This study offers a starting point for bringing art to adolescents on the issue of climate change, climate change actions and migrations and the role of being an interactive science communicator in conversation with respondents in the personal sphere of transformation. It would be more beneficial to conduct further investigation and give voice to other age groups about their willingness to know more about climate change and other science topics through art, their acceptance of involving art in science communication from their viewpoint and their transformation with art.

Further examination of the drivers of science communication in higher levels of transformation, such as practical and political spheres, should be considered to discuss the correlation of the personal sphere with the other two spheres. The recent question raised from this study is: What are the shared perspective and different viewpoints of three spheres from cultural backgrounds and geographical locations? Answers to this question can orientate how science communication should be approached in various cultural

settings and how science public relations will be established in a specific society. Attention should be paid to those aspects for better conversations and interactions with the relevant public.

Furthermore, this study also suggests more research on the role of art as an effective tool for professional science communicators in presenting their ideas and results to research organisations, working with other researchers and communicating with the public. With the role of communicator about science to several groups in society, one must be clear that it attracts more attention and interest from the audiences if we offer them a no-worry space to express themselves and talk to us and no art skills requirements. An informative context is where all visitors are free to discover what is around them, able to touch, act, do and present their products and have a space for them to show their performance and listen, watch and talk about their work and others in an equal position. There is no "you", no "me", but only "us" equally.

Last but not least, the findings of this study cannot be generalised to other schools. This study discovered the findings from adolescent participants from four Centres in Ho Chi Minh City. We need more studies to draw a transferable and objective picture about how we can bring transformative experiences to learners of different ages, find similarities and differences at different levels of ages and cultural backgrounds, and how personal experiences can affect their willingness to learn new things. It will be a very long pathway, but it is worth paying our efforts and determination to discover how humans adapt to science in this constantly changing world.

In conclusion, this study successfully presented meaningful work, art-integrated science communication and education on climate change adaption for adolescents with Solomon-four group research design and answered the research questions and objectives outlined in Sections 1.2 and 1.3 of Chapter 1 previously. In summary, the study's findings, discussion and recommendations may help develop the future practical implementation of science communication activities to obtain a stronger connection between the general public and scientists. Future research may be challenging, but the results will provide a comprehensive overview of science communication for educators, students and stakeholders.

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APPENDICES

Appendix A. KAP Survey

Dear Participants,

We are delighted to invite you to participate in the study "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change". A research group including Professor Beena Giridharan as principal supervisor, Dr Christos Kostopoulos as co-supervisor, and Truong Thi Kim Oanh, Master of Philosophy (Media, Culture and Creative Arts) student, currently enrolling School of Media, Creative Arts, and Social Inquiry, Faculty of Humanities, Curtin University is conducting this study.

The study aims to find how adolescents can adapt to climate change through arts-science collaboration activities and how personal sphere changes affect participants' awareness, engagement, appreciation, and social consciousness through art-based science communication and participatory approaches. These changes raise a more prolonged impact on practical and political spheres. Change measures with pre-test and post-test activities will be applied in this research. More importantly, the study's findings may show that the arts can propose scientific advancement in developing adolescents' sense of climate change ownership and a form of translation and communication to complex topics through art-science collaborations.

By joining the pre-test activity, you will meet with Truong Thi Kim Oanh to talk about your knowledge, attitudes towards climate change, and practices to be taken or considered helpful about climate change adaptation and your media preferences. A survey given below, completed by you, presents this pre-test activity.

This survey will take 30 minutes via face-to-face interaction or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam at the centres where adequate facilities are available. A participant number refers to your provided information, so it cannot be traced to you, and we will also change any names you mention as further protection.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

For more information, you can contact the researchers by emailing oanh.truongthikim@postgrad.curtin.edu.au, and beena.giridharan@curtin.edu.au.

Best regards.

Location				
Code				
Date				
Time			AM	PM

I. Socio-demographic background

1. Age

Answer: _____

2. Current Level of Education

☐ 1. No schooling ☐ 2. Primary School ☐ 3. Secondary School ☐ 4. High School

3. Gender

☐ 1. Male ☐ 2. Female

4. Years living in the current community

☐ 1. Less than a year ☐ 2. 1-5 year(s) ☐ 3. 6-10 years ☐ 4. 10-18 years

Details: Details: Details: Details:

5. Number of persons, including you, residing in the same household

☐ 1. Less than 3 ☐ 2. 3-5 persons ☐ 3. 6-10 persons ☐ 4. Others

Details: Details: Details: Details:

6. Have you heard of climate change?

☐ 1. Yes ☐ 2. No

Details: Details:

7. Have you heard of art-based projects on climate change?

☐ 1. Yes ☐ 2. No

Details: Details:

II. Knowledge of Climate change

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No information / Do not know

8. **How much do you agree or disagree with the following information?** *Please tick the box in each row*	1	2	3	4	5	99

8.1. Evidence for climate change[1]							
1.	Global temperature rise	☐	☐	☐	☐	☐	☐
2.	Warming ocean	☐	☐	☐	☐	☐	☐
3.	Shrinking ice sheets	☐	☐	☐	☐	☐	☐
4.	Decreased snow cover	☐	☐	☐	☐	☐	☐
5.	Sea level rise	☐	☐	☐	☐	☐	☐
6.	Declining Arctic Sea ice	☐	☐	☐	☐	☐	☐
7.	Extreme events (for example, intense rainfall events)	☐	☐	☐	☐	☐	☐
8.	Ocean acidification	☐	☐	☐	☐	☐	☐
9.	For other evidence, please specify and rate	☐	☐	☐	☐	☐	☐
8.2. Drivers of climate change[2]							
	Human activities: Industrialization	☐	☐	☐	☐	☐	☐
2.	Human activities: Urbanization	☐	☐	☐	☐	☐	☐
3.	Human activities: Growth of industry and urban expansion for higher levels of land and water use and air pollution	☐	☐	☐	☐	☐	☐
4.	Human activities: Agricultural intensification and encroachment	☐	☐	☐	☐	☐	☐
5.	Natural changes in the environment	☐	☐	☐	☐	☐	☐
6.	Human activities and natural changes	☐	☐	☐	☐	☐	☐
7.	Other reasons, please specify and rate:	☐	☐	☐	☐	☐	☐
8.3. Impacts of climate change in Vietnam[3]							
	Increase in the number and severity of typhoons	☐	☐	☐	☐	☐	☐
2.	Reduce productivity of coastal fisheries	☐	☐	☐	☐	☐	☐
3.	Reduction in agricultural land and productivity in coastal and other areas prone to flooding and erosion	☐	☐	☐	☐	☐	☐
4.	Increase in extensive saline intrusion reducing water quality for agriculture, drinking, and industrial uses	☐	☐	☐	☐	☐	☐
5.	Increase in energy and water consumption	☐	☐	☐	☐	☐	☐
6.	Permanent inundation of coastal and low-lying areas	☐	☐	☐	☐	☐	☐
7.	Permanent losses of land for cultivation and aquaculture	☐	☐	☐	☐	☐	☐
8.	Other impacts, please specify and rate:	☐	☐	☐	☐	☐	☐

[1] Earth Science Communications Team at NASA's Jet Propulsion Laboratory | California Institute of Technology, *Climate Change: How Do We Know?*, https://climate.nasa.gov/evidence/. Accessed 5 September 2021.

