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ASSESSING CONCEPTIONS OF CLIMATE CHANGE:

AN EXPLORATORY STUDY AMONG JAPANESE EARLY-ADOLESCENTS

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Adviser: **Professor Yuto Kitamura**

KELVIN TANG

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ABSTRACT

As the world is approaching global warming of 1.5 °C above pre-industrial levels, more atrocious consequences of climate change are projected to occur in the future. Consequently, it is today's adolescents who will encounter the grand consequences of climate change. Therefore, nurturing adolescents that are well-informed, emotionally engaged, and motivated to take actions for combating climate change may be pivotal. Climate change education has a role in not only raising awareness, but also promoting behaviour change for climate change mitigation and adaptation. However, what kind of climate change education is suitable for whom? Requiring a learner-centred approach, tailoring climate change education requires comprehensive understanding of the audience and their preconditions. In Japan where climate change education has yet to be recognised as a field of environmental education, understanding climate change conceptions possessed by early adolescents is critical for a better design and more impactful implementation of climate change education. This exploratory study aims to investigate climate change conceptions among Japanese early adolescents from the perspective of cognition, affective, and conative dimensions. Questionnaire surveys were conducted targeting 423 students aged 12–14 in three public junior high schools located in Kashiwa City and Oita City. Findings suggest that majority of Japanese early adolescents belong to groups that exhibit lower levels of cognition, affect, and conation in relation to climate change. The relationships among those dimensions were found to be positive and bidirectional. Moreover, several misconceptions about climate change and effectiveness of its solutions were identified among the sample.

Keywords: Climate change conceptions, climate change education, early adolescence, knowledge, attitude, concern, hope, willingness to act

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Kashiwa, 20 July 2022

Kelvin Tang

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LIST OF ABBREVIATIONS

ACE	Action for Climate Empowerment
ANOVA	Analysis of Variance
AVE	Average Variance Extracted
CCE	Climate Change Education
CR	Composite Reliability
EE	Environmental Education
ESD	Education for Sustainable Development
GAP	Global Action Programme
HTMT	Heterotrait-Monotrait
IPCC	Intergovernmental Panel on Climate Change
MEXT	Japan’s Ministry of Education, Culture, Sports, Science and Technology
PCA	Principal Component Analysis
SDGs	Sustainable Development Goals
SEM	Structural Equation Modelling
TPB	Theory of Planned Behaviour
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund

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CHAPTER 1

INTRODUCTION

Designing climate change education requires understanding of the current conditions of target learners in a specific social and cultural context. However, previous studies on conceptions of climate change in Japan exclusively concentrated on adults. In respect to the projection that it is today's young people who will encounter the grand consequences of climate change in the future, this research primarily aims to explore the conceptions of climate change possessed by Japanese early adolescents. This chapter will provide an introduction to the study by first determining the background and context, followed by the research aim, objectives and questions, and finally the significance of the study.

1.1. Background

The anthropogenic climate change has been among the biggest challenge faced by humanity in this century. It imposes direct and indirect threats to the survivability of humanity through the change in weather patterns, increase in land and ocean temperature, and other phenomena driven by climate change that are affecting and will continue to affect the sustainability in all aspects (MOEJ, 2018; UNEP, 2007; WMO, 2021). Amidst the call for urgent climate solutions, Intergovernmental Panel on Climate Change (2021) warns that the world is outpaced by the rapid increase in global temperature, and that it is almost too late to limit global warming at 1.5 degree Celsius above pre-industrial levels. This means that more atrocious climate change consequences will occur in the future. Consequently, it is today's young people who will encounter the grand consequences of climate change. As future leaders, educators, policy makers, and citizens, young people should be prepared for the consequences as well as the uncertainties surrounding climate change (Ojala, 2012; Schauss & Sprenger, 2021; Shafiei & Maleksaeidi, 2020; Sulistyawati et al., 2018; Trott, 2019; UNESCO, 2020).

In response, education has been offered to table as an instrument to prepare humanity for the future consequences of climate change by nurturing individuals that are well-informed, emotionally engaged, and motivated to act. International community has recognised the significant role of education in addressing climate change (Reid, 2019; UNESCO, 2022). Climate change education does not only attempt to raise awareness, but also to promote behavioural change for climate change mitigation and adaptation through nurturing knowledge, skills, attitude, and motivation (UNESCO, 2017a; 2022). On a larger scale, it helps extend climate change mitigation and adaptation capacities of communities by enabling individuals to make informed decisions for the realisation of "societal transformation" (Selby & Kagawa, 2013, p. 5). Well-informed populaces are required for the successful implementation of climate change mitigation and adaptation measures (Cordero et al., 2020; Stevenson et al., 2014).

The challenge is that climate change education's design and implementation need to be tailored to the preconditions of learners to maximise learning outcomes (Clayton et al., 2015; Kuthe et al., 2019; Lehtonen et al., 2018; Moser & Dilling, 2011; UNITAR, 2013; Zaval & Cornwell, 2017). As suggested by the UNESCO (2017b) and supported by constructivist learning theories, climate change education requires a learner-centred approach in which learners' prior knowledge and experience are the starting points for learning processes. Accordingly, understanding the current conditions of target learners is required in the design and implementation of climate change education. In other words, the very first step to designing climate change education is investigating the conceptions of climate change possessed by the potential learners.

1.2. Research gaps

From the literature, there are several research gaps that need to be addressed in this study. First, most academic studies on climate change conceptions concentrate on adults. Works that examine youth voices tend to include data relating to young adults, putting aside the

adolescents (Corner et al., 2015; Grønhøj & Thøgersen, 2017; Hibberd & Nguyen, 2013; Lee et al., 2020; Weber, 2010). Similarly, in Japanese context, studies on similar issue exclusively focus on age groups above 20 years old (Ohe & Ikeda, 2005; Shirai et al., 2015; Shirai et al., 2014). These Japanese studies focuses on the awareness about the occurrence of climate change and behavioural intention, mainly regarding energy saving behaviours.

Second, most studies on climate change conceptions and education exhibit over-emphasis on cognitive dimension that involves knowledge and/or awareness (McKenzie, 2021; UNESCO, 2019). As promoted by the UNESCO (2020), Education for Sustainable Development such climate change education is enforced to cover cognitive, affective/socio-emotional, and conative/behavioural learning dimensions. Therefore, it is also important to investigate on socio-emotional and action-oriented learning dimensions associated with Japanese early adolescents' conceptions of climate change and how they are affecting each other.

Third, connected to the second gap, the correlations among the three learning dimensions have been thought to be linear and unidirectional by most well-known behavioural theories (Ajzen, 1991; Hines et al., 1987; Ramsey & Rickson, 1976). They have claimed that behaviour is influenced by behavioural intention (conation), and behavioural intention is further affected by knowledge (cognition) and socio-emotional factors (affect), such as attitude. However, the relationships of those dimension are argued to be more complex despite understudied (Brosch, 2021; Gifford et al., 2011; Hilgard, 1980; Kollmuss & Agyeman, 2002; Militello et al., 2006). They might intercorrelate bidirectionally and form feedback loops in the system.

1.3. Objectives

Taking the identified research gaps in the literature into consideration, this study, as an advocacy tool, intends to contribute to improving climate change education in particular, and environmental education as well as Education for Sustainable Development]\in general by

providing educators, schools, and/or policy makers with insights on Japanese early adolescents' conceptions of climate change that can be considered in the design of target-specific learning settings that comply with different preconditions of target learners.

Detailed objectives include:

1. To identify trends and inconsistencies in their knowledge about climate change.
2. To analyse cognitive, affective, and conative dimension in relation to their conceptions of climate change.
3. To examine different preconditions of early adolescents regarding climate change conceptions at the individual level.

1.4. Research questions

Based on the research aim and objectives, this study attempts to answer the following questions:

1. What are Japanese early adolescents' conceptions of climate change in relation to its causes, impacts, and solutions?
2. If any, what are their scientific misconceptions about climate change?
3. What are the correlations between cognitive, affective, and conative dimension in relation to their conceptions of climate change?
4. How do demographics affect early adolescents' conceptions of climate change?

1.5. Conceptual framework

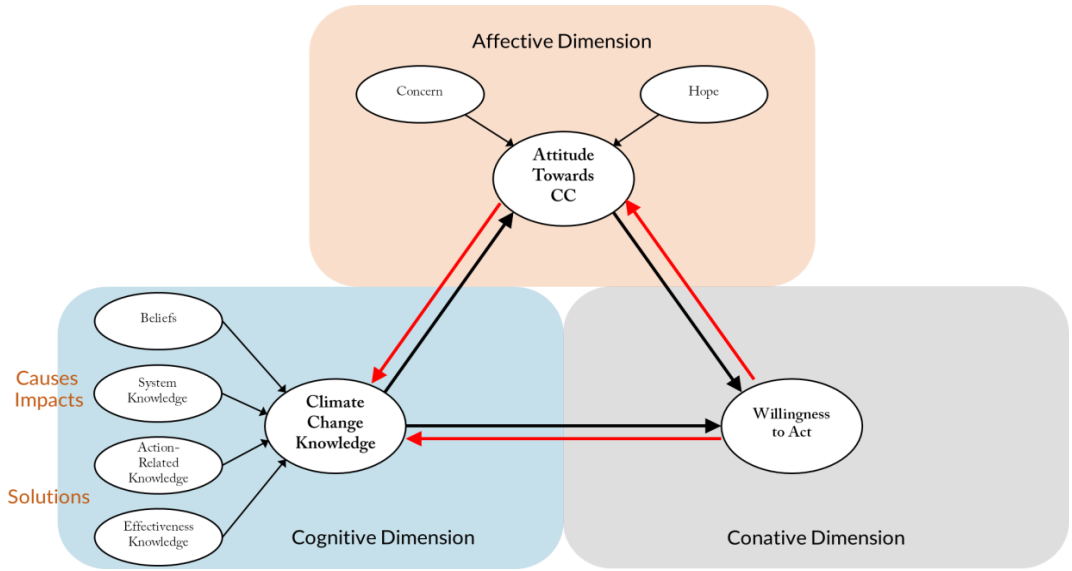
Figure 1 shows the conceptual framework used in this study. The framework was constructed based on UNESCO's (2020) learning dimensions for Education for Sustainable Development and Hilgard's (1980) trilogy of mind that explain the three mental dimensions, namely cognition (knowledge), affect (socio-emotion), and conation (behaviour). Within the framework, cognitive domain involves climate change knowledge that is mainly affected by

beliefs about climate change occurrence (Leiserowitz et al., 2011) and factual knowledge about climate change's causes, impacts, and solutions (Dijkstra & Goedhart, 2012; Frick et al., 2004; Kirk, 2018; Roczen, 2011; Taddicken et al., 2018). Affective/socio-emotional domain handles attitude towards climate change (Dijkstra & Goedhart, 2012; Kuthe et al., 2019; Trott, 2021) which is affected by concern (Kuthe et al., 2019; Stevenson et al., 2016) and hope (Ojala, 2012). Lastly, conative/behavioural domain deals with the willingness to take actions for climate change mitigation and adaptation (Boyes & Stanisstreet, 2012; Skamp et al., 2013).

The framework has also considered previous behavioural models, such as the Hines model of responsible environmental behaviour (Hines et al., 1987) and Ajzen's (1991) Theory of Planned Behaviour that also involve the three dimensions of mind. However, in opposed to the traditional unidirectional behavioural models, and taking the complex and unclear relationships among the dimensions into consideration (Dijkstra & Goedhart, 2012), this study has hypothesised that the Willingness to act might reversely affect Attitude and Knowledge, and Attitude might affect Knowledge as illustrated by red arrows in the model. All causal relationship among the variables have been hypothesised to be positive and significant.

Figure 1

Conceptual model



1.6. Significance

This study will contribute to the body of knowledge on conceptions of climate change among Japanese early adolescents that have not been thoroughly studied. Moreover, as there is a distinct overemphasis on cognitive dimension in studies on climate change conceptions, this study will involve all learning dimensions—cognitive, affective/socio-emotional, and conative/behavioural dimensions—and investigate their complex interrelationships. In terms of contribution to practice, this study will help policy makers, educators, and schools understand the urgency of climate change education implementation in the Japanese formal education by providing an insight on current conditions of Japanese early adolescents in relation to their conceptions of climate change. This insight can also be utilised in the design of target-specific learning settings as suggested by climate change education's learner-centred approach.

1.7. Thesis structure

This thesis is divided into 6 chapters. Chapter 1 provided a general overview of the study. Chapter 2 discusses various concepts related to the topic by reviewing previous research on similar theme. Chapter 3 introduces research area, methodology and theoretical framework behind the study. Chapter 4 presents the findings of the study, while chapter 5 provides interpretations of the results by connecting them with the reviewed literature. Chapter 5 also discusses the value and contribution of this study to the body of knowledge and practice. Finally, chapter 6 concludes the study by summarising the key research findings in relation to the research aims and questions. This chapter also reviews the limitations of the study and proposes suggestions for future studies.