[2] Asian Development Bank. (2013). *Viet Nam: Environment and climate change assessment*. Mandaluyong City, Philippines. Cataloging-In-Publication Data. ISBN 978-92-9254-131-6 (Print), 978-92-9254-132-3 (PDF), pp. 2-3.

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III. Attitude on Climate change [4][5][6][7]

1	2	3	4	5	99
Not at all important	Slightly important	Important	Fairly important	Very important	No information / Do not know

	9. How important are the following aspects of youth attitude toward climate change? *Please tick the box in each row*	1	2	3	4	5	99
1.	Youth awareness of climate change, its causes, and effects	☐	☐	☐	☐	☐	☐
2.	Youth interest in learning climate change knowledge	☐	☐	☐	☐	☐	☐
3.	Youth interest in knowing activities aimed at protecting the environment	☐	☐	☐	☐	☐	☐
4.	Youth interest in applying activities aimed at protecting the environment	☐	☐	☐	☐	☐	☐
5.	Youth initiative for climate change adaptation and mitigation	☐	☐	☐	☐	☐	☐
6.	Youth engagement in climate change response	☐	☐	☐	☐	☐	☐
7.	Youth role in climate change action	☐	☐	☐	☐	☐	☐
8.	Youth readiness to transfer climate change knowledge to parents	☐	☐	☐	☐	☐	☐
9.	Youth readiness to transfer climate change knowledge to peers	☐	☐	☐	☐	☐	☐
10.	Other opinions, please specify and rate:	☐	☐	☐	☐	☐	☐

IV. Practices toward climate change[8]

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No information / Do not know

	10. How much do you agree or disagree with the following practices? *Please tick the box in each row*	1	2	3	4	5	99
	Planting trees	☐	☐	☐	☐	☐	☐
Renewable energy							
	Solar energy	☐	☐	☐	☐	☐	☐
	Hydroelectricity	☐	☐	☐	☐	☐	☐
	Wind power	☐	☐	☐	☐	☐	☐
	Energy-efficient cooking	☐	☐	☐	☐	☐	☐
	Fuel-saving	☐	☐	☐	☐	☐	☐
	Electricity-saving	☐	☐	☐	☐	☐	☐

[4] O'Brien, K. and Sygna, L. (2013). Responding to climate change: The three spheres of transformation. Proceedings of Transformation in a Changing Climate, 19-21 June 2013, Oslo, Norway. University of Oslo (pp.16-23). ISBN 978-82-570-2000-2.

[5] O'Brien, K. L., and Selboe, E. (2015). Climate change as an adaptive challenge. In: The Adaptive Challenge of Climate Change, 1-23. New York, NY: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9781139149389.002

[6] Sánchez-Mora, M. C. (2016). Towards a taxonomy for public communication of science activities. *Journal of Science Communication, 15*, 1-8. DOI:10.22323/2.15020401.

[7] Schlitz, M., Vieten, C. and Miller, E. M. (2010). Worldview transformation and the development of social consciousness. *Journal of Consciousness Studies 17*(7-8),18-36.

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	Water-saving	☐	☐	☐	☐	☐	☐
	Other opinions, please specify and rate:	☐	☐	☐	☐	☐	☐

V. Preferred media usages as sources of information on climate change

1	**2**	**3**	**4**	**5**	**99**
Very unlikely	Unlikely	Neutral	Likely	Very likely	No information / Do not know

No.	**Media**	**1**	**2**	**3**	**4**	**5**	**99**
1.	Artwork	☐	☐	☐	☐	☐	☐
2.	Brochures	☐	☐	☐	☐	☐	☐
3.	Comics	☐	☐	☐	☐	☐	☐
4.	Infographic	☐	☐	☐	☐	☐	☐
5.	Posters	☐	☐	☐	☐	☐	☐
6.	Videos	☐	☐	☐	☐	☐	☐
7.	Charts	☐	☐	☐	☐	☐	☐
8.	Newsletters	☐	☐	☐	☐	☐	☐
9.	Newspapers	☐	☐	☐	☐	☐	☐
10.	Surveys	☐	☐	☐	☐	☐	☐
11.	For other preferences, please specify and rate	☐	☐	☐	☐	☐	☐

End of Survey./.

Appendix B. Reflective Journal

INDIVIDUAL ASSIGNMENT: REFLECTIVE JOURNAL

We encourage you to express your analysis of your participation after attending each session within the research context and your assessment of the group interactions that may have occurred. More importantly, personal reflection will help you recognize what you learned and gained for your self-analysis, ideas, and interests.

Use the following form to help you express your thoughts.

Item	Question
LEARNING POINTS	**What did you learn?**
	What did you contribute?
	What did the other members of the group contribute?
PROCESS	**How did you learn?**
	How did you learn with other members of the group?

Item	Question
PERSONAL DEVELOPMENT	**How were your personal feelings about the session today?**
	What was new for you?
	What did this learning experience mean to you?
	What are your plans after this learning session?

End of Document./.

Appendix C. Interview Questions

INTERVIEW INTRODUCTION

WELCOME (1 minute)

My name is Truong Thi Kim Oanh, a Master of Philosophy Student at Curtin University.

INTRODUCTION (1 minute)

Thank you for giving our research team your consent to be part of the focus group of the research titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change". We appreciate your willingness to participate.

PURPOSE of INTERVIEW (3 minutes)

I will take 45 minutes of your time to gather your opinions and attitudes about climate change. I will then ask some questions and encourage you to share your open thoughts and voice. I will be moderating our talk today.

I also would like you to know that we will make digital audio and video recordings to concentrate on what you say and not distract ourselves from taking notes. Information identifying you or your centre will be removed from the data we collect. The information collected in this study will be re-identifiable in data analysis, storage, and data management systems for the study to develop research papers and presentations.

GROUND RULES (5 minutes)

I would like to mention some ground rules to allow our conversation to flow more freely.

There are no right or wrong answers, only different opinions. You say what is true for you, even if you are the only one who feels that way. If you change your viewpoint, let me know and tell me your updates.

Only one person will speak at a time.

This is a confidential discussion in that I will not report your name or who said what to your centre, parents, or team members.

This session will be recorded. We want to concentrate on what you share with us and not distract ourselves from taking notes and other outside factors. We do not identify anyone by name in our report. You and your provided information will remain anonymous.

There is one bottle of water and a snack for you. You can have a break if you think you need it, and let me know when you are ready to continue our talk.

INTRODUCTION of PARTICIPANTS (3 minutes)

Before we start, I invite you to pick a colour card on the table before you and write a nickname for you. The card and nickname you provide will help us remember and call you.

Now, tell us the colour of the card and the nickname you want us to call you.

An icebreaker question for your great imagination, tell me: If you could have a superpower, what would it be? Why?

INTERVIEW QUESTIONS (15-30 minutes)

[see the page with interview questions]

CLOSING (2 minutes)

Thank you for spending time with me today and discussing climate change. Your thoughts and comments have given us many different ways to see this issue.

INTERVIEW QUESTIONS

We encourage you to provide your analysis with some interview questions within the research context. These questions will help us know what you know and think and your ideas and interests.