CHAPTER 2

LITERATURE REVIEW

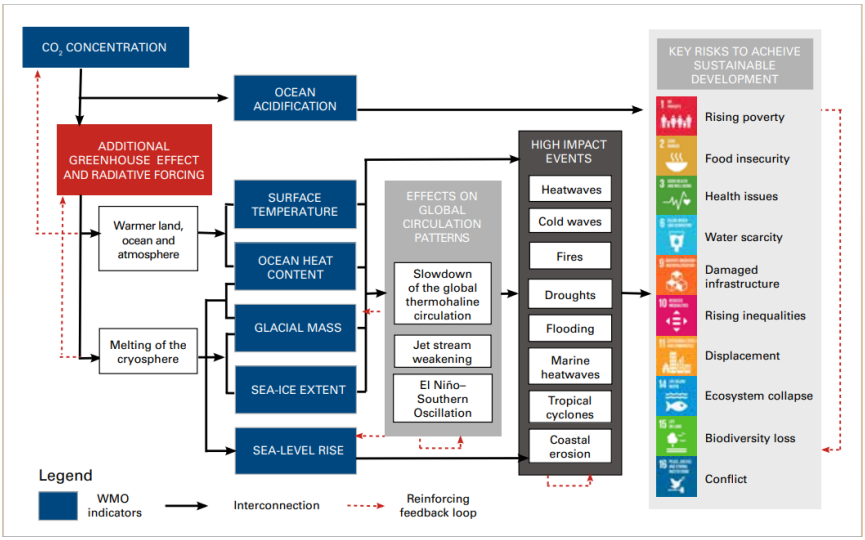
2.1. Climate emergency

Anthropogenic climate change—meaning human induced climate change—has been considered as one of the most pervasive threats to the "survival of humanity and other species on Earth" in the 21st century (UNEP, 2007). Change in weather patterns and individual phenomena driven by climate change have been affected and will further directly and indirectly impact the sustainability in all aspects: environment, society, and economy (MOEJ, 2018). Those individual climate change-driven phenomena include increasing land and ocean temperatures, sea level rise, melting ice and glacier retreat, extreme weather, and many more (WMO, 2021).

As illustrated in Figure 2, the World Meteorological Organisation (2021) have identified the interconnections between the CO2 concentration—one of the main causes of climate change—and risks of achieving sustainable development. The high impact events resulted by increasing CO2 concentration, such as heatwaves, cold waves, fires, droughts, flooding, cyclones, coastal erosion, will have impacts on increasing poverty, food insecurity, health issues, water scarcity, damaged infrastructure, raising inequalities, displacement, ecosystem collapse, biodiversity loss, and conflict (WMO, 2021).

Figure 2

Climate change-related risks to the achievement of the SDGs

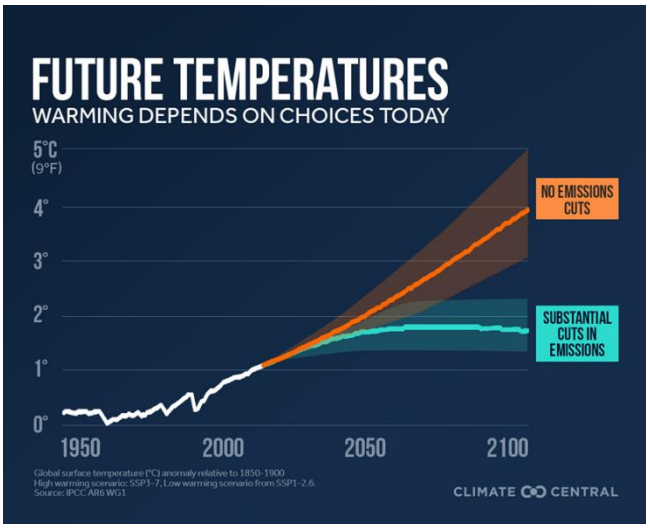


Note. From *State of the Global Climate 2020*, by WMO, 2021, (https://library.wmo.int/index.php?lvl=notice_display&id=21880#.YNQYj2gzZPb).

According to the latest report published by the Intergovernmental Panel on Climate Change (IPCC) in 2021, the world is far off track to cap global warming at 1.5 degree Celsius above pre-industrial levels. In other words, IPCC confidently warns that global warming of 1.5°C or even 2°C—regarded as catastrophic—will be exceeded during the 21st century as illustrated in Figure 3. Consequently, more apparent and horrendous social and environmental impacts caused by the warming will occur in the future. Global warming of 1.5°C is projected to result in increasing mean temperature in most land and ocean regions, hot extremes in most inhabited regions, heavy precipitation in several regions, drought and precipitation deficits in some regions; continuing sea-level rise, species loss and extinction; increasing ocean acidity and decreasing ocean oxygen levels; surging climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth (IPCC, n.d.). The abovementioned impacts will be unevenly spread, with the largest risks imposed towards economically and socially marginalised, whose livelihoods are jeopardised by climate change (O'Brien et al., 2018).

Figure 3

Current human-induced warming rate and its pathway



Note. From *IPCC 6th Assessment Report - The Physical Science Basis*, by Climate Central, 2021, (https://www.climatecentral.org/climate-matters/ipcc-6th-assessment-report-the-physical-science-basis).

Sir David Attenborough mentioned in his latest documentary "Climate Change: The Facts",

> It may sound frightening, but the scientific evidence is that if we have not taken dramatic action within the next decade, we could face irreversible damage to the natural world and the collapse of our societies.

2.1.1. The victim and the future

Considering the future projections of climate change, it is today's young people and the following generations who will encounter the grand consequences of climate change, together with all the complexities and uncertainties surrounding it (Ojala, 2012; Schauss & Sprenger, 2021; Sulistyawati et al., 2018; Trott, 2019; UNESCO, 2020). "It is their present and future that are at stake" (UNESCO, 2020, p. 32). At the same time, they are also the "guards, planners, policymakers and educators" of future sustainability (Shafiei & Maleksaeidi, 2020). In other words, they are the "agents of change" (Boakye, 2015, p. 3). In response, it is young people

who are developing into more outspoken and proactive, pressing for critical shift, and seeking accountability from world leaders, to address the climate crisis (UNESCO, 2020).

Lee and colleagues (2020) have identified that youth voices on climate change have never been more impactful and extensively announced. These occurrences have the power to influence public opinion that may eventually affect the future direction of climate change policy (Capstick et al., 2015). Kickstarted by the event in 2015 when students skipped school to participate in #ClimateStrike campaign, millions of young people to date have come out on to the streets and demanded bolder action from their governments to combat climate change. In 2018, other movements emerged following the COP24 in Katowice, including Greta Thunberg's *Skolstrejk för Klimatet* that is also known as Fridays For Future, Youth for Climate, and Youth Strike for Climate. In 2019, more than 1 million young people in more than 100 countries marched and demanded climate actions from their governments. That could also be witnessed in Japan where large-scale protests rarely happen (Rauner, 2020). Although the number of attendances could not be compared with other developed countries, it could represent a positive shift in Japanese young people's engagement in climate change movements.

In addition, according to the Peoples' Climate Vote (UNDP, 2021), the largest ever survey of public opinion on climate change with more than 1.2 million respondents, respondents under 18 years of age showed higher awareness of climate emergency compared to other age groups. However, United Nations Environmental Programme (UNEP), through their survey in 2011, found out that most of surveyed young people agreed that they need more information to prevent climate change (UN, n.d.b). Moreover, numerous studies have found that there are scientific misconceptions about causes, impacts, and solutions to climate change possessed by young people (Chang & Pascua, 2016; Lee et al., 2020; McCaffrey & Buhr, 2008). Furthermore, the lifestyles of youth are not more sustainable than those of older generations

(Bell et al., 2016; Gifford & Comeau, 2011; Mead et al., 2012; Meneses & Palacio, 2005; Ojala & Bengtsson, 2018; Wray-Lake et al., 2010).

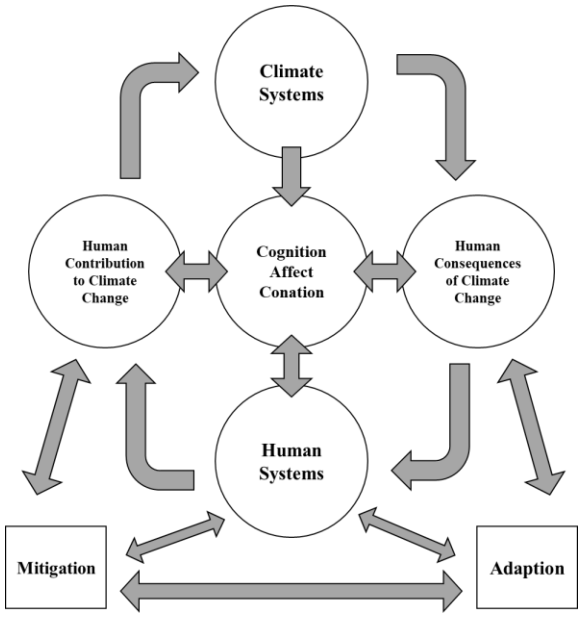
2.2. Conceptions of climate change

The discussion of environmental systems has been included in natural science domain for a long time (Swim et al., 2011). Physical, biological, and chemical processes of heat, land, water that affect climate system are discussed within the domain. Nevertheless, going beyond the long-engaged natural dimension of climate change, "the science of the human dimensions of climate change" was introduced amidst the increasing anthropogenic influence on the environment, including climate systems, (p. 242). This field aims to "understand human activities that affect climate change, consequences of climate change that directly and indirectly affect people, human responses to anticipated and experienced climate change, and ways to help people respond effectively" (p. 242). Consequently, the inclusion of psychological dimension into climate change cannot be dismissed.

Figure 4 shows the relationships between climate systems and human systems, involving psychological attributes in the middle that directly and indirectly impact on changes in the systems (Swim et al., 2011). Left side of the figure depicts human's activities that directly change the climate, including using fossil fuels and cutting forests. These activities are the results of "a full range of cultural, economic, political, and social conditions and processes" (p. 242)—referred as *human systems*, and of psychological attributes which include "human understanding of climate change, affective responses to climate change, and psychological motivations" (p. 242). Right side of the figure explains direct impacts of climate systems on human through phenomena, such as changes in climate pattern, food and water availability. At larger scale, these consequences are affected by human systems and psychological attributes. Adaptation and mitigation are human responses to climate change that are also affected by psychological attributes through their influence on human systems.

Figure 4

Human and psychological dimensions of climate change

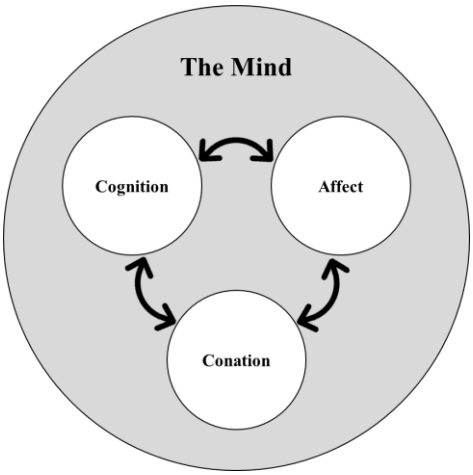


Note. Adapted from "Psychology's contributions to understanding and addressing global climate change", by J. K. Swim, P. C. Stern, T. J. Doherty, S. Clayton, J. P. Reser, E. U. Weber, … and G. S. Howard, 2011, *American psychologist*, *66*(4), 241.

Swim et al.'s arguments on psychological attributes align with Hilgard's (1980) the *Trilogy of Mind*, a theory that classifies mental faculties into three domains: cognition, affect, and conation. The tripartite classification of mind had also been in the discourse among psychologists from as early as 18th century. At the end of 20th century, the well-known American psychologist attempted to revive the theory. The theory had been neglected as the focus of studies about mental processes was put exclusively onto cognitive aspect. Figure 5 shows the three domains that include: Cognition, concerning knowledge and beliefs; affect, concerning feeling including pleasure and pain; and conation, concerning motivation or will or action (Hilgard, 1980). These three domains are robustly connected to each other (Brosch, 2021; Militello et al., 2006).

Figure 5

The trilogy of mind



Note. From "Conation: Its Historical Roots and Implications for Future Research", by L. G. Militello, F. C. Gentner, S. D. Swindler and G. Beisner, 2006, *International Symposium on Collaborative Technologies and Systems (CTS'06)*, 240-247.

The UNESCO also incorporate similar concept into their framework for Education for Sustainable Development (ESD). Their Roadmap towards ESD for 2030 defines ESD as "a lifelong learning process that enhances cognitive, social and emotional, and behavioural dimensions of learning" (UNESCO, 2020, p. 8). Here, UNESCO attempted not to oversimplify learning dynamics by including three learning dimensions into the key features of ESD for 2030 illustrated in Figure 6:

> Cognitive learning dimension: Understand sustainability challenges and their complex interlinkages, explore disruptive ideas and alternative solutions. Social and emotional learning dimension: Build core values and attitudes for sustainability, cultivate empathy and compassion for other people and the planet, and motivate to lead the change. Behavioural learning dimension: Take practical action for sustainable transformations in the personal, societal and political spheres. (p. 17)

Figure 6

Aims of Education for Sustainable Development

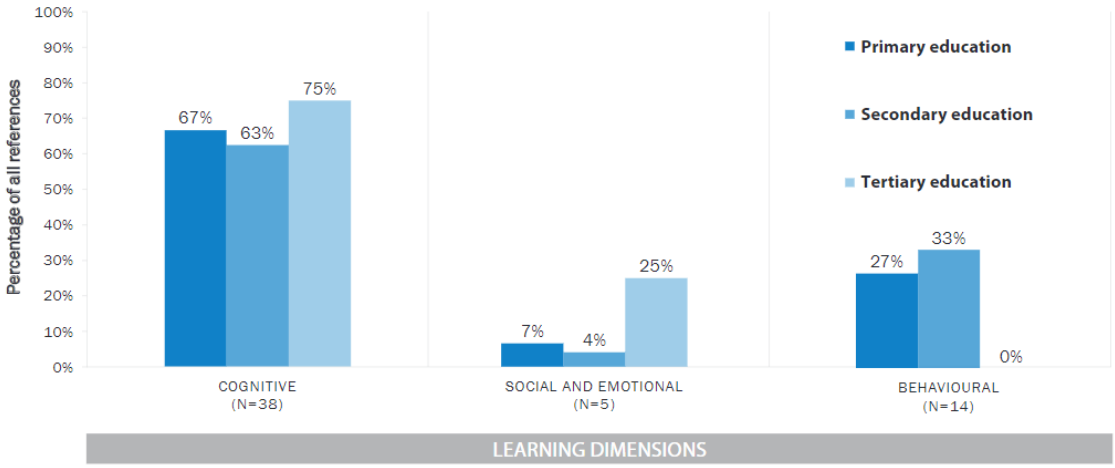
Note. From "Education for Sustainable Development: A Roadmap", by UNESCO, 2020, (https://www.gcedclearinghouse.org/sites/default/files/resources/200782eng.pdf).

2.2.1. Cognitive or knowledge dimension

Understanding about climate change is commonly referred to a collection of cognition about what climate change means, climate attributes and their connections, and causes, impacts, and solutions of climate change (Weber & Stern, 2011). The popularity of cognitive dimension in climate change education (CCE) has also been identified as a worldwide trend. As illustrated in Figure 7, around 70% of CCE in formal education of all levels—primary, secondary, and tertiary—reported by 194 countries to the UNESCO, focus on cognitive learning dimension (UNESCO, 2019; McKenzie, 2021). In other words, it can be concluded that there is a distinct overemphasis on cognition or knowledge in CCE programmes and studies.

Figure 7

CCE learning dimensions in formal education



Note. From "Country progress on climate change education, training and public awareness: an analysis of country submissions under the United Nations Framework Convention on Climate Change", by UNESCO, 2019, (https://unesdoc.unesco.org/ark:/48223/pf0000372164).

Knowledge-based campaigns have been widely utilised to promote certain behaviours to public, especially in health and sex education (Frick et al., 2004). Undoubtedly, knowledge essential role cannot be underestimated in combating climate change as well. As explained before, climate change is deeply connected to human systems that involve actions of general public as well as professional decision-makers (Swim et al., 2011). Therefore, well-informed public and professionals are required to deal with complex challenges related to climate change (Stevenson et al., 2014). Moreover, public knowledge about the issue is influential for climate change mitigation and adaptation strategies and activities (Gazzaz & Aldeseet, 2021). The success of mitigation and adaptation measures for climate change is massively dependent on public's support and ability to make informed decisions (Kuthe et al., 2019).

On the other hand, Frick et al. (2004) have argued that knowledge is important but inadequate in forming expected behaviour, particularly when the knowledge is too general or incomplete. In their study, they identified three types of factual knowledge associated with environmental education (EE), namely "system knowledge, action knowledge, effectiveness knowledge" (p. 1599). First, *system knowledge* is the type of factual knowledge that is

commonly discussed. This type of knowledge looks at "the mechanistic understanding of how different variables relate within a system, how the variables interact, and the resulting outcomes from this interaction" (Bofferding & Kloser, 2015, p. 179). An instance of system knowledge is knowledge about how greenhouse gases can affect global warming then climate change. Albeit popularly discussed, system knowledge is found to be the weakest predictor for pro-environmental behaviour among the three types of factual knowledge (Bofferding & Kloser, 2015; Roczen et al., 2014; Shi et al., 2016).

Second, *action knowledge* describes one's understanding about different "behavioural options and course of actions" (Frick et al., 2004, p. 1599). An individual might understand that greenhouse gases cause global warming, however they might not have any idea about actions they can take to contribute to reducing their own greenhouse gas emissions. It is tangible and verbalizable. Action knowledge is found to be more effective to predict behaviour because it is undoubtedly more closely related to behaviours (Bofferding & Kloser, 2015; Frick et al., 2004). Aitken et al. (2011) identify that even informed people with remarkable system knowledge might not take actual actions to combat climate change without knowledge of possible actions.

The final type of factual knowledge is *effectiveness knowledge*. This knowledge focuses on comparative potential advantages of certain behaviours (Bofferding & Kloser, 2015; Frick et al., 2004). For instance, purchasing a fuel-efficient car can more effectively contribute to reducing greenhouse gas emissions than less frequently driving an old car (Frick et al., 2004). Other examples include the understanding that producing meat needs more energy compared to producing vegetable with the same number of calories, and that energy-efficient light bulbs consume less energy compared to traditional ones with the same Lumens (Roczen, 2011). It can be said that with the possession of effectiveness knowledge people can make better decisions to take actions among available choices (Bofferding & Kloser, 2015).

Connecting Frick et al.'s types of factual knowledge to cognitive dimension of CCE, the primary mission is to provide a complete set of knowledge about climate change in relation to its causes, impacts, and solutions. Especially, in terms of mitigative and adaptive solutions, the provision of action knowledge and effective knowledge is critical. An understanding of what behaviours can reduce greenhouse gas emissions therefore mitigating the impacts of climate change, or an understanding of what actions can be taken to prepare for climate catastrophe, will likely result in substantial behaviour change (Bofferding & Kloser, 2015). Nonetheless, despite system knowledge has the smallest influence on behaviour among other types of knowledge, insufficient fundamental understanding of the issue has negative impacts on promoting behaviour change (Roczen et al., 2014).

2.2.2. Socio-emotional or affective dimension

For a long time, policymaking and behaviour theories have been solely rotating on humans' rationality and neglecting the involvement of emotions (Sniehotta et al., 2014; Weber, 2020). However, human is more complex (Weber, 2020). Socio-emotional aspects concerning climate change have been reported to be the most powerful predictors of decisions and behaviours associated with climate change by recent studies (Brosch, 2021; Ranney & Velautham, 2021; Williamson et al., 2018). That involves predicting a wide range of decisions and behaviours, such as "risk perceptions, mitigation behaviour, adaptation behaviour, policy support, and technology acceptance" (Brosch, 2021, p. 15). Therefore, to overcome climate change-related challenges, experts in decision-making suggest a more proactive and intentional involvement of people's socio-emotions (Schneider et al., 2021).

Socio-emotional dimension of climate change—or the environment in general—involves *attitude* which is defined by Eagly and Chaiken (1993) as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (p. 1). Therefore, attitude towards climate change can be defined as a psychological tendency to

evaluate climate change with some degree of favour or disfavour. In behavioural theories, such as the Theory of Planned Behaviour (Ajzen, 1991) and Value-Belief-Norm Theory (Stern et al., 1999), attitude is considered as one of the critical antecedents that directly influence formation of certain behaviours. Roczen et al. (2014) also found that adolescents' level of attitude towards nature was more influential in adopting environmentally friendly lifestyles compared to environmental knowledge.

As attitude touches upon favour or positive emotions and disfavour or negative emotions, there are two concepts that may have strong linkage with attitude, namely *concern* (Arikan & Günay, 2021; Borsch, 2021), and *hope* (Ojala, 2012). Previous studies have identified possible relationship between concern, hope, and behaviour (Stevenson et al., 2014; Stevenson et al., 2018). First, concern is something to do with perceived risk or threats associated to climate change consequences (Stevenson et al., 2016). In other words, it is the degree of wariness about impacts of climate change on one's life, their family, and humanity in general (Boyes & Stanisstreet, 2012; Stevenson et al., 2016). Concern has been reported to be the strongest driver for individual support of climate change policy and willingness to engage in pro-environmental behaviours (Arikan & Günay, 2021; Borsch, 2021; Stevenson et al., 2014).

Despite concern's possible benefits, exceeding a certain degree, concern may impose harm to mental health and emotional well-being (Clayton, 2020). This wariness usually generates "anxiety and fear" more than "perceived threats" (Arikan & Günay, 2021, p. 160). The term *climate anxiety* emerged and considered as the "biggest pop-culture trend" in 2019 (McGinn, 2019). Climate anxiety is referred as "the experience of intense anxiety about climate change, even among people who have not personally experienced substantial adverse impacts of climate change" (Borsch, 2021, p. 19). Other negative emotions associated to climate change are also identifiable, such as guilt, anger, grief, hopelessness, however, concern seems to be the most significant (Clayton, 2020; Clayton & Karazsia, 2020; Williamson et al., 2018). This

has been exacerbated by the trends in media coverage on climate change that utilises negative connotation and *doom and gloom narratives* (Hinkel et al., 2020). After more than 35 years researching about this specific issue, Weber (2020) came up with an insight that "motivating climate action through fear or guilt is a bad idea" (p. 141).

In contrast, different strategies of utilising positive emotions have been proved to result in forming pro-environmental behavioural intentions (Williamson et al., 2018; Schneider et al., 2021; Trott, 2021; Zelenski & Desrochers, 2021). One of the most prevalent concepts is *hope*, and Ojala (2012) is the leading scholar in analysing hope and climate change. Ojala (2015) define hope as "a positive feeling about the future that is related to positive expectations about a desired goal" (p. 135). In the discussion of global issues, such as environmental problems and climate change, "hopelessness and pessimism" are common (p. 625). Therefore, looking for ways to include hope into climate change education and communication is crucial considering the evident positive impacts of positive emotions. However, the dilemma is that hope could be a mere "unrealistic optimism" (p. 627), and it can be "based on denial" (p. 626). These types of hope have been proven to have negative correlation with behaviour.

Ojala (2012) classified hope into two categories: "constructive hope" and "hope based on denial" (p. 625). Unlike the latter, constructive hope was found to have positive effect on pro-environmental behaviour. Constructive hope is the type of hope based on three themes, including "positive reappraisal, trust in different societal actors, and trust in the efficacy of individual action" (p. 628). The first theme, *positive reappraisal*, explains conditions or strategies when an individual think about their concerns about climate change in a unique way to trigger hope. For instance, it can be in a form of focusing on the positive side of the issue such as the fact that global awareness of climate change has been increasing. Second, *trust in different societal actors* encompasses trust in technology, environmental organisations, and politicians. The last theme of constructive hope is *trust in own* ability to positively contribute

to overcoming climate change. The example would be an individual's confidence of their ability to change their behaviour and perform a climate change mitigative action. Table 1 shows Ojala's (2012; 2015) list of statements to measure one's hope.

Table 1

The hope measurement

I feel hope concerning climate change because…
Positive reappraisal
"Humanity has confronted complex and seemingly hopeless societal problems before and has been able to solve them eventually"
"The awareness about this problem has increased considerably during recent years"
"Even though there is a risk that humanity will go under due to this problem, nature will survive"
"Ultimately we will be forced to take climate problems seriously and to take our responsibility"
"I try to focus on positive news about climate change in the media"
Trust self
"We as individuals can change our behaviour; together we can influence climate change in a positive direction"
"I know that there are a number of things that I myself can do to contribute to the improvement of the climate change problem"
Trust others
"I believe that research and technical solutions will contribute to the improvement of the climate change problem"
"Politicians in more and more countries take climate change seriously"
"As long as there are people who are active in environmental organizations there is a possibility that the climate issue will be solved"
Denial
"I do not think that climate change is as big of a problem as certain researchers claim"
"I believe that climate change is natural, and I doubt that climate change is caused by emissions that we humans create"
"I doubt that there is any change in the climate"
"I think it's a good thing that the summers in Sweden are getting warmer as a result of climate change"

Note. Adapted from "Hope and climate change: the importance of hope for environmental engagement among young people", by M. Ojala, 2012, *Environmental Education Research*, *18*(5), p. 630.; "Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation", by M. Ojala, 2015, *The Journal of Environmental Education*, *46*(3), p. 140.

2.2.3. Behavioural or conative dimension

Overall, the ultimate mission of this whole discourse about climate change and its cataclysmic consequences to the planet and humanity is to promote climate action. That includes adaptation and mitigation efforts in the form of decision making and actions supported by parties in all levels of society, from policy makers to private sector to public. It is human actions that has brought humanity to this critical point (UNESCO, 2020). It is also human actions that will determine the future fate of climate change. One may see the hopelessness of transformative impact in individual actions and behaviours, however, when billions of people collectively engage in climate action, individual efforts can prompt a significant difference (Bofferding & Kloser, 2015; Williamson et al., 2018).

Conative or behavioural dimension encompasses an individual's willingness, determination, or motivation to take an action. According to APA Dictionary of Psychology (APA, n.d.), conation is defined as "the proactive part of motivation that connects knowledge, affect, drives, desires, and instincts to behaviour". Some scholars argue that conation is what connects cognition and affect to substantial action (Militello et al., 2006). Similarly, willingness to act is reported to be an important outcome factor for climate change mitigative actions (Gifford et al., 2011; Xie et al., 2019). Concerning socio-emotional dimension, Sinatra and team (2012) indicated that individuals with more receptive attitude towards climate change showed higher willingness to take actions. Meanwhile, associating with cognitive dimension, Boyes and Stanisstreet (2012) identified the interdependency of willingness to act upon "believed usefulness" of that particular action (p. 1595), concerning Frick et al.'s (2004) effectiveness knowledge. Table 2 shows the list of questionnaire items constructed by Boyes and Stanisstreet (2012) for investigating *willingness to act* and *believed usefulness of action*.