Item	Question
KNOWLEDGE	1. The global climate is changing. What do you think about this statement?
	2. Climate change is caused by natural factors, human actions or both. What do you think about this statement?
ATTITUDE	1. How will you feel if you and your family are affected by climate change?
	2. How will you feel if you have a responsibility to reduce climate change?
	3. How will you feel if art can contribute to tell you more about climate change?
	4. How will you feel if art-based science learning activities can develop your cooperation with your teammates?
PRACTICE	1. What will happen if we do nothing?
	2. What will you do to cope with climate change?

End of Interview./.

Appendix D. Participant Consent Form

PARTICIPANT CONSENT FORM

HREC Project Number:	HRE2022-0111
Project Title:	Art for science communication: The transformation in the personal sphere of adolescents in response to climate change
Chief Investigator:	Prof. Beena Giridharan
Student researcher:	Truong Thi Kim Oanh

- I have read the participant information form provided in this project and understand its contents.
- I understand the purpose, extent, and possible risks of my involvement in this project.
- I understand participation in this research project is fully voluntary.
- I know that my responses will be recorded when I answer questions in this study.
- I know that photographs and video recordings will be carried out during the research context's surveys, learning sessions, interviews, and research activities under this study and will only be used for data analysis in the thesis.
- I know that photographs, videos and audio recordings, and information provided by me in this study will be stored and kept under secure conditions at Curtin University for seven years after publication or completion of the project, or subjects have reached 25 years of age, whichever is later, and then it will be destroyed.
- I know that my reflective journals required for each learning session within the project context will be used for research purposes.
- I have had an opportunity to ask questions, and I am satisfied with the answers I have received.
- I understand that Curtin University Human Research Ethics Committee has approved this project, and it will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007).
- I understand I will receive a copy of the participant information and consent forms.

Participant's Name	
Participant's Signature	
Date	

Declaration by the researcher: I have supplied an Information Letter and Consent Form to the participant who has signed the above, and I believe they understand the purpose, extent, and possible risks of their participation in this project.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

Researcher Name	
Researcher Signature	
Date	

End of Document./.

Appendix E. Participant Information Form

PARTICIPANT INFORMATION FORM

HREC Project Number:	HRE2022-0111
Project Title:	Art for science communication: The transformation in the personal sphere of adolescents in response to climate change
Chief Investigator:	Prof. Beena Giridharan
Student researcher:	Truong Thi Kim Oanh

What is the Project About?

We are carrying out a study titled "**Art for science communication: The transformation in the personal sphere of adolescents in response to climate change**" with participants from 16-18 years old.

The study aims to find how adolescents can adapt to climate change through art-science collaboration activities and how personal sphere changes affect participants' awareness, engagement, appreciation, and social consciousness through art-based science communication and participatory approaches. These changes raise a more prolonged impact on practical and political spheres. Change measures with pre-test and post-test activities will be applied in this Research. More importantly, the study's findings may show that art can propose scientific advancement in developing adolescents' sense of climate change ownership and a form of translation and communication to complex topics through art-science collaborations.

Who is doing the Research?

- The project team members are Prof. Beena Giridharan - Principal Supervisor; Dr Christos Kostopoulos - Co-Supervisor; and Ms Truong Thi Kim Oanh - Master of Philosophy (Media, Culture and Creative Arts) Student, School of Media, Creative Arts and Social Inquiry, Faculty of Humanities from the Curtin University.
- The project is being conducted by Truong Thi Kim Oanh (First name: Oanh; Family name: Truong; Middle name: Thi Kim). The Research will contribute to Truong Thi Kim Oanh's Master of Philosophy (Media, Culture and Creative Arts) Degree at the Faculty of Humanities, Curtin University.
- The results of this research project will be used by Truong Thi Kim Oanh to obtain a Master of Philosophy at Curtin University, which is funded by the University.

- There will be no costs to Truong Thi Kim Oanh, and Truong Thi Kim Oanh will not be paid for participating in this project.

Why am I being asked to participate, and what will I have to do?

We will have four groups. Groups 1 and 3 undergo learning sessions, and groups 2 and 4 receive no learning sessions.

Firstly, with groups 1 and 2, we ask participants 16-18 years old at centres in Ho Chi Minh City, Vietnam, to participate in our pre-test activity. We will survey your knowledge, attitudes, and practices toward climate. We will ask you to complete a short survey, taking 30 minutes via face-to-face interaction or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam at the centres where adequate facilities are available. By involving in the pre-test activity of the study titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change", you will be reimbursed for your time. Reimbursement for time is equal for all participants in the study, which is US$2 (in words: United States two dollars) or the equivalent amount in Vietnamese Dong according to the exchange rate at the date of study participation.

Secondly, with groups 1 and 3, we will have four learning sessions at centres to provide activities for you. We will directly assess your changes based on completing learning sessions, tasks requested per session, reflective journals, and group discussions. Each session should take 60 to 120 minutes and will be facilitated by Truong Thi Kim Oanh.

The list of four sessions includes:

1. Learning session 1. Climate change effects and causes
2. Learning session 2. Climate change investigation
3. Learning session 3. Climate change actions
4. Learning session 4. Climate change exhibition

We will take photos and make a digital video per session. As part of each session, you will keep a reflective journal. We encourage you to express your analysis of your participation, ideas and interests after attending each session within the research context and your assessment of the group interactions that may have occurred during the session.

Thirdly, we will have a post-test activity presented by climate change interviews for all participants in four groups. We will ask you to complete eight interview questions, taking 60 minutes via face-to-face interaction or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam at the centres where adequate facilities are available.

The list of eight questions includes the following:

1. The global climate is changing. What do you think about this statement?
2. Climate change is caused by natural factors, human actions or both. What do you think about this statement?
3. How will you feel if you and your family are affected by climate change?
4. How will you feel if you have a responsibility to reduce climate change?
5. How will you feel if art can contribute to tell you more about climate change?
6. How will you feel if art-based science learning activities can develop your cooperation with your teammates?
7. What will happen if we do nothing?
8. What will you do to cope with climate change?

We will make digital audio and video recordings to concentrate on what you say and not distract ourselves from taking notes. By involving in the post-test activity of the study titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change", you will be reimbursed for your time. Reimbursement for time is equal for all participants in the study, which is US$2 (in words: United States two dollars) or the equivalent amount in Vietnamese Dong according to the exchange rate at the date of study participation.

Are there any benefits to being in the research project?

Participants appreciate the opportunity to discuss their opinions, feelings, and conditions.

We hope the results of this study will allow us to:

- develop educational programs
- add to the existing knowledge regarding climate change

Are there any risks, side-effects, discomforts, or inconveniences from being in the research project?

- There are no known risks associated with participation in this study. Due to the current COVID-19 situation, particularly in Ho Chi Minh City, Vietnam, the student researcher is committed to following guidance and instructions strictly from the Ministry of Health in Vietnam, Department of Health in Ho Chi Minh City, and HCMC Centre for Disease Control, which include 5K Message and Vaccine:

6. Khẩu trang (Face mask): regularly wear face masks in public places and crowded areas, and wear medical masks at medical facilities and quarantine areas.