Table 2

Questionnaire items for "willingness to act" and "believed usefulness of action"

Theme	Items about Believed Usefulness of Action	Items about Degree of Willingness to Act
Direct actions		
Transport (use)	If people didn't use their cars so much, global warming would be reduced	Even if it took me longer and was more inconvenient, I would try to use buses and trains instead of a car
Transport (type)	If people had smaller cars that used less petrol or diesel, global warming would be reduced	Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or diesel
Power generation (renewable)	If more of our energy was produced from the wind, waves and sun, global warming would be reduced	Providing more of our energy was produced from the wind and waves and sun, I would be willing to pay more for electricity
Power generation (nuclear)	If more of our energy was produced from nuclear power stations, global warming would be reduced	Providing more of our energy was produced from nuclear power stations, I would be willing to pay more for electricity
The home (electricity use)	If people used less electricity in their homes, global warming would be reduced	To save electricity, I would switch things off at home when I didn't need them
The home (insulation)	If people got their homes insulated better, global warming would be reduced	Even though it cost me money, I would get extra insulation for my home
The home (consumer durables)	If people got things for their homes (like fridges and washing machines) that used less energy, global warming would be reduced	Even if it cost me more, I would buy things for my home (like fridges and washing machines) that use less energy
The home (consumables)	If people were prepared to buy fewer new things and make do with the old ones, global warming would be reduced	Even if it meant that I didn't always have the latest 'gear' or fashion, I would be prepared to buy new things less often
Environmentally friendly (trees)	If more trees were planted in the world, global warming would be reduced	Even if I had to pay more taxes, I think there should be more trees planted in the world
Environmentally friendly (recycle)	If people recycled things more, global warming would be reduced	Even if it was more trouble for me, I would recycle things rather than just throw them away
Food (Reducing meat)	If people eat less meat, global warming would be reduced	Even if I really liked meat, I would eat fewer meals with meat in them
Food (Reducing artificial fertilizers)	If farmers stopped using artificial fertilisers with nitrogen in them, global warming would be reduced	Even if it was more expensive, I would buy food grown without the use of artificial fertilisers
Indirect actions		
Environmental legislation	If politicians made the right kind of new laws, global warming would be reduced	I would vote for a politician who said they would bring in laws to reduce global warming, even though it would stop me doing some of the things I enjoy
Environmental taxation	If politicians made people pay more tax and spent the money on the right kind of things, global warming would be reduced	I would vote for a politician who said they would increase taxes to pay for reducing global warming, even though it meant me having less money to spend
Environmental education	If people were taught more about it, global warming would be reduced	I would like to learn more about global warming, even though it would mean extra work for me
Environmental international cooperation	If there could be more agreement between different countries about not putting certain gases into the air, global warming would be reduced	Even though it might mean some inconvenience to me (like changing my job), I would vote for a politician who said they would sign agreements with other countries on global warming

Note. Adapted from "Environmental education for behaviour change: Which actions should be targeted?", by E. Boyes and M. Stanisstreet, 2012, *International Journal of Science Education*, *34*(10), p. 1596.

2.2.4. Scientific misconceptions

Studies have identified that individuals, regardless of age, display scientific misconceptions about climate change (Bofferding & Kloser, 2015; Chang & Pascua 2016; Leiserowitz et al., 2011; Monroe et al., 2017; Ranney & Velautham, 2021; Shepardson et al., 2011; Weber & Stern, 2011). Despite scientifically correct conceptions could be seen to be increasing with age, misconceptions persisted (Lee et al., 2020; Schauss & Sprenger). This has something to do with *naïve knowledge* that consists of preconception or prejudice about issues, and misconceptions (Chi & Roscoe, 2002; McCaffrey & Buhr, 2008). Preconceptions can be handily fixed with education, meanwhile misconceptions are more tenacious (Chang & Pascua, 2016). Misconceptions involve three characteristics of "incorrectness, incoherence, and incompleteness" (p. 86).

General public that might use non-scientist ways to understand climate change imposes more vulnerability towards misconceptions about climate change (Weber & Stern, 2011). Scientists have multiple methods to understand climate change to prevent errors, for instance, through experiments and observations based on fundamental theories, the use of systematic mathematical models, peer-reviewed studies, and scientific discourse within scientific community. In contrast, majority of public uses non-scientist ways to understand the phenomenon. They might base their understanding on their subjective experience and judgement that might be misleading as they have the tendency to be guided more by "affect, values, and worldviews than by evidence" (p. 318). However, understanding climate change based on subjective experience is difficult, therefore, most people need to count on secondary information sources, such as "news coverage, internet postings, informal conversations, and documentaries" (p. 320), that are often unreliable (Aoyagi, 2017; Stevenson et al., 2014; Weber & Stern, 2011). Unlike science, media might have other agendas on top of providing accurate view of the world.

Overwriting misconceptions resulted from the unreliable personal experience and judgement as well as misguiding information from secondary sources, can be extremely challenging (Lee et al., 2020; McCaffrey & Buhr, 2008; Weber & Stern, 2011). Particularly, eliminating misconceptions in adults seems to be more difficult than dealing misconceptions among children and adolescents. That is because their worldviews are still in the formation stage (Stevenson et al., 2014). Lee and colleagues (2020) indicated that misconceptions emerged among children do hinder further learning and actions. Moreover, the misconceptions children possess up to 13 years of age are likely to remain throughout the transition to adolescence and adulthood. They also identified that early educational intervention that directly criticizes common climate change misconceptions could obstruct the perseverance of those misconceptions.

Several studies done on investigating children and adolescents' conceptions of climate change have pointed out several common scientific misconceptions about climate change exhibited by young people. The most widespread scientific misconception was about the causes of climate change. It is that climate change is caused by the hole in the ozone layer (Monroe et al., 2017). In the United States, 35% of surveyed teenagers aged 13–17 believed in that statement (Leiserowitz et al., 2011). Similar misconceptions could also be witnessed among undergraduate students (Rebich & Gautier, 2005). The idea is that more solar energy or ultraviolet radiation enters the Earth through the ozone hole and induce global warming and climate change (Shepardson et al., 2011). Moreover, approximately 40% of surveyed high school students in Turkey thought that littering and river pollution could worsen climate change (Kilinc et al., 2008).

Scientific misconceptions about greenhouse gases can also be identified. In Singapore, junior high school students were reported to be confused with the idea of greenhouse gases (Chang & Pascua, 2016). They used the term *greenhouse gases* and *pollutants* synonymously.

Moreover, they could identify carbon dioxide as one of the greenhouse gases alongside methane and nitrous oxide; however, water vapour, another important type of greenhouse gases, was not in their understanding. Similar confusion also happened among American undergraduate students (Rebich & Gautier, 2005). They reportedly used the term *aerosol* to explain greenhouse gases without a proper understanding of its scientific definition. Water vapour was also missing from their conceptions about greenhouse gases.

In terms of the impacts of climate change, several misconceptions could be identified. Although students in the US could indicate that global warming and climate change might have impacts on sea level rise from the melting snow, glaciers and ice caps, and increased precipitation, they did not exhibit understanding about thermal expansion phenomena (Rebich & Gautier, 2005; Shepardson et al., 2011). Overall, it can be concluded that young people are more aware of impacts of climate change on natural systems than on human systems (Lee et al., 2020). The foci tend to be on sea level rise or biodiversity loss rather than migration caused by sea level rise or food insecurity caused by the change of climate pattern.

Furthermore, some studies have also identified misconceptions about mitigative solutions for combating climate change (Bofferding & Kloser, 2015; Lee et al., 2020). Unleaded petroleum was perceived to be a solution for climate change which is scientifically inaccurate (Kilinc et al., 2008). Hestness and colleagues (2016) found that around 30% of studied grade 6 students in the US believed that eliminating littering and waterway pollutions could solve the issue. Another common perceived solution was stopping the use of chlorofluorocarbons (CFCs) (Lee et al., 2020; Leiserowitz et al., 2011). It was perceived to be more effective than reducing number of flights. Finally, excluding controversies surrounding it, young people did not seem to consider nuclear power as a solution to climate change (Hestnesset al., 2016), although scientists globally support nuclear power's potential to be a massive contributor to climate change mitigation (Lorenzini, 2005).

2.3. Climate Change Education (CCE)

In her opening address on the "Educating for a sustainable future" Rio+20 side-event on 21 June 2012 Irina Bokova, Director-General of UNESCO (2009–2017), emphasised the importance of education in sustainability discourse:

> Education is the most powerful path to sustainability. Economic and technological solutions, political regulations or financial incentives are not enough. We need a fundamental change in the way we think and act. (Bokova, 2012, p. 2)

The essentialities of education and training in addressing climate change has been recognised and accepted by the international community (Reid, 2019; UNESCO, 2022). This is due to proactive advocations and leadership by international organisations, such as the UNESCO (Cordero et al., 2020). Through the UN Framework Convention on Climate Change (UNFCCC) in 1992, the Paris Agreement in 2015, and the *ESD for 2030* agenda—ESD's latest global framework effective from 2020—governments all around the world have been demanded to "educate, empower, and engage" all layers of society on climate change associated policies and actions (UNESCO, 2022).

In the promotion of climate action, education is pivotal (UNESCO, 2022). It plays a significant role to not only raise awareness, but also promote behavioural change for climate change mitigation and adaptation (UNESCO, 2017a). In other words, people are helped to understand the causes, impacts, and solutions of climate change through education and expected to take actions to combat climate change. Therefore, education helps extend climate change mitigation and adaptation capacities of communities by enabling individuals to make informed decisions (UNESCO, 2017a) through the nurture of "knowledge, skills, values and attitudes" required to act as agents of change (UNESCO, 2022). As solutions to climate change have the tendency to concentrate on mitigation and adaptation strategies, ensuring success implementation of both measures demands well-informed people (Cordero et al., 2020).

2.3.1. History

The emergence of CCE can be traced back to the United Nations Conference on the Human Environment in Stockholm in 1972. The environmental had been considered as a major issue for the first time as the conference declared "to defend and improve the environment for present and future generations has become an imperative goal for mankind" (UNESCO, 2020, p. 65). It also highlighted the crucial role of EE to address environmental catastrophes happening in the world as Principle 19 of the Stockholm Declaration states:

> Education in environmental matters, for the younger generation as well as adults, giving due consideration to the underprivileged, is essential in order to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises and communities in protecting and improving the environment in its full human dimension. (UNESCO, 2020, p. 65)

In 1997, the First Intergovernmental Conference on Environmental Education was established in Tbilisi, Georgia. The conference comes up with the role, goals and objectives, and guiding principles of EE (UNEP, 1978). Tbilisi Declaration indicated "the important role of EE in the preservation and improvement of the world's environment, as well as in the sound and balanced development of the world's communities" (UNESCO, 2020, p. 65). The goals of EE included: "(a) to foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas; (b) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; (c) to create new patterns of behaviour of individuals, groups and society as a whole towards the environment" (UNEP, 1978, p. 26).

Fifteen years later, the United Nations Conference on Environment and Development or known as Rio Summit or Earth Summit was held in 1992. On this occasion, spotlight was put onto climate change through the establishment of UNFCCC in addition to the continuing

discourses on the vital role of "education, training and public awareness in achieving sustainable development" (UNESCO, 2020, p. 65). The convention served as a tangible form of commitments and provides a framework for global joint efforts to combat climate change. Article 6 of the treaty concentrates on education, training, and public awareness, including public access to information on climate change (UN, 1992). Afterwards, efforts to implement Article 6 was labelled under the name of Action for Climate Empowerment (ACE) in June 2015. Table 3 shows the scope and objectives of ACE. Furthermore, ACE elements were included in Articles 11 and 12 of the Paris Agreement of Paris Climate Conference of Parties in 2015 (UN, 2015, p. 16).

Table 3

Elements of Article 6 - Scope and objectives

Scope	Objective	
Education	Change habits in the long-term	Foster a better understanding of, and ability, to address climate change and its effects
Training	Develop practical skills	
Public Awareness	Reach people of all ages and walks of life	Promote community engagement, creativity and knowledge in finding climate change solutions
Public Access to Information	Make information freely available	
Public Participation	Involve all stakeholders in decision-making and implementation	Engage all stakeholders in debate and partnership to respond collectively to climate change
International Cooperation	Strengthen cooperation, joint efforts, and knowledge exchange	

Note. From "Action for Climate Empowerment: Guidelines for accelerating solutions through education, training and awareness," by UNESCO & UNFCCC, 2016, p. 3.

Together with inclusive and high-quality education, climate change remains one of the vital foci in ESD for 2030, the most recent framework adapted by UNESCO for the achievement of the Sustainable Development Goals (SDGs). It was built on the previous framework of Global Action Programme (GAP) on ESD which began in 2015 and ended in

2019 (UNESCO, 2020). Through its GAP framework (UNESCO & UNFCCC, 2016), UNESCO attempted to promote the centralisation of education in the worldwide response towards climate change; to assist with CCE integration into education and training systems in different countries by creating "technical guidance materials" and developing "teaching and learning resources"; and to aid countries so that they could accomplish a seamless shift to "green economies and resilient societies" through education and training (p. 8).

2.3.2. Expectations of CCE

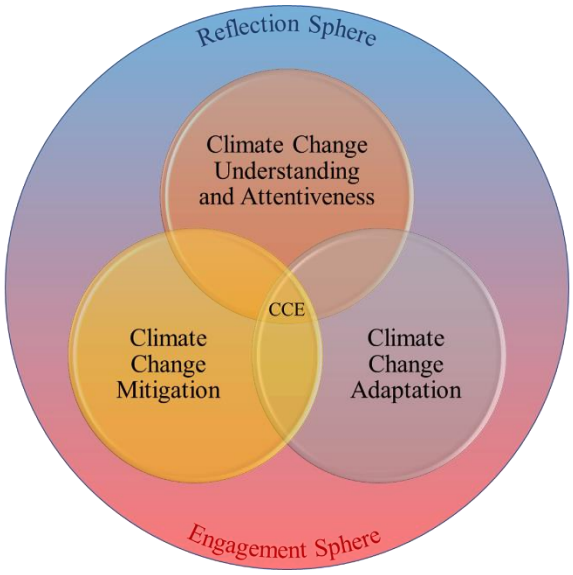
CCE has an extremely ambitious role to play as it attempts to tackle a complex *socio-scientific issue* that involves social and political situation surrounding it besides science and technology (Monroe et al., 2017; Morris, 2014; Stevenson et al., 2017; Zeidler & Nichols, 2009). As illustrated in Figure 8, Selby and Kagawa (2013) have identified three dimensional roles of CCE in their UNESCO Course for Secondary Teachers on Climate Change Education for Sustainable Development. First, it must build "social and individual capacities and attitudes for climate change mitigation" to anticipate the worst-case climate change scenarios in the future (p. 4). The focus here is on nurturing individuals with knowledge and skills required to analyse the roots of climate change. Individuals are encouraged to investigate how "economic systems, social structures, cultural patterns, lifestyle expectations, consumerism, wealth distribution, aspirations and value systems" contribute to greenhouse gas emissions (p. 5).

Second, it must develop "skills, capacities, and attitudes for adaptation" in dealing with already conspicuous climate impacts (Selby & Kagawa, 2013, p. 4). Similar to "disaster risk reduction education" (p. 5), the highlight here is on developing resilience and decreasing vulnerabilities associated with climate change impacts. In this adaptation dimension, learning involves technicalities, such as learning about drought resistant agricultural methods, flood management strategies, or climate-resilient infrastructure plannings (GCA, 2019; Selby & Kagawa, 2013).

Third, it must strengthen and vitalise "understanding of and attentiveness to the realities of climate change" (Selby & Kagawa, 2013, p. 4). The foci of this dimension include building on understanding of what is happening to the climate and improving watchfulness to the already happening change. Even though climate change imposes enormous threats to humanity, it is often imperceptible and undetectable by general public (Rudiak-Gould, 2013). Therefore, it is easily downplayed, or even dismissed under stresses of everyday life. In other words, there is a need to confront the phenomena of climate change avoidance, denial and inaction, as well as misconceptions that are widely spread among the population (Selby & Kagawa, 2013; Wullenkord & Reese, 2021).

Figure 8

Three dimensions of CCE



Note. From "*Climate Change in the Classroom*", by D. Selby and F. Kagawa, 2013, (http://unesdoc.unesco.org/images/0021/002197/219752e.pdf).

Ultimately, CCE has a fundamental objective of "self-transformation" which is associated with a profound personal change within an individual (Selby & Kagawa, 2013, p. 4). It must let learners to "engage with the full seriousness of the climate change threat, search for new meanings and values, and move into personal and collective empowerment and action"

(p. 5). The previously discussed three dimensions of CCE allow learners to continuously experience engagement and reflection which are crucial to the self-transformation objective. This is expected to lead to an overall comprehensive "societal transformation" which forms new ways of seeing reality, determining or redetermining values, modifying intentions, and conceiving different futures (p. 5).

Consequently, according to Stevenson and colleagues (2017), conventional education methods are insufficient. CCE should advance from business-as-usual method of education that emphasises on memorisation (IMEF, 2021), focuses merely on transfer of knowledge, and applies teacher-centred educational approaches (Deisenrieder et al., 2020; Stevenson et al., 2017). CCE must not only address a collection of scientific facts, but must also emphasises on social, ethical, and political dimensions of climate change (Monroe et al., 2017; Trott, 2019). Learner's emotional needs should be met in the process (Ranney & Velautham, 2021). Furthermore, it must demand the learners to re-examine their own and others' "assumptions, perspectives and worldviews" on the issue (Selby & Kagawa, 2013, p. 11) as Boakye (2015) emphasises that teaching and learning should not only touch the mind, but also the heart. In other words, a holistic curricular and pedagogical transformations should occur. Nevertheless, conventional pedagogical approaches are still dominating CCE (Deisenrieder et al., 2020) as McKenzie (2021) pointed out that there was an over-emphasis on cognitive dimension—that mainly incorporates knowledge—in studies about CCE.

2.3.3. Pedagogical approaches of CCE

As a part of ESD, CCE requires three crucial pedagogical approaches, namely "learner-centred approach, action-oriented learning, and transformative learning" (UNESCO, 2017b, p. 55). Acting as a guiding principle, CCE's specific learning methods should align with these pedagogical approaches. It favours active learning to nurture learners into "active sustainability citizens" and empower them to take actions to combat climate change in this case (p. 54).

Overall, any kind of teaching and learning method selected for a particular context should match “the needs of the learner group (based on age, prior knowledge, interests, abilities); the context in which the learning takes place (space in the curriculum, pedagogical climate, cultural traditions); and the resources and support available (teacher competencies, teaching materials, technology, money)” (p. 54).

First, CCE requires a learner-centred approach. It means that CCE uses the learners’ prior knowledge and experiences as the starting points for stimulating learning processes in which construction of knowledge is done by the learners themselves (Ichinose, 2017; UNESCO, 2017b). Consequently, one of the most important rules of CCE is to recognise the audience and to adjust the education programme to their preconditions—"age, prior knowledge, interests, and abilities” (UNESCO, 2017b, p. 54)—so that it directly connects to the perspectives of the target groups (Clayton et al., 2015; Kuthe et al., 2019; Lehtonen et al., 2018; Moser & Dilling, 2011; UNITAR, 2013; Zaval & Cornwell, 2017). The importance of learners’ preconditions is also accentuated by numerous constructivists learning theories, such as Piaget’s (1937) and Bruner’s (1956). Here, the role of educators is changed, from being an expert who acts as a dispenser of knowledge, to being a “facilitator of learning processes” (UNESCO, 2017b, p. 55).

The second pedagogical approach is action-oriented learning. As CCE attempts to promote climate action, it must provide opportunities for learners to engage in real-life experiences and reflect on the experiences. It helps learners to acquire knowledge and competencies to connect concepts learnt in a classroom, for example, with their own subjective experiences—therefore weakening passivity and advocating empowerment (Trott, 2019; UNESCO, 2017b). The forms of action-oriented learning might include “a project, an internship, a workshop, a campaign, etc.” (UNESCO, 2017b, p. 55). Here, educators are required to ensure the forming of learning environment in which learners can maximise their experiential learnings and perform reflexive thinking. The UNESCO (2017b) refers action-

oriented learning to Kolb's theory of the experiential learning cycle that comes with four stages: 1) "Having a concrete experience; 2) observing and reflecting; 3) forming abstract concepts for generalization; and 4) applying them in new situations" (p. 55).

The final pedagogical approach guided by the UNESCO is transformative learning. Popularised by Mezirow (1997), transformative learning is defined as a process of questioning and changing one's own "frame of reference—associations, values, concepts, and conditioned responses"—that define one's worldview and "line of action" (p. 5). People tend to reject new ideas that fail to correspond with their pre-existing frames of reference. Therefore, successful transformative learners will advance towards a more inclusive frames of reference (Mezirow, 1997). Similarly, CCE attempts to enable learners to question their worldviews—the way they see and think—as working on the complex climate change issue requires crushing the status quo, thinking differently, and generating new knowledge (UNESCO, 2017b). Here, educators act as a facilitator that guides learners in the journey of worldview transformation that might be discomforting at times.

2.3.4. Key competencies and learning objectives

In Education for Sustainable Development Goals: Learning Objectives, the UNESCO (2017b) also characterised several key cross-cutting competencies for sustainability that apply to CCE as well. Table 4 contains the list of key competencies for sustainability. The competencies portray what are needed for sustainability citizens of all ages and nationalities to encounter complex challenges generated by fast-paced development of technological advancement and globalisation. These competencies are an interaction of "knowledge, capacities and skills, motives and affective dispositions" as they consist of "cognitive, affective, volitional and motivational elements" (p. 10). Competencies are obtained from "experience and reflection" by the learners themselves, and they "cannot be taught" (p. 10).

Table 4

Key competencies for sustainability

Competency	Explanation
Systems thinking competency	The abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.
Anticipatory competency	The abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
Normative competency	The abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.
Strategic competency	The abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
Collaboration competency	The abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.
Critical thinking competency	The ability to question norms, practices and opinions; to reflect on own one's values, perceptions and actions; and to take a position in the sustainability discourse.
Self-awareness competency	The ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
Integrated problem-solving competency	The overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the abovementioned competences.

Note. From *Education for Sustainable Goals: Learning Objectives*, by UNESCO, 2017b, (https://www.unesco.de/sites/default/files/2018-08/unesco_education_for_sustainable_development_goals.pdf).

In addition, the UNESCO (2017b) has come up with learning objectives or outcomes that particularly target SDG 13, Climate Action. Table 5 shows the objectives of SDG 13. Consistently, the learning objectives touch upon the three learning dimensions: cognitive, socio-emotional, and behavioural. Cognitive learning objectives focus on understanding the phenomena of anthropogenic climate change in regards of its causes, impacts, and solutions. In addition, it also emphasises on the understanding of multilevel strategies of "prevention,

mitigation, and adaptation" (p. 36). Next, socio-emotional learning objectives concentrates on collaboration and encouragement in the protection of the global climate. Finally, behavioural learning objectives highlight the ability to measure the environmentally friendliness of activities in personal, local, and global level. Moreover, it expects the ability to support public policies and economic activities that are protecting the climate.

Table 5

Learning objectives for SDG 13 "Climate Action"

Learning dimension	Learning objective
Cognitive	1. The learner understands the greenhouse effect as a natural phenomenon caused by an insulating layer of greenhouse gases. 2. The learner understands the current climate change as an anthropogenic phenomenon resulting from increased greenhouse gas emissions. 3. The learner knows which human activities—on a global, national, local and individual level—contribute most to climate change. 4. The learner knows about the main ecological, social, cultural and economic consequences of climate change locally, nationally and globally and understands how these can themselves become catalysing, reinforcing factors for climate change. 5. The learner knows about prevention, mitigation and adaptation strategies at different levels (global to individual) and for different contexts and their connections with disaster response and disaster risk reduction.
Socio-emotional	1. The learner is able to explain ecosystem dynamics and the environmental, social, economic and ethical impact of climate change. 2. The learner is able to encourage others to protect the climate. 3. The learner is able to collaborate with others and to develop commonly agreed-upon strategies to deal with climate change. 4. The learner is able to understand their personal impact on the world's climate, from a local to a global perspective. 5. The learner is able to recognize that the protection of the global climate is an essential task for everyone and that we need to completely re-evaluate our worldview and everyday behaviours in light of this.
Behavioural	1. The learner is able to evaluate whether their private and job activities are climate friendly and—where not—to revise them.

	2. The learner is able to act in favour of people threatened by climate change. 3. The learner is able to anticipate, estimate and assess the impact of personal, local and national decisions or activities on other people and world regions. 4. The learner is able to promote climate-protecting public policies. 5. The learner is able to support climate-friendly economic activities.

Note. Adapted from Education for Sustainable Goals: Learning Objectives, by UNESCO, 2017b, (https://www.unesco.de/sites/default/files/2018-08/unesco_education_for_sustainable_development_goals.pdf).

2.3.5. CCE in practice

Amidst the increasing acknowledgement that conventional method of teaching and learning is inadequate to encounter today's challenges, there has been a call for shift to innovative methods of teaching and learning within CCE. Lehtonen and colleagues (2018) introduced several unconventional practices of CCE that had been incorporated into national curriculum in Finland—country that its education system has been recognised as one of the best in the world for the past decades (Symeonidis & Schwarz, 2016). Among them, art-based learning and phenomena-based learning were explained.

First, art-based learning can connect the conceptualisation of a sustainable society with the real world in new perspectives (Bentz, 2020; Lehtonen et al., 2018). Even though science has been considered as *a process of discovery*, art may provide a different method to obtain and make sense of knowledge (Jacobson et al., 2016); therefore, expanding one's creative imagination and deepening emotional engagement in relation to climate change. Art-based learning uses "narrative and metaphors" that are essential in the process of "reflection and deeper meaning-making" within emotional domain (Anderson, 2012; Bentz, 2020, p. 1609). Moreover, there is no right or wrong in the learning process, giving rooms and values to every piece of "ideas, attitudes, opinions and interpretations" (Lehtonen et al., 2018, p. 359). The products of art-based learning might include "a collective piece of art, a play, a performance, dance, film, or by writing a poem or lyrics for a song, etc." (p. 359).

Bentz (2020) suggested a framework for guiding art-based practices to be utilised in the fostering climate change engagement. Table 6 shows her ideas on three levels of climate change engagement depth, including "*in* art, *with* art, and *through* art" (p. 1597). First, climate engagement *in* art describes the utilisation of art as a platform to present or communicate the issue of climate change. Through the more "aesthetic, attractive, and easily accessible" methods of communication, art can enhance narrative and extend its scope towards a broader public communicating the complexities of climate change (p. 1597). Second, climate engagement *with* art views art as "a medium to facilitate dialogue and express learning" (p. 1597). Beyond mere climate change communication, through participatory art project for example, art can be utilised to provide a creative engagement among artists, scientist, and broader public in generating deeper understanding of climate change. Finally, climate engagement *through* art which uses art as an instrument of "transformation" (p. 1597). Through theatrical performances or storytelling for instance, art can affect people in emotional and personal level, therefore generating powerful and long-lasting impacts on transforming how people think and act on climate change.

Table 6

Climate engagement in, with, and through art

	***In* art**	***With* art**	***Through* art**
Role	Art as platform for introducing the issue/as communication	Art as medium to facilitate dialogue and express learning	Art as means of transformation
Characteristics	Aesthetic, attractive, accessible communication of climate change; goal oriented	Participatory, experiential, community engaging; process and goal oriented	Co-creational, transdisciplinary, open-ended; process oriented
Examples	Illustrating climate change with comics, infography, or documentaries	Providing creative experiences related to climate change including art-&-science labs and participatory art	Using art as a process to discover meanings of climate change, and to deepen and embody experiences e.g. through dance, storytelling, or independently creating an artwork prompted by an open-

			ended and personally relevant climate-related question

Note. Adapted from "Learning about climate change in, with and through art", by J. Bentz, 2020, *Climatic Change*, *162*(3), p. 1598.