7. Khử khuẩn (Disinfection): regularly wash hands with soap or hand sanitisers; clean surfaces and frequently contact objects; Keep clean and keep the house well-ventilated.
8. Khoảng cách (Distance): keep a safe distance from other
9. Không tụ tập (No gathering): avoid mass gatherings
10. Khai báo y tế (Health declaration): make a health declaration on nationally approved apps, and install BlueZone, which will help detect the risk of COVID-19 infection.

The student researcher Truong Thi Kim Oanh has been fully vaccinated since September 2021 and received a booster shot on December 28, 2021, with Oxford/AstraZeneca COVID-19 vaccine.

- We have been careful to ensure that the survey questions and tasks do not cause you any distress. But, if you feel anxious about any questions, you do not need to answer them. If the questions cause concern or upset you, we can refer you to your centre's social staff.
- Whilst all care will be taken to maintain the privacy and confidentiality of any information shared at a focus group or group discussion. You should be aware that they may feel embarrassed or upset if one of the group members repeats things said in a confidential group meeting. If the conversations cause concerns or upset you, we can refer you to Ho Chi Minh City Children's Rights Protection Association by telephoning the hotline: 18009069.
- Apart from giving up your time, we do not expect that there will be any risks or inconveniences associated with taking part in this study.

Who will have access to my information?

- The laptop and all hard drives/devices used during this study are password protected.
- The information collected in this Research will be re-identifiable through codes. Any information we collect that can identify you will stay on the information we collect, and it will be treated as confidential and used only in the project unless otherwise stated. We can only let others know this information if we say so or the law says we need to.
- All information will be stored securely at Curtin University.
- In case of an audit or investigation, the following people will have access to the information we collect in this Research: the research team and staff from the Curtin University Office of Research and Development.
    - The information collected in this Research will be re-identifiable (coded). This means we will collect data that can identify you, remove identifying information on any data or sample and replace it with a code when analysing the data. Only the research team has access to the

code to match your name if it is necessary to do so. Any information we collect will be treated as confidential and used only in this project unless otherwise specified. In case of an audit or investigation, the following people will have access to the information we collect in this Research: the research team and staff from the Curtin University Office of Research and Development.

- Electronic data will be password-protected, and hard copy data (including video or audio tapes) will be in locked storage.
- The information collected in this study will be re-identifiable. Participants will be de-identified in data analysis, storage, and data management systems for the study. The data will be stored electronically on a secure drive or in a locked cupboard at Curtin University that the research team can only access. The information we collect in this study will be kept under secure conditions at Curtin University for seven years after the date of publication or completion of the project or until subjects have reached 25 years of age, whichever is later, and then it will be destroyed.
- The results of this research may be presented at conferences or published in professional journals. You will not be identified in any results that are published or presented.
- Whilst all care will be taken to maintain the privacy and confidentiality of any information shared at a focus group or group discussion. You should be aware that you may feel embarrassed or upset if one of the group members repeats things said in a confidential group meeting. If the conversations cause concerns or upset you, we can refer you to Ho Chi Minh City Children's Rights Protection Association by telephoning the hotline: 18009069.

Will you tell me the results of the Research?

- We will write to you at the end of the Research (in about three months) and let you know the results. Results will not be individual but based on all the information we collect and review as part of the Research.
- The results of this Research are expected to publish either in a journal or a conference.

Do I have to take part in the research project?

- Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to participate and change your mind, that is okay. You can withdraw from the project.
- You do not have to give us a reason; just tell us you want to stop. Please let us know if you want to stop so we can ensure you know anything that needs to be done so you can withdraw safely.

- With your permission, if you choose to leave the study, we will use any information collected unless you tell us not to.

What happens next, and whom can I contact about the Research?

- If you decide to participate in this Research, we will ask you to sign the consent form. Signing tells us that you understand what you have read and what has been discussed. Signing the consent indicates that you agree to be in the research project. Please take your time and ask any questions before deciding what to do. You will be given a copy of this information and the consent form to keep.
- Due to unexpected events caused by the pandemic, some research activities may be taken via face-to-face or online interaction platform by Webex Meetings prevailing the pandemic situation and travel restrictions in Vietnam and at your convenience.
- For more information, you can contact the researchers by emailing oanhtruong@postgrad.curtin.edu.my.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

Appendix F. Letter to Participant

LETTER TO PARTICIPANT

HREC Project Number:	HRE2022-0111
Project Title:	Art for science communication: The transformation in the personal sphere of adolescents in response to climate change
Chief Investigator:	Prof. Beena Giridharan
Student researcher:	Truong Thi Kim Oanh

Declaration by the researcher: I have supplied an Information Letter and Consent Form to the participants and believe they understand the purpose, extent, and possible risks of their involvement in this project.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

Researcher Name	
Researcher Signature	
Date	

LETTER TO PARTICIPANT

Dear Participant,

My name is Truong Thi Kim Oanh, and I am a master's student working under the supervision of Prof. Beena Giridharan at Curtin University. As part of my master's degree, I am conducting a research study titled Art for science communication: The transformation in the personal sphere of adolescents in response to climate change. I would like to invite you to participate in this study.

If you decide to volunteer for this study, your participation will consist of survey completion, learning sessions, and interview completion about climate change.

Please read the attached Information Letter for more details regarding what participation will involve. If you require additional information to assist you in deciding on participation, please do not hesitate to contact me at oanhtruong@postgrad.curtin.edu.my. You may also contact my supervisor at beena@curtin.edu.my.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

Sincerely,

Truong Thi Kim Oanh

Appendix G. Letter to Centres

LETTER TO CENTRES

HREC Project Number:	HRE2022-0111
Project Title:	Art for science communication: The transformation in the personal sphere of adolescents in response to climate change
Chief Investigator:	Prof. Beena Giridharan
Student researcher:	Truong Thi Kim Oanh

Declaration by the researcher: I have supplied an Information Letter and Consent Form to the participants and believe they understand the purpose, extent, and possible risks of their involvement in this project.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2022-0111). 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 at (08) 9266 9223 or the Manager, Research Integrity at (08) 9266 7093 or email hrec@curtin.edu.au.

Researcher Name	
Researcher Signature	

LETTER TO CENTRES

Dear [Name of Representative of Center], Representative of [Name of Center], Ho Chi Minh City, Vietnam

My name is Truong Thi Kim Oanh, and I am a master's student at Curtin University.

We are carrying out a study titled "Art for science communication: The transformation in the personal sphere of adolescents in response to climate change" with the age group of the research in Years 16 and 18. The project team members are Prof. Beena Giridharan - Principal Supervisor; Dr Christos Kostopoulos - Co-Supervisor; and Ms Truong Thi Kim Oanh - Master of Philosophy (Media, Culture and Creative Arts) Student, School of Media, Creative Arts and Social Inquiry, Faculty of Humanities from the Curtin University.

The study aims to find how adolescents can adapt to climate change through arts-science collaboration activities and how personal sphere changes affect participants' awareness, engagement, appreciation, and social consciousness through art-based science communication and participatory approaches. These changes are to raise a more prolonged impact on practical and political spheres. Change measures with pre-test and post-test activities will be applied in this research. More importantly, the study's findings may show that the arts can propose scientific advancement in developing adolescents' sense of climate change ownership and a form of translation and communication to complex topics through art-science collaborations.

We will have four groups: groups 1 and 3 to undergo learning sessions and groups 2 and 4 to receive no learning sessions.