The second CCE practice is phenomena-based collaborative learning. Climate change is "a wicked problem" that requires coherence and collaboration in its resolution (Lehtonen et al., 2018, p. 360). Consequently, learning that nurtures "systemic and holistic thinking" is essential (p. 360). Encouraging learners to obtain an "interdisciplinary and holistic" view of discussed phenomena associated to their curiosity and communities is the objective of this learning (p. 361). Therefore, phenomena-based collaborative learning must not exclude collaborative-ness—as entitled in its name—and must happen in "real world" settings (p. 361). This can only be successful with the involvement of learners' subjective experiences and dispositions, as well as their dialogic communication with and respect towards others.

It has been recognised as the alternative for the more conventional subject-orientated learning in Finland (Lehtonen et al., 2018). In this mode of learning, a phenomenon is separated into several subjects and taught by experts of respective field. For example, in the context of climate change, science would be responsible for technical and scientific parts, such as the concepts of greenhouse gases. Geography would discuss human-nature relationships. Meanwhile, making environment-themed *objet d'art* would be taken care by arts, and recycling activities might be included in home economics. Under the most favourable circumstances, this mode of learning might give a multifaceted idea of climate change. However, learners might overlook or disregard the understanding that climate change is an extremely complex issue might if there is a disconnect between those subjects. In-depth understanding of climate change could not be achieved through disintegrated knowledge.

Phenomena-based learning in Finland motivates learners to choose learning topics based on their own curiosity although they do not have full freedom as frameworks for learning projects are planned by school in a yearly basis (Lehtonen et al., 2018). The learning process

begins with students' questioning their surroundings. Instances of commonly emerged questions include: "What is our future? How will we live on this planet? What kinds of innovations will we see? How will climate and vegetation change? Will there be hamburger restaurants in the future?" (p. 362). After that, learners altogether with the educator collaboratively perform a reflection and analysis on the risen questions and decide one question to focus on. Next, they come up with ideas on the study methods they should take to answer the selected question. For instance, they could analyse previous studies, or conduct questionnaire surveys and interviews with suitable parties. Here, educators must not determine answers or methods that are considered to be correct. Students may create any sorts of learning products, such as "videos, art pieces, participatory theatre, portfolios, web-pages, blogs, active project days, etc." (p. 362).

Overall, aligned with Lehtonen et al. (2018), Monroe and colleagues (2017) argued that any types of learning selected for a particular setting should follow these two strategies to be effective: 1) attempting to let learners to view climate change as a personally significant issue; and 2) maximising learners' involvement. It is crucial to present climate change as personally significant rather than distant or global as it has been presented. It can be achieved by focusing on actions and solutions that are being taken within the local communities (Selby & Kagawa, 2013). Focusing too intensely on climate change as a global, complex, multidimensional challenge might cause *ecophobia*—expression of fear towards environmental problems (Aarnio-Linnanvuori, 2013; Strife, 2012)—that might instead lead to disengagement, avoidance, denial and inaction (Anderson, 2012; Brosch, 2021; Selby & Kagawa, 2013; Wullenkord & Reese, 2021). Secondly, as suggested by the UNESCO (2017b), CCE requires a learner-centred approach which values learner engagement within learning processes. Learners would not only be equipped with deeper understanding of climate change, but they

would also get a sense of empowerment through “small group discussions, debates, laboratory experiments, online chats”, and many more (Monroe et al., 2017, p. 15).

2.4. CCE in Japanese formal education

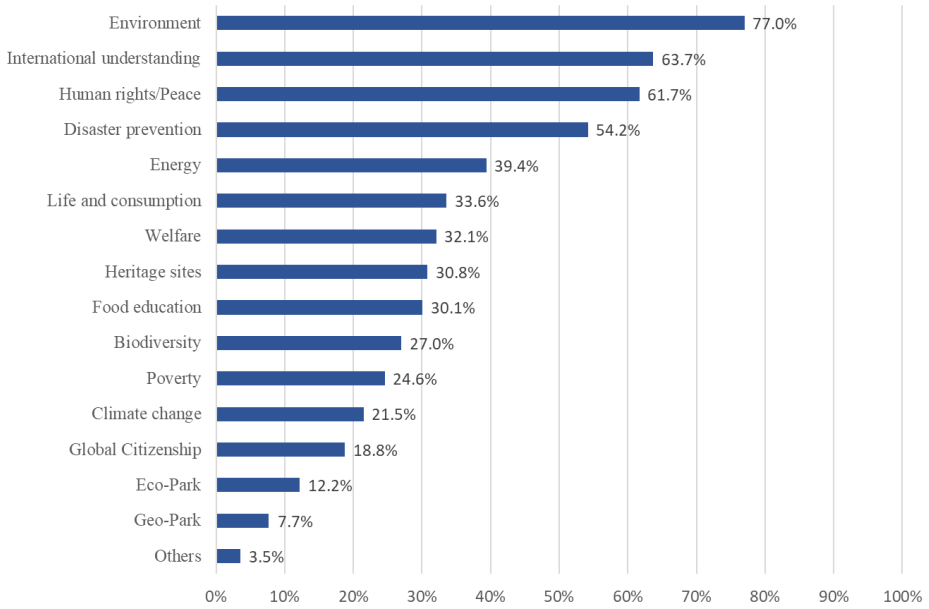
2.4.1. Current situation

For more than 15 years, Japan’s demonstration of leaderships and initiatives towards the implementation of ESD cannot be denied (Kitamura, 2017; Nagata, 2017). Japan was the one that proposed the 2005–2014 United Nations Decade on Education for Sustainable Development (UNDESD) to the United Nations in 2005, and since then has acted as a donor country providing financial and technical supports for international ESD initiatives (Nagata, 2017). Nationally, Japan has considered ESD one of the critical ideals that drives policy direction in the educational sector by the establishment of the Roundtable Meeting on ESD in 2017 and the creation of the Basic Plan for the Promotion of Education in 2008 (Kitamura, 2017). Nevertheless, Nagata (2017) and Ichinose (2017) argues that no one can assure that ESD has led to fresh changes into Japanese traditional education system.

In Japanese school, *environment* is still the number one theme for ESD practices. In 2016, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) surveyed 469 UNESCO Associated Schools in Japan about the actual educational situation in their schools. As illustrated in Figure 9, they found that almost 80% of the respondents chose *environment* as the top priority theme for ESD. Regardless of the long-rooted history of EE establishment and implementation, as well as its popularity in Japan, CCE is yet to be recognised as a field of EE in the country as there is no specific remark given to CCE (Takahashi et al., 2016).

Figure 9

Japanese UNESCO Associated Schools' views on prioritised areas of ESD



Note. Adapted from Heisei 28-nendo yunesukosukūru nenji ankēto kekka [Results of the Annual UNESCO School Survey 2016], by MEXT, 2016, (https://uskir.net/wp-content/uploads/2020/11/%E5%B9%B3%E6%88%9028%E5%B9%B4%E5%BA%A6.pdf).

According to *Kankyō Kyōiku Jiten* or the Encyclopaedia of Environmental Education released by the Japanese Society of Environmental Education in 2013, EE in Japan is categorised into 18 classifications, such as conservation education, energy environmental education, and development education (Takahashi et al., 2016). Moreover, looking at the contents of EE in the New Course of Study that has its full implementation since 2012 (MEXT, n.d.), environmental elements are incorporated into different existing subjects—utilising subject-orientated approach. Using the contents for junior high school level for instance, global warming, technological approaches for environmental problems, and energy are discussed in science; importance of environmental conservation and cooperation in the region is included in social studies, such as geography, civics, and moral education; and thinking about environmentally friendly consumption lifestyles is done in home economics. Only one point about climate change-related issue—global warming—is included in the science domain.

Although EE in Japanese schools has shown progressions towards learning about environmentally friendly lifestyles, learning about global environmental issues, resources and energy, the reality might be different on the ground. Ichikawa (2016) examined the contents of EE in 1999, 2005, 2008, and 2014 at primary and lower-secondary level. He concluded that EE in Japanese elementary and junior high schools consisted of three core subject matters: 1) volunteering activities including local environment clean ups and waste separation projects; 2) experiencing animal breeding and gardening; and 3) learning about waste and recycling. It is difficult to say that these subject matters have changed in the past 20 years (Glackin & Greer, 2021; Ichikawa, 2016; Kodama, 2017). Wals (2012) considered them as the *narrow* interpretations of EE, whereas *broader* interpretations are desirable. For instance, they might include complexities of environmental issues, interdependencies of multiple stakeholders, and human irrationalities and political elements (Glackin & Greer, 2021; Wals 2012).

2.4.2. History

As CCE has not been recognised as an independent discipline, we shall instead investigate the history of EE in Japanese context. It started in early 1970s as *Kōgai* or pollution education entered formal education in Japan (Ando & Noda, 2017; Glackin & Greer, 2021; Imamura, 2017). After the World War II, Japan attempted to rebuild their economy through heavy industrialisation that caused devastating environmental degradation and health hazards, including the infamous Itai-itai disease, Minamata disease, and Yokkaichi asthma. In response, *Kōgai* education was established as the result of societal *environmentalisation* attempt (Buttel, 1992). It is defined as the "education against environmental disruption aimed at teaching natural history, social history, history of the respect for humans, and the formation of citizens through the comprehensive study of the history and current state of pollution" (Ando & Noda, 2017, p. 41). The term EE was later brought from abroad in late 1970s replacing *Kōgai* education (Ando & Noda, 2017).

In 1991, the then Ministry of Education published the first edition of *Kankyō Kyōiku Shidō Shiryō* or the Teacher's Guide for Environmental Education for elementary, junior high, and senior high school (Kodama, 2017). Here, the definition of EE was purely directed to resolving worldwide environmental problems. However, since the 2007-published second version, the definition changed through the additional economic and social elements that aligned with international ESD trends (Glackin & Greer, 2021; Kodama, 2017). The newest version of Teacher's Guide for Environmental Education for kindergarten and elementary school was published in 2014; meanwhile, the one for junior high school was published in 2016. ESD is still considered as the key concept in these latest versions (Centre for Curriculum, National Institute for Educational Policy Research, 2014; 2016). Figure 10 shows the cover pages of every version. Providing concepts, objectives, evaluation methods, past examples of projects and learning activities, the guides act as valuable references for educational institutions to implement EE within their schools (Kodama, 2017).

Figure 10

Cover pages of the Teacher's Guide for Environmental Education

Note. Left to right: First edition for elementary school (1991), first edition for junior and senior high school (1991), second edition for elementary school (2007), third edition for kindergarten and elementary school (2014), third edition for junior high school (2016). From *Guidance materials and case studies*, by National Institute for Educational Policy Research, (https://www.nier.go.jp/kaihatsu/shidousiryou.html).

More closely reaching CCE, the terms global warming and climate change had their first legal ground in Japanese policy after the enactment of the Act on Promotion of Global Warming Countermeasure in 1998 that was the result of Kyoto Protocol signation in December

1997 (Takahashi et al., 2016). Education was specifically assigned to help the promotion of global warming prevention (MOEJ, 1998). The act formed Climate Change Action Officers to promote knowledge about global warming countermeasures to public at local level. Prefectural Promotion Centres for Climate Change Action were established to support such activities, and a national body that had the responsibility for administering Climate Change Action Officers and Prefectural Promotion Centres for Climate Change Action, Japan Centre for Climate Change Actions (JCCCA) was created (MOEJ, 1998). As of 2016, there were 55 prefectural centres and around 7.000 action officers throughout the country (Takahashi et al., 2016).

In 2001, the School Education Act was established and required public schools to conduct *sōgō tekina gakushū no jikan* or the period for integrated study (Glackin & Greer, 2021; Kodama, 2017). It was the era where schools attempted to touch upon "cross-curricular" issues that were close to them (Kodama, 2017, p. 22). Conducted from the first grade of elementary school to the third grade in junior high school, the period of integrated study aims to equip students with *ikiru-chikara* or the ability to live. Additionally, schools are required to include "timetabled opportunities for subject integration through problem-based learning which might include hands-on activities and opportunities to experience nature" (Glackin & Greer, 2021, p. 169). Schools have the freedom to design curricula and select themes, such as "environment, international understanding, information technology, welfare or health" (Kodama, 2017, p. 22). Ichikawa (2016) finds that more than 50% of public elementary schools and almost 20% of public junior high schools chose environment as the theme for the period for integrated study.

2.4.3. Challenges and suggestions

Amidst the urgency of encountering climate catastrophe, it can be argued that Japan needs to start planning and implementing well defined and structured CCE. There are challenges faced by the implementation of CCE in Japanese education. Takahashi et al. (2016) have identified that CCE in Japan is lacking common definition, contents, methods, and

evaluation measures. Learning contents of CCE programmes do not consider learner's stages of development. The methods used usually do not develop key competencies for sustainability, and there is an absence of evaluation methods which are needed to assess transformations among learners and to improve the programmes themselves (Ichinose, 2017; Takahashi et al., 2016). Glackin and Greer (2021) argued that Japanese schools had failed to reach "far reaching societal changes" needed for preventing and encountering climate cataclysm (p. 183).

Moreover, teacher's insufficient knowledge and skills hinder the implementation of CCE in Japan. Teachers seem unsure with their role as instructors, facilitators, or coaches (Ichinose, 2017). Therefore, it might be necessary to develop training programmes to cultivate knowledge and skills required to facilitate CCE via collaboration among teachers, experts, organisations, and policy makers (Takahashi et al., 2016). The Ministry of the Environment and MEXT are conducting nationwide teacher trainings on EE; however, only limited number of teachers can participate in these trainings (Ichikawa, 2016).

Another issue is that Japanese schools seem to put aside the commitment for CCE implementation. Without schools' commitment and intention in implementing ESD, EE, or CCE, all abovementioned educational resources—teacher's guide, textbooks, additional teaching materials, frameworks—provided by different entities will serve no purpose (Kodama, 2017). Undoubtedly, efforts that schools would have to give are extensive. They include allocating time and budget, forming coordinating body, coordinating or participating in teacher trainings, planning systematic integration of CCE into their curricula, etc. In response, collaboration between schools, social educational facilities, and organizations across the nation might help schools with technical and financial support through network building and information sharing (Kodama, 2017; Takahashi et al., 2016).

2.5. Adolescents and cognitive development

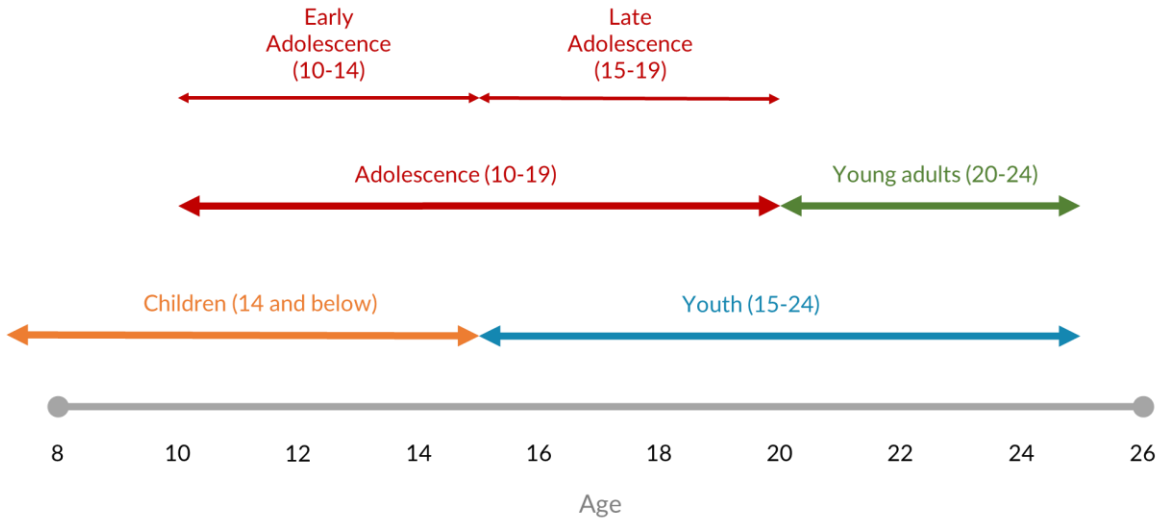
CCE requires learner-centred approach that includes consideration of learner's preconditions, including age, prior knowledge, and experiences (UNESCO, 2017b). Therefore, learner's stages of physical and psychological development, as well as stages of cognitive development cannot be dismissed in the design and implementation of CCE. Age-appropriateness of the contents is required as young learners under certain age might not be ready to deal with complex climate change issue (Aarnio-Linnanvuori, 2013). One of the most well-known theorists in the field of cognitive psychology is Jean Piaget. His work on child development has massive influence even on current trajectory of cognitive psychology field. His theory of cognitive development explains how children intellectually develop throughout various stages in childhood (Piaget, 1937). In this section, the definition of adolescents, Piaget's theory of cognitive development, and the process of cognitive adaptation will be discussed.

2.5.1. Definition of adolescents

Multiple definitions of children, adolescents and youth can be found defined by different bodies. However, in this study, definitions from specialised agencies under the United Nations are used. According to the UN (n.d.a), youth is defined as the group of people between the ages of 15 and 24 years, while children are considered those persons with the age of 14 or younger. Classified under youth, young adults are individuals who are between 20 and 24 years of age (WHO, 2022). Meanwhile, UNICEF (2022) defines adolescents as persons who are between the ages of 10 and 19. Adolescence is a transition period between childhood and youth. Those definitions are overlapped and often used for different contexts. Figure 11 explains the abovementioned definitions in more visually understandable manner.

Figure 11

Stages of adolescence, children, and youth



Note. Adapted from "Global issues: youth", by UN, n.d.a, (https://www.un.org/en/global-issues/youth); "The State of the World's Children 2011: Adolescence - An age of opportunity", by UNICEF, 2011, (https://data.unicef.org/resources/the-state-of-the-worlds-children-2011-adolescents-an-age-of-opportunity/); "Adolescents", by UNICEF, 2022, (https://data.unicef.org/topic/adolescents/overview/); "Older adolescent (15 to 19 years) and young adult (20 to 24 years) mortality", by WHO, 2022, (https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-older-adolescent-(15-to-19-years)-and-young-adult-(20-to-24-years)-mortality).

Further, the UNICEF (2011) classifies adolescence into early adolescence (10–14 years) and late adolescence (15–19 years). Early adolescence stage is when external physical transformations start to occur. Albeit less apparent than the external changes, the internal transformations are evenly significant. Pointed out by neuroscientific studies, the brain in early adolescent periods experiences "a spectacular burst of electrical and physiological development" (p. 6). It results in the doubling number of brain cells over a period of one year. Moreover, "neural networks" inside the brain are "radically reorganised" which influences on "emotional, physical, and mental ability" (p. 6).

Meanwhile, late adolescence is the period when children have transitioned to youth, becoming more proactive in "shaping the world around them" (UNICEF, 2011, p. 6). Even though the physical body continues its development, main physical transformations have already transpired. Internally, "the capacity for analytical and reflective thought" is significantly improved as the brain continues its development (p. 6). The major characteristic

here is that late adolescents start comprehending their own identity and worldviews with clearness and certainty. Moreover, they also start developing the ability to assess risk and make deliberative decisions.

According to Harker-Schuch (2019), early adolescents may be the central target group for CCE and climate change communication considering their "physiological and social characteristics", involving "intellectual development, cultivation of self-determination, and emergence of the adolescent into society" (p. 279). She believed that social and behavioural transformation could truly develop among early adolescents, naming them the quintessential agents of change. This group share several common characteristics. First, considering their intellectual development, they are at the most susceptible stage to develop and revaluate their worldviews. Second, considering their age and position in the society, they have the biggest potential to deliver long-term transformation, and are the most approachable group through education and policy. Third, they have the fluency in digital technology where communication and information exchange occur nowadays. Lastly, they are forming "social allegiances"—self-awareness, empathy, sense of community—that will be the foundation of their adulthood (p. 284).

2.5.2. Piaget's theory of cognitive development

Before discussing the stages of cognitive development, Piaget (1964) suggested that the difference between *development* and *learning* should be first understood. Development of knowledge is a "spontaneous" process associated with "embryogenesis"— biological and psychological development of the body, nervous system, and mental functions (p. 176). This process finishes when children enter adulthood. He describes development as "a process which concerns the totality of the structures of knowledge" (p. 176). He adds that the concept of *operation* should be discussed to understand the development of knowledge. *Operation* is a set of actions that used to alter a reality, and therefore to comprehend the change process of the

reality. Knowledge is not a mere "copy of reality", actions need to be taken to know the reality—that is operation. Operation is always connected to other operations as a part of a total structure that forms "the basis of knowledge" (p. 177).

On the other hand, learning is not spontaneous, but it is evoked by external situations (Piaget, 1964). For instance, learning might be evoked by teacher's didactic agenda. As opposed to development which involves structures of knowledge as an entirety, learning specifies a lone issue or structure. Learning involves what is called the *stimulus-response schema* which is a process of adaptation to a new reality or knowledge. This will be discussed more detailed in the next sub-chapter.

As illustrated in Table 7, Piaget (1964) proposed the four stages of development of the abovementioned *operational structures* including "sensorimotor, pre-operational, concrete operations, and formal operations" (p. 177). The first stage is sensorimotor stage which extends from birth to approximately 18 months to 24 months. Infants tries to understand the world using coordination of sensory perceptions—looking and hearing—and motor activities—reaching, touching, biting (McLeod, 2022). The biggest achievement in this stage is that infants develop an *object permanence* which is the ability to understand that objects still exist even out of the field of perception. In the first months, an infant would think that if a toy is hidden from them, it no longer exists. They do not try to find it. Then the schema of the object is formed approximately when they turn 9 months old, and they will start to find it.

Table 7

Piaget's Stages of Cognitive Development

Stage	Age	Characteristic
Sensorimotor	0–2	The child learns by doing: looking, touching, sucking. The child also has a primitive understanding of cause-and-effect relationships. Object permanence appears around 9 months.
Preoperational	2–7	The child uses language and symbols, including letters and numbers. Egocentrism is also evident. Conservation marks the end of the preoperational stage and the beginning of concrete operations.
Concrete Operations	7–11	The child demonstrates conservation, reversibility, serial ordering, and a mature understanding of cause-and-effect relationships. Thinking at this stage is still concrete.
Formal Operations	12+	The individual demonstrates abstract thinking, including logic, deductive reasoning, comparison, and classification.

Note. From *The Jean Piaget Stages of Cognitive Development*, by The Psychology Notes Headquarters, n.d., (https://www.psychologynoteshq.com/piagetstheory/).

The second stage is preoperational stage in which the use of language and symbols commence (Piaget, 1964). This stage encompasses children from 2 to 7 years of age. Children in this stage gain the ability to differentiate one object or one word from another. They also perform *animism*, meaning they think inanimate objects live and feel like persons (Babakr et al., 2019; McLeod, 2022). Other characteristics of children in preoperational stage include intuitiveness and *egocentrism* which means that their process of thought heavily depends on their personal intuitions and perspectives of the world. Moreover, preoperational child would not be able to tell that water poured from a glass to another of a different shape has the same quantity, due to the undeveloped "conservation of quantity and operational reversibility" (Piaget, 1964, p. 177).

In the third stage of concrete operations that happens to children between 7–11 years of age, *operation* commences for the first time (Piaget, 1964). It means that children can figure things out inside their head rather than needing to physically experience things in real life, although it is only effective if the object of thought is physical (McLeod, 2022). Those operations include "classification, ordering, the construction of the idea of number, spatial and temporal operations, and all the fundamental operations of elementary logic of classes and

relations, of elementary mathematics, of elementary geometry, and even of elementary physics" (Piaget, 1964, p. 177). Children begin to think more logically through conservation—ability to understand that elements of things might remain although their appearance changes—and mental reversibility—ability to mentally depict reversion of things (McLeod, 2022). They also become more aware of others' thought and feeling as egocentrism subsides.

The fourth stage is called the formal operational stage (Piaget, 1964). Approaching year 12, a child begins to be able to reason abstract concepts in addition to physical objects (McLeod, 2022). For instance, they do not have to think about slicing cakes in order to understand division. Moreover, they can now think of hypothetical issues with many possible consequences or solutions—displaying what is called "scientific thinking" emergence (McLeod, 2022). They begin to anticipate their life roles in the future and begin to analyse social issues happening in the world (North Carolina Department of Environmental Quality, 2017). Finally, they gain the ability to perform planning and task organisation without adults' support and direction.

2.5.3. Process of cognitive adaptation

Piaget believed in the existence of the structure that makes sense of the world, or what is referred to as *schema*. McLeod (2022) defined a schema as "a set of linked mental representations of the world, which we use both to understand and to respond to situations. The assumption is that we store these mental representations and apply them when needed". In simpler way, schema can be defined as "the basic building block of intelligent behaviour—a way of organising knowledge" (McLeod, 2022). For instance, an individual with a schema about eating at a restaurant has this behavioural pattern that when they enter the restaurant, they would look at the menu, order the food, eat it, and pay for it. The *development* explained by Piaget refers to one's growth in terms of quantity and complexity of their schemata.

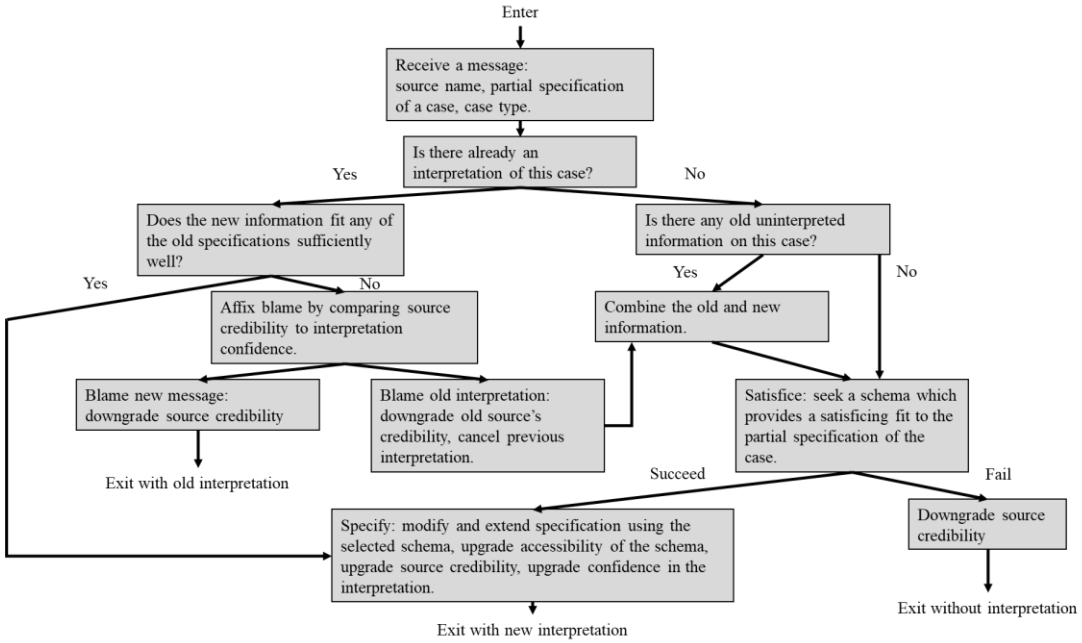
Learning involves the process of cognitive adaptation to new knowledge that affects schemata of an individual. There are three important processes involved in the process of

adaptation, namely assimilation, accommodation, and equilibration (McLeod, 2022; Piaget, 1952). *Assimilation* is defined as the process of matching new information into pre-existing structures of knowledge or schemata. This process does not necessarily alter one's understanding of the reality. Meanwhile, when the new information does not match with the existing schema, the schema would be revaluated hence the new information can fit in. This process is called *accommodation*. The process of accommodation often causes discomfort as humans are intolerant towards "contradictions and inconsistencies", instead always looking for a stable system or *equilibrium* in the knowledge structures (McLeod, 2022).