Firstly, with groups 1 and 2, we intend to ask participants aged 16 and 18 at centres in Ho Chi Minh City, Vietnam, to participate in our pre-test activity. We will assess your knowledge, attitudes, and practices toward climate through a questionnaire, which will take about 20-30 minutes via telephone, online, or face-to-face interviews at your convenience.

Secondly, groups 1 and 3 will have six learning sessions at centres to provide activities for you. We will directly assess your changes based on completing learning sessions, tasks requested per session, reflective journals, group discussions, and interviews. Each session should take 60 to 120 minutes and will be facilitated by Truong Thi Kim Oanh.

The list of four sessions includes:

1. Learning session 1. Climate change effects and causes
2. Learning session 2. Climate change investigation
3. Learning session 3. Climate change actions

4. Learning session 4. Climate change exhibition

As part of each session, you will keep a reflective journal. We will take photos and make a digital video per session.

Thirdly, we will have post-test activities, such as climate change interviews for four groups. We will make digital audio and video recordings to concentrate on what you say and not distract ourselves from taking notes.

We hope we can have your letter of support for this research. Please let us know your feedback by sending your reply through this email. We do accept either English or Vietnamese for your best convenience!

We are looking forward to hearing from you soon.

All the best,

Oanh.

--

Oanh Truong Thi Kim

MPhil (Media, Culture and Creative Arts) Student

Faculty of Humanities

Curtin University, Malaysia

Email | oanhtruong@postgrad.curtin.edu.my

Web | www.curtin.edu.my

Appendix H. Learning Sessions

Appendix H. Learning Session 1

#	Step	Details	Time	Materials
Overview: This season's content focused on providing general knowledge about climate change (definition, causes, impacts). It aims to help participants understand climate change, see how human activities are causing it, and create a platform for participants to have initiatives on climate change - action to adapt to climate change (will be covered in the following sessions). Using components of the art of colours and materials, participants create and present their perception and understanding of the causes of climate change through visual products and create a learning environment for participants to present their ideas and ask questions.				
Learning session 1: Climate change effects and causes				
1	**Commencement**	A few Yes/No questions are asked to find out what participants know about climate change as follows: Question 1. Have you heard about climate change? If yes, what and where do you know? Question 2. Do you know what the effects of climate change are? If yes, what is it? Question 3. Do you know what the causes of climate change are? If yes, what is it? Question 4. Do you know of any activities you can do at home or school to stop climate change? If yes, can you give some solutions? The answers will be noted to increase the participant's concentration.	5 minutes	flip chart flipchart markers
2	**Cognisance**	**Input 1. Differences between weather and climate** **Input 2. What is climate change**	15 minutes	

#	Step	Details	Time	Materials
		Input 3. Evidence of climate change - Global temperature rise (watch video: Global warming from 1880 to 2021) *Credit* *NASA's Scientific Visualization Studio. Data provided by Robert B. Schmunk (NASA/GSFC GISS).* - Warming Ocean (watch the video: Antarctic ice mass loss 2002-2020) *Credit* *https://climate.nasa.gov/climate_resources/264/video-greenland-ice-mass-loss-2002-2020/.* *NASA and JPL/Caltech* - Shrinking ice sheets (watch the video: Greenland ice mass loss 2002-2021) *Credit* *Felix W. Landerer (NASA/JPL CalTech): Scientist* *Marit Jentoft-Nilsen: Visualizer* *NASA and JPL/Caltech* *Short URL to share this page: https://svs.gsfc.nasa.gov/31156* - Sea level rise (watch a photo: Sea Level Rise 1990 – 2018) *Data source: Frederikse et al. (2020)* *Credit: NASA's Goddard Space Flight Center/PO.DAAC*		printable information package printable posters video

#	Step	Details	Time	Materials
		Input 4. Cause of climate change Watch video: ***Climate models project 21st-century global temperatures*** ***Credit:*** *NASA's Scientific Visualization Studio and NASA Center for Climate Simulation* ***Short URL to share this page:*** *https://svs.gsfc.nasa.gov/11453* *https://climate.nasa.gov/causes/* *https://climate.nasa.gov/climate_resources/269/human-and-natural-drivers-of-climate-change-1850-2018/*		
3	**Creation**	**Question 1. What is my Ecological Footprint?** https://www.footprintcalculator.org/home/en With the support of an instructor, participants are invited to participate in calculating their ecological footprint. **Question 2. What are the results of my Ecological Footprint?** Participants were asked to record their results and share them with the group. **Question 3. What can I do to reduce my Ecological Footprint?**	45 minutes	printable footprint art materials

#	Step	Details	Time	Materials
		Participants are asked to suggest ways to reduce their Ecological Footprint by drawing a picture of their Ecological Footprint and stating the solutions the participant thought they could implement in the community. Participants take turns sharing their ideas with the study group members. Image source: *https://www.footprintnetwork.org/content/uploads/2016/10/Footprint-highres.png*		
4	**Connection**	Write your reflective journal The instructor provides instructions on completing the session and answering participants' questions and concerns. Participants are required to complete the Study Log after completing the session. It is a mandatory requirement.	15 minutes	printable reflective journal per participant
5	**Closure**	Summary of today's lesson. Briefly describe the activity of the upcoming class, time and preparations.	5 minutes	

Appendix H. Learning Session 2

#	Step	Details	Time	Materials
Learning session 2. Climate change investigation				
1	**Commencement**	Some "Quick Facts" about Earth before the start of the class for participants to "brainstorm" about today's topic! "Quick Facts" includes: Day 23.9 hours Year 365.25 days Radius 3,959 miles | 6,371 kilometres *Source: https://solarsystem.nasa.gov/planets/earth/in-depth/*	5 minutes	printable cards
2	**Cognisance**	Facts about Earth) **Fact 1. Earth in the Solar System** The Solar System Planet Sizes Mercury – 1,516mi (2,440km) radius; about 1/3 the size of Earth, is the closest planet to the Sun and is the smallest planet Venus – 3,760mi (6,052km) radius; only slightly smaller than Earth Earth – 3,959mi (6,371km) radius Mars – 2,106mi (3,390km) radius; about half the size of Earth Jupiter – 43,441mi (69,911km) radius; 11x Earth's size Saturn – 36,184 mi (58,232km) radius; 9x larger than Earth. One orbit around the Sun is equal to 29.4 Earth years Uranus – 15,759mi (25,362km) radius; 4x Earth's size, has the lowest temperature of all the planets of the Solar System, with a minimum atmospheric temperature of -224 degrees Celsius Neptune – 15,299mi (24,622km) radius; only slightly smaller than Uranus, one year in Neptune is 165 years on Earth This illustration shows the approximate sizes of the planets relative to each other. Looking beyond the Sun, the planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, followed by	20 minutes	printable cards