Piaget's explanation of schema is consistent with Axelrod's (1973) schema theory of information processing model. He represented the dynamic process of schema which is illustrated in Figure 12. The process starts when new information is acknowledged. The first response will be questioning whether interpretation of similar information exists. If it does, the next response will be questioning whether it adequately fits any of the existing specifications. If it fits then there will be no issue, and the new information will be interpreted by the old schema. If it does not fit the old specifications, then condemnation will occur, and the credibility of new information will be compared to the "confidence of the old interpretation" (pp. 1250). If the new information is blamed, credibility of the source will be downgraded for "future reference" (pp. 1250), then the process finishes with the old interpretation remains unaltered. If the old interpretation is blamed, credibility of the old source will be downgraded, and the old interpretation will be terminated. Furthermore, everything that can be remembered from the old interpretation will be combined with the new information.

Figure 12

Process model for schema theory



Note. From "Schema theory: An information processing model of perception and cognition," by Axelrod, R., 1973.

Next, the process of seeking a satisfactory fitting schema with the information occurs. If the process fails, the source's credibility will be downgraded, and the entire process finishes without interpretation which results in confusion. If succeeds, the schema will be used to specify the information. This stage is also reached if the new information fits any of the old specification well enough. First, the new information will be transformed to fit into the selected schema. All inconsistencies will be clarified to form a balanced schema. Then, the modified specification will be extended so that the person may extend the utilisation of the schema. Once the modification and specification are done, the individual will increase the accessibility of the schema, source credibility and confidence in the interpretation for future use.

2.6. Pro-environmental behaviour theories

2.6.1. The early theories

Since the 1970s, psychologists have attempted to identify factors that influence the forming of behaviour (Gifford et al., 2011; Kollmuss & Agyeman, 2002). In particular,

environmental psychologists have come up with pro-environmental behavioural theories and models that have been utilised in the design of "effective interventions and evaluations" (Swim et al., 2011, p. 244). Among the earliest theories, there was Ramsey and Rickson's (1976) model of environmental knowledge and attitudes that explains change in attitude and behaviour is made possible by increase in knowledge as depicted by Figure 13. Another theory was the knowledge deficit theory popularised by Burgess et al. (1998) that explained public unacceptance of environmental issues was caused by their deficit in knowledge or information (Brunk, 2006; Burgess et al., 1998). Therefore, the theory rationally claimed that through means of knowledge transfer, pro-environmental behaviour could be automatically generated. However, it has been proved wrong as environmental knowledge does not simply result in environmental behaviour (Gifford et al., 2011; Kollmuss & Agyeman, 2002).

Figure 13

Early models of pro-environmental behaviour

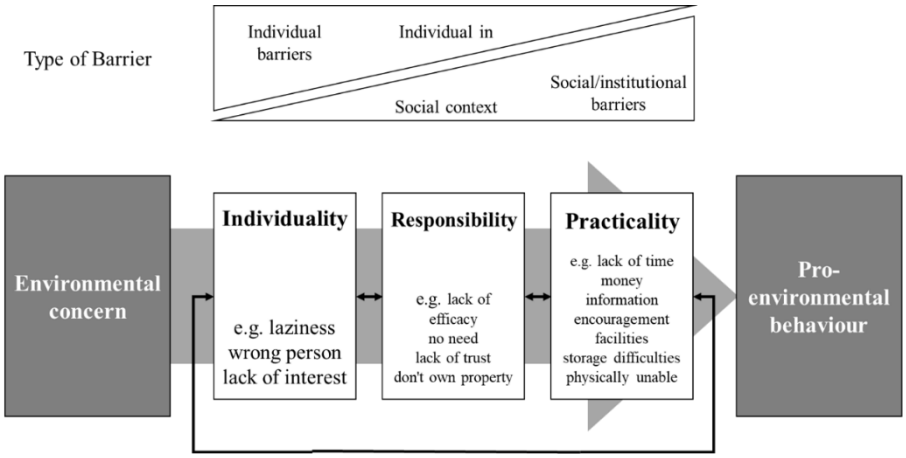
Note. From "Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?", by A. Kollmuss and J. Agyeman, 2002, *Environmental Education Research*, *8*(3), p. 241.

This discrepancy between environmental knowledge or awareness, attitude, and pro-environmental behaviour has been discussed by Blake (1999) in his *value-action gap*. He claimed that earlier pro-environmental behaviour models had oversimplified the phenomena as they failed to consider various constraints—he referred to as *barriers*. As illustrated in Figure 14, three barriers to environmental behaviour are identified, namely "individuality, responsibility, and practicality" (p. 267). First, *individual* barriers are located within oneself. He claims that people who do not possess a solid environmental concern are easily influenced by this type of barriers. However, Kollmuss & Agyeman (2002) argue that even people who

possess a strong environmental concern would be affected by individual barriers. The examples of individual barriers include conflicting attitudes, such as negligence or lack of enthusiasm. People with these barriers would think they are not suitable for a certain type of behaviours (Blake, 1999).

Figure 14

Barriers between environmental concern and action



Note. Adapted from "Overcoming the 'value-action gap' in environmental policy: Tensions between national policy and local experience", by J. Blake, 1999, p. 267.

The second set of barriers is called *responsibility* which involves how social or external factors affect the way people appraise the possible outcomes of a particular environmental behaviour (Blake, 1999). The ideas that they are helpless about changing the situation, or they do not have to take the responsibility for it, interrupt the forming of actual pro-environmental behaviours. Furthermore, having trust issues with the government or community often prevents individuals from behaving pro-environmentally.

The last set of barriers is *practicality* which Blake (1999) specifies as "social or institutional constraints that may prevent people from adopting pro-environmental action, regardless of their attitudes or intentions" (p. 268). Examples of practicality barriers include deficiency of time, deficiency of money, and physical disability. Despite of the detailed and

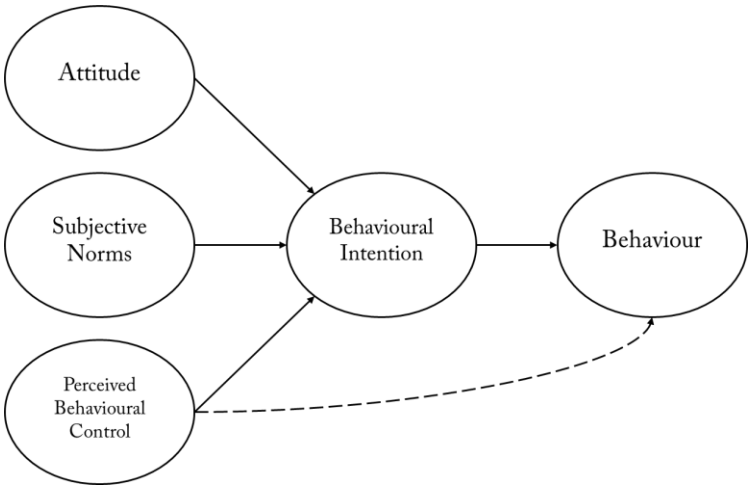
extensive insights given by this model combining internal and external factors, “social factors such as familial pressures and cultural norms” are absence (Kollmuss & Agyeman, 2002, p. 247).

2.6.2. The Theory of Planned Behaviour

The second model is Icek Ajzen’s (1991) Theory of Planned Behaviour (TPB) that is modified from the Theory of Reasoned Action (Ajzen & Fishbein, 1980). The theory concludes that intention is the primary factor that influences one’s performing a desired behaviour. Therefore, intention is considered as the direct antecedent of behaviour. The behavioural intention then is influenced by three factors: *attitude*, *subjective norm*, and *perceived behavioural control* as depicted by Figure (Ajzen, 1991). For more than 3 decades, this theory has been well acknowledged within health behaviour studies (Sniehotta et al., 2014; Tan et al., 2016) and environmental behaviour studies, such as waste separation (Hu et al., 2021), recycling (Nigbur et al., 2010), and energy-saving behaviour (Wang et al., 2014).

Figure 15

The Theory of Planned Behaviour Model



Note. From “The theory of planned behaviour”, by I. Ajzen, 1991, *Organizational Behaviour and Human Decision Processes, 50*(2), p. 182.

Attitude, subjective norms, and perceived behavioural control do not affect behaviour directly but indirectly through behavioural intention (Ajzen, 1991). First, *attitude* is defined as how an individual positively or negatively appraise the behaviour in address. The person might think "this act will or will not have positive consequences" (Gifford et al., 2011, p. 804). Moreover, the TPB emphasises the influence of situational pressures. People do not only consider their attitude to form behavioural intention, but also evaluate their ability to perform it. That is the *perceived behavioural control*. It is also thought to be directly influence behaviour. The person might think "it would be easy or difficult for me to do this" (Gifford et al., 2011, p. 804). The final factor is *subjective norms* that is people's perceived social pressure from significant others whether to perform or not perform the behaviour. The person might think "people who are important to me think I should do or not do this" (Gifford et al., 2011, p. 804). These social norms might be effective because of people fear being socially excluded (Bamberg & Moser, 2007, p. 16).

On the other hand, the theory is not without criticism despite its popularity. The most common criticism is that the theory is being excessively logical (Barber, 2011). The theory assumes every individual behaves rationally and completely understand the consequences of their behaviour (Santoso & Farizal, 2019). LaMorte (2019) claimed that the TPB did not consider environmental and economic situations and other personal factors, such as mood, fear, and past experience. Meanwhile, Sniehotta and colleagues (2014) emphasised the theory's lacking substantial experimental tests and evidence, and the conducted ones were not in line with the theory. In response, Ajzen (2011) accepted those critiques and ensured open possibility for adding more predictors into the model with the intention to increase the number of variances in explaining intention and behaviour.

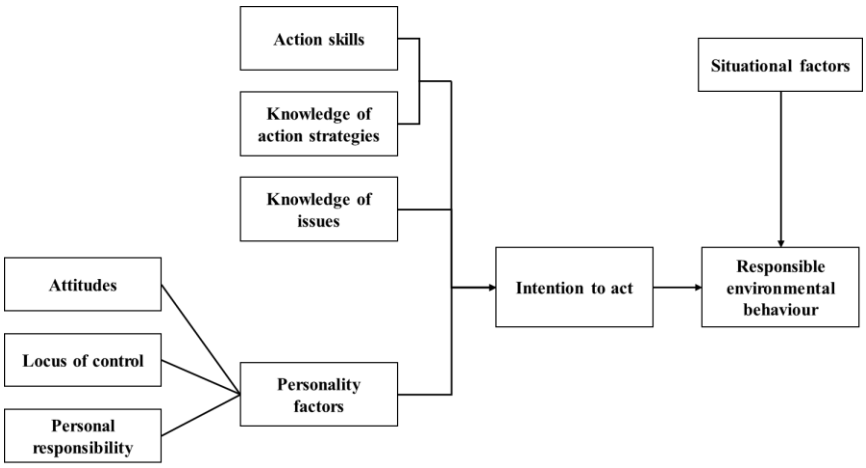
2.6.3. Hines model for pro-environmental behaviour

Hines, Hungerford, and Tomera (1987) published their model of responsible environmental behaviour which was based on their meta-analysis to indicate factors that influence environmental behaviour by assessing 128 previous studies on the topic. They classified indicated variables into four categories, namely "cognitive variables, psycho-social variables, demographic variables, and a category of experimental studies" (p. 3). Cognitive variables entail knowledge about the environment in general, the environmental issue and its consequences, and actions to overcome the problem. Psycho-social variables are associated with "individual personality characteristics" (p. 4), including attitude, locus of control—similar to the TPB's perceived behavioural control—commitment, personal responsibility, and economic orientation. Demographic variables include "age, income, education, and gender" (p. 5). Finally, experimental studies category touches upon different intervention strategies to form environmental behaviour.

Figure 16 shows the Hines model of responsible environmental behaviour. Intention to act appears to have direct effects on environmental behaviour (Hines et al., 1987). An individual with the intention to act would have more tendency to engage in the real action than an individual without it. This intention to act is then influenced by a combination of "cognitive knowledge, skills, and personality factors" (p. 6). An individual needs to know about the existence of a particular environmental issue and its causes in order to have an intention to act on it. Also, it seems to be crucial for the individual to know a set of action options they can select and their effectiveness in a specific situation. Moreover, even though it was undetected in the meta-analysis, Hines and colleagues emphasised the importance of action skills to properly apply the knowledge to the issue.

Figure 16

Model of responsible environmental behaviour



Note. From "Analysis and synthesis of research on responsible environmental behaviour: A meta-analysis", by J. M. Hines, H. R