#	Step	Details	Time	Materials
		the dwarf planet Pluto. The diameter of Jupiter is about 11 times the diameter of the Earth, and the diameter of the Sun is about ten times the diameter of Jupiter. Pluto's diameter is less than 1/5 of Earth's. The planets are not shown at the proper distance from the Sun. ***Photo:*** *Solar System Sizes* ***Credit:*** *NASA/Lunar and Planetary Institute* *Source: https://solarsystem.nasa.gov/resources/686/solar-system-sizes/* **Fact 2. Orbit** As the Earth orbits the Sun, it completes one revolution every 23.9 hours. It takes 365.25 days for the Earth to complete one trip around the Sun. We add a day every four years to ensure our annual calendar matches our orbit around the Sun. That day is called a leap day, and the year it is added is called a leap year. **Fact 3. Rotation** The Earth's axis of rotation is tilted 23.4 degrees relative to the plane of Earth's orbit around the Sun. This tilt causes the seasonal cycle of our year. During part of the year, the Northern hemisphere is tilted towards the Sun and the Southern hemisphere is tilted away. With the Sun higher in the sky, the more significant solar heating in the north creates summer. Less direct solar heating produces winters in the south. Six months later, the situation reversed. When spring and autumn begin, both hemispheres receive roughly equal amounts of heat from the Sun. **Fact 4. Atmosphere** Earth is a habitable planet because it has a beautiful atmosphere and protective layer around it. This gas jacket protects us from harmful radiation, keeps us warm, provides oxygen to breathe, and is where our weather takes place. The atmosphere surrounding our planet is a cake with many layers of different characteristics and thicknesses. The Earth's atmosphere has five main layers: the troposphere, the stratosphere, the mesosphere, the thermosphere, and the ecosphere. These layers protect our planet by absorbing harmful radiation. *Photo: Layers of the Earth's Atmosphere, designed on Canva* https://www.nasa.gov/mission_pages/sunearth/science/atmosphere-layers2.html https://www.aeronomie.be/en/encyclopedia/layers-earths-atmosphere-order-and-characteristics		

#	Step	Details	Time	Materials
		Layers **Fact 5. Surface** Like Mars and Venus, Earth has volcanoes, mountains, and valleys. A landform is a feature on the Earth's surface that is part of the terrain. Mountains, hills, plateaus and plains are the four prominent landforms. Small landforms include buttes (earth mounds), canyons, valley valleys, and basins. Oceans cover nearly 70% of the planet's surface, have an average depth of about 2.5 miles (4 km) and contain 97% of the water on Earth. Almost all of the volcanoes on Earth are hidden under these oceans. *Watch Google Earth: https://earth.google.com/web/*		
3	**Creation**	My investigator of our Earth! Each participant uses their imagination and available materials to create the Earth and convey the message of protecting the Earth from the effects of climate change. This activity can be done independently or in pairs. Each participant presented their model of the Earth and the message through their creation.	45 minutes	art materials
4	**Connection**	Write your reflective journal The instructor provides instructions on completing the session and answering participants' questions and concerns. Participants are required to complete the Study Log after completing the session. It is a mandatory requirement.	15 minutes	printable reflective journal per participant
5	**Closure**	Summary of today's lesson. Briefly describe the activity of the upcoming class, time and preparations.	5 minutes	

Appendix H. Learning Session 3

#	Step	Details	Time	Materials
Learning session 3. Climate change actions				
1 2	**Commencement** **Cognisance**	Images of Change: Participants are asked to tell the difference between pairs of pictures **1. BEFORE AND AFTER** **Photo 1. Indonesia** **Deforestation in Papua, Indonesia** **Nov. 20, 2002 - Nov. 27, 2019** The 2019 image shows an area of Papua (also known as Western New Guinea) where the forest was cleared between 2011 and 2016, reportedly to make way for plantation agriculture. Read more at NASA's Earth Observatory. The 2002 image was taken by the Thematic Mapper instrument on the Landsat 5 satellite. The Operational Land Imager took the 2019 image on the Landsat 8 satellite. Source: NASA's Earth Observatory **2. BEFORE AND AFTER** **Photo 2. Parana** **Water Level Drops in Argentina's Paraná River** **July 1, 2019 - July 3, 2020** These images show the drop in water level in a section of the Paraná River near Rosario, Argentina, over one year. The difference is especially apparent in the adjacent marshes, lagoons, and streams of	30 minutes	

#	Step	Details	Time	Materials
		the river delta. A prolonged period of hot weather and drought caused the decline. The scene is shown in false colour, representing both infrared and visible light and making distinguishing between water and land easier. Water appears dark blue or black. Also, see Drought in Paraguay. Read more at NASA's Earth Observatory. The Operational Land Imager took images on the Landsat 8 satellite. Source: NASA's Earth Observatory **3. BEFORE AND AFTER** **Photo 3. Mekong** **Mekong River Changes Colour** **Jan. 27, 2015 - Jan. 25, 2020** These images show a section of the Mekong River that forms a border between Laos (top) and Thailand. Its water is usually fast-flowing and loaded with sediments, giving it the cloudy brown appearance in the 2015 image. Nevertheless, in the 2020 image, the river was unusually shallow and slow-moving, resulting from drought and flow-reducing dams. That enabled sediment to settle to the bottom and promoted algae growth, giving the river a blue-green cast. Read more at NASA's Earth Observatory. The Operational Land Imager took images on Landsat 8. Source: NASA's Earth Observatory **4. BEFORE AND AFTER** **Photo 4. Aculeo Chile**		

#	Step	Details	Time	Materials
		Chile's Lake Aculeo Dries Up **February 26, 2014 - March 12, 2019** Central Chile's Lake Aculeo has completely dried up. These images contrasted the lake in 2014 when it still contained substantial water, and in 2019, it consisted of dried mud and green vegetation. Scientists attribute the lake's decline to an unusual decade-long drought and increased water consumption from a growing population. Read more at NASA's Earth Observatory. The Operational Land Imager took images on Landsat 8. Source: NASA's Earth Observatory **5. BEFORE AND AFTER** **Photo 5. Florida** **Hurricane damage to Florida's Everglades** **March 28, 2017 - December 1, 2017** These images contrast the Ten Thousand Islands mangrove ecosystem of Florida's Everglades before and after hurricanes Irma and Maria tore through the area in September 2017. A NASA research team found that 60% of their study areas were damaged heavily. The team will track areas under stress from development and encroaching saltwater before the storm to see how well they recover. When mangrove trees are destroyed and not recovered, neighbouring ecosystems often face an increased risk from storm surges and saltwater intrusion. The airborne Goddard Lidar, Hyperspectral and Thermal Imager took images. Source: NASA Earth Observatory		

#	Step	Details	Time	Materials
		6. BEFORE AND AFTER **Photo 6. Arctic Sea** **Older, thicker Arctic Sea ice declines** **September 1984 - September 2016** The area covered by Arctic Sea ice at least four years old has decreased from 718,000 square miles (1,860,000 square kilometres) in September 1984 to 42,000 square miles (110,000 square kilometres) in September 2016. Ice built up over the years tends to be thicker and less vulnerable to melting away than newer ice. In these visualisations of data from buoys, weather stations, satellites and computer models, the age of the ice is indicated by shades ranging from blue-grey for the youngest ice to white for the oldest. Source: NASA Earth Observatory. https://climate.nasa.gov/images-of-change		
3	**Creation**	**Part 1. Question of the day: What can you do to reduce the impact of climate change?** Participants think and express ideas about actions to respond to climate change. The instructor introduces a few examples that participants can practice at home. These guidelines are based on the UN Act Now Guide. The facilitator introduces action topics (information cards) for participants to get more ideas. Participants can learn more at:	45 minutes	printable information cards

#	Step	Details	Time	Materials
		https://www.un.org/sites/un2.un.org/files/actnow_action_guide_2021.pdf https://www.un.org/en/actnow/ten-actions https://www.un.org/en/actnow/facts-and-figures Part 2. Question of the day: Do you enjoy creating dynamic visual content that tells a story? You can share and express your thoughts on how you can take action to respond to and mitigate the impacts of climate change. **Imagine you are a climate activist. Using art tools, you make a model or product to present your ideas.** All ideas are welcome!		
4	**Connection**	Write your reflective journal The instructor provides instructions on completing the session and answering participants' questions and concerns. Participants are required to complete the Study Log after completing the session. It is a mandatory requirement.	15 minutes	printable reflective journal per participant
5	**Closure**	Summary of today's lesson. Briefly describe the activity of the upcoming class, time and preparations.	5 minutes	

Appendix H. Learning Session 4

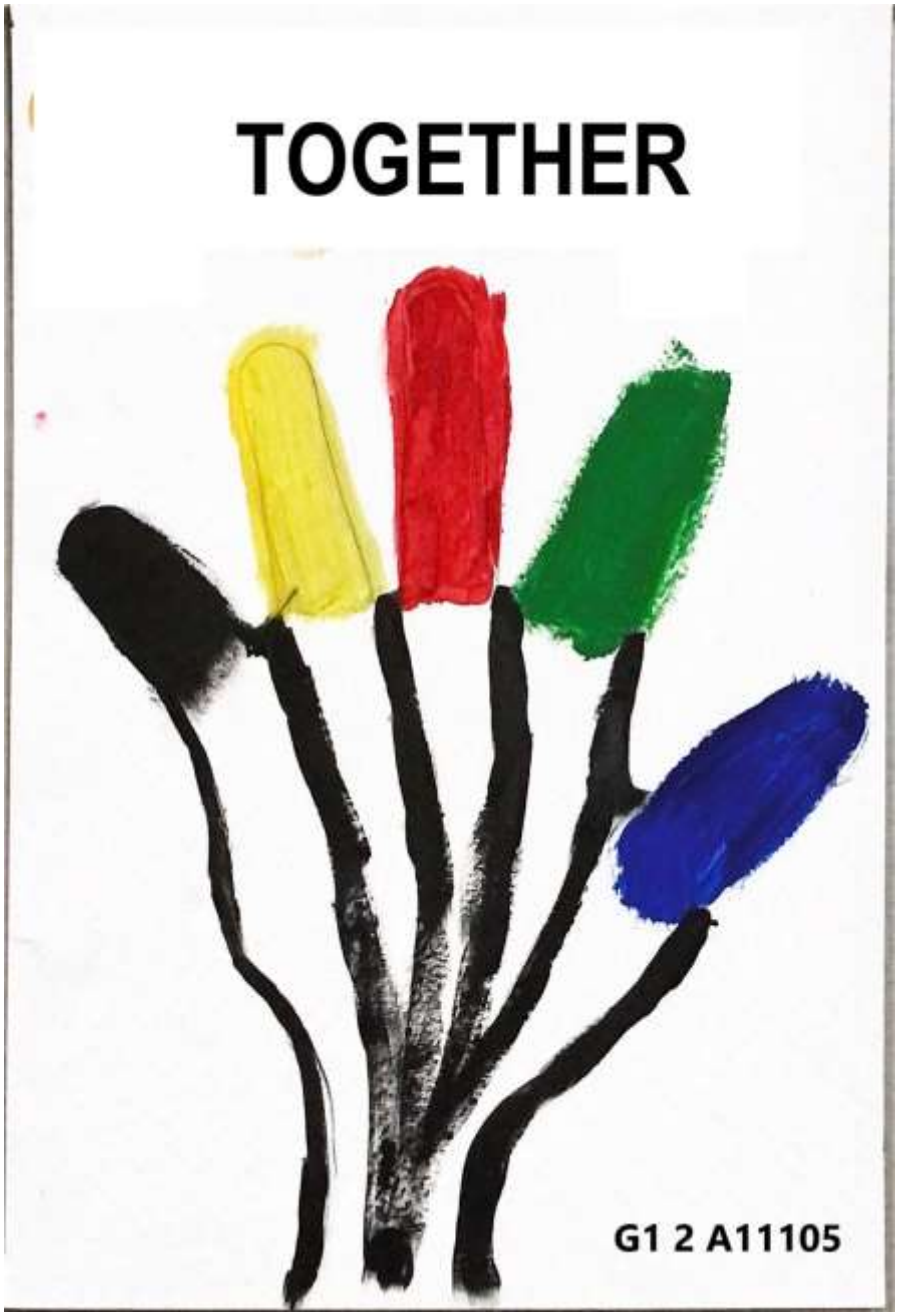
#	Step	Details	Time	Materials
Learning session 4. Climate change exhibition				
1	**Commencement**	Participants share the most impressive things about the past sessions.	10 minutes	
2	**Cognisance**	The instructor summarises the knowledge of the past lessons.	10 minutes	
3	**Creation**	Each participant is encouraged to share their story and ideas through their work.	60 minutes	
4	**Connection**	Write your reflective journal The instructor provides instructions on completing the session and answering participants' questions and concerns. Participants are required to complete the Study Log after completing the session. It is a mandatory requirement.	15 minutes	printable reflective journal per participant
5	**Closure**	Summary of today's lesson. Briefly describe the interview activity and time arrangement with participants	5 minutes	

Appendix I. Artwork of case study

Appendix I. Artwork of Case Study 1

Case study code number: G1 2 A11105

Artwork from learning session 1



Artwork from learning session 2

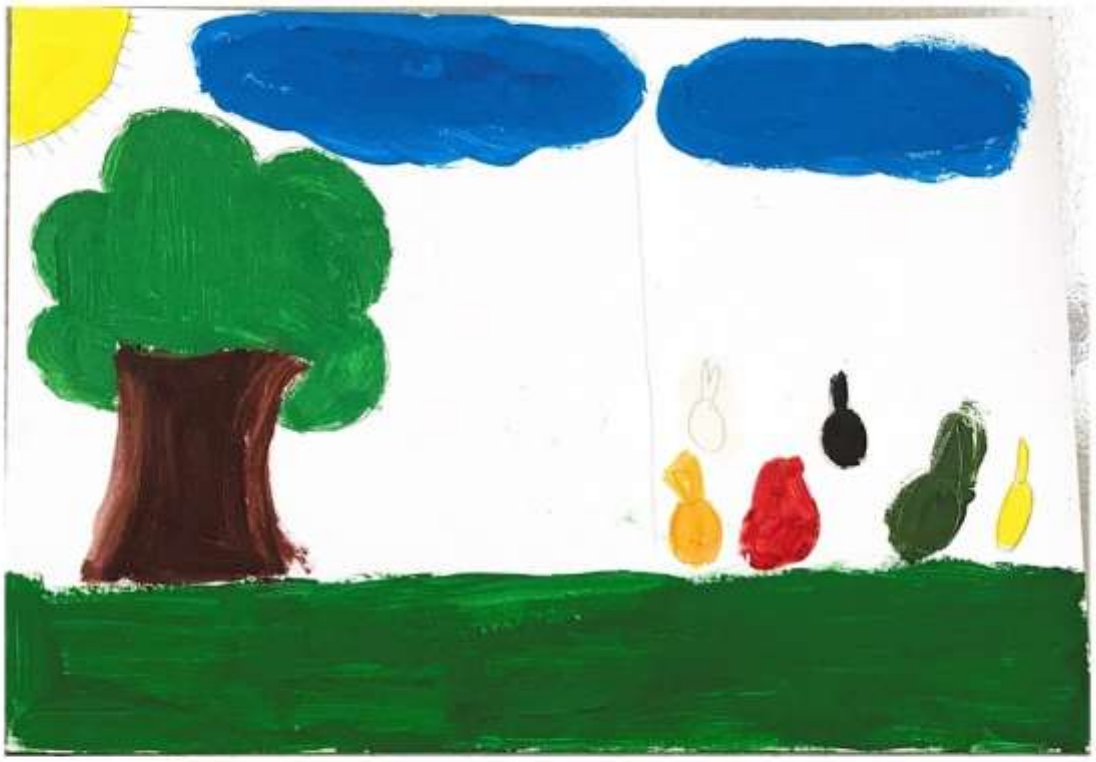
Artwork from learning session 3

Appendix I. Artwork of Case Study 2

Case study code number: G1 12 A11144

Artwork from learning session 1

Artwork from learning session 2



G1 12 A11144

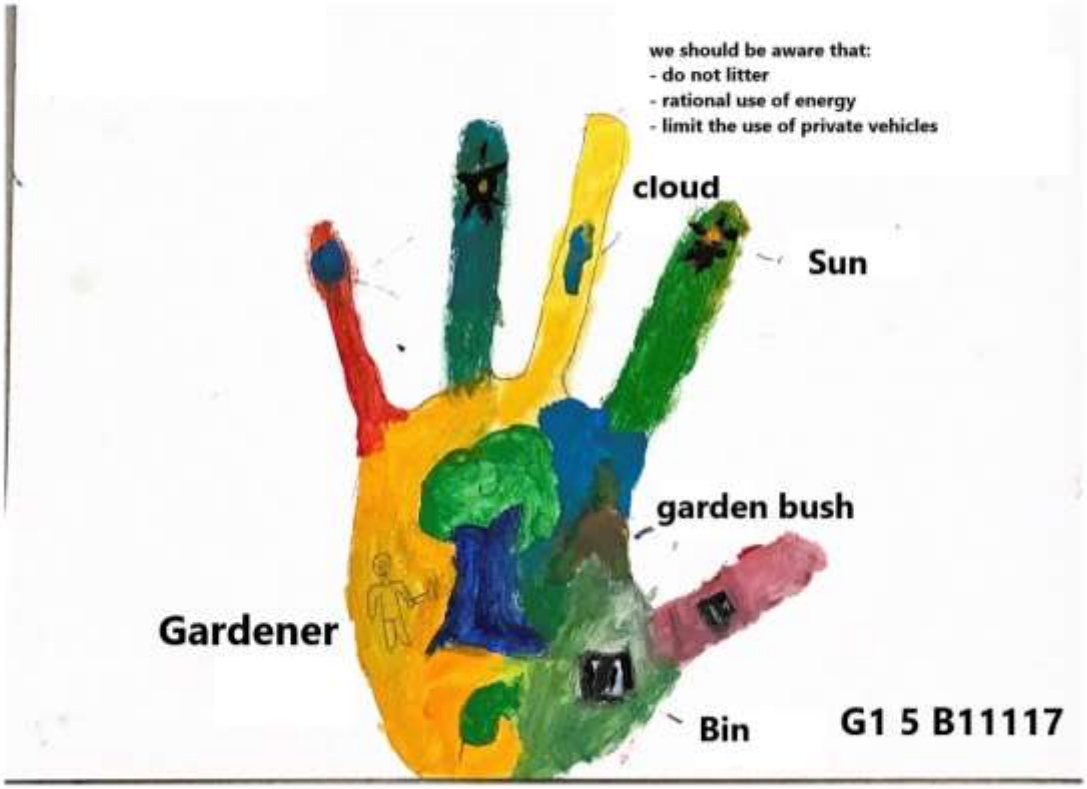
Artwork from learning session 3

G1 12 A11144
From left to right:
Water Saving
No Water Saving

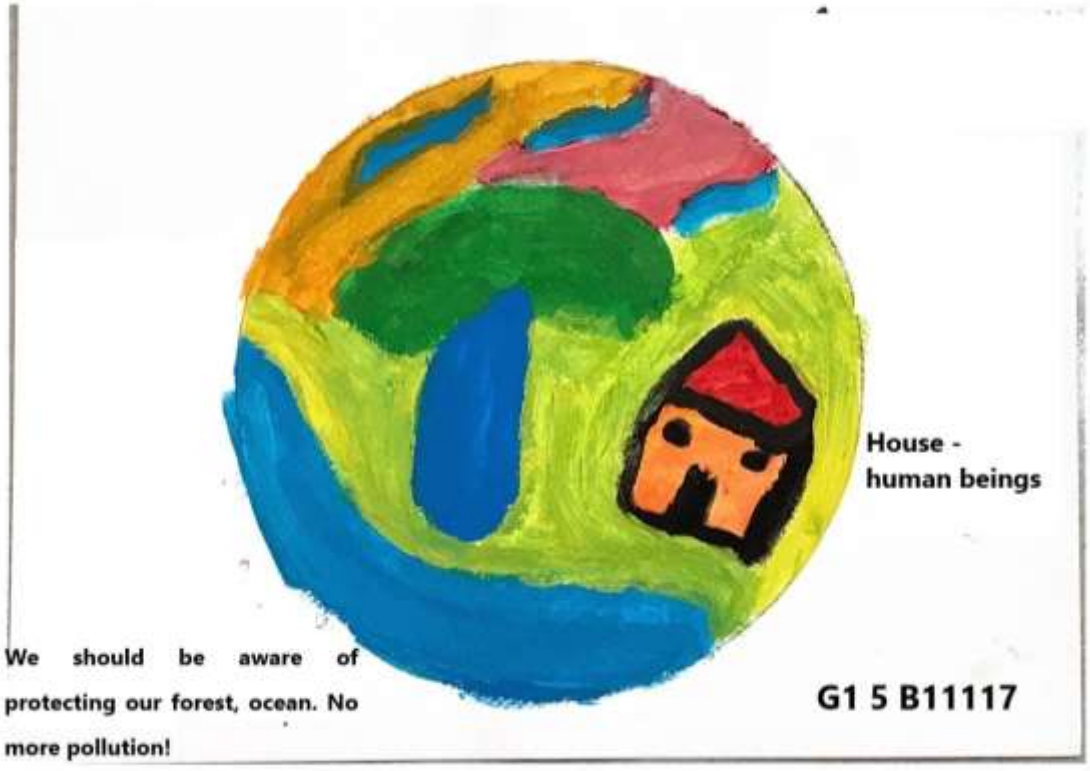
Appendix I. Artwork of Case Study 3

Case study code number: G1 5 B11117

Artwork from learning session 1



Artwork from learning session 2



Artwork from learning session 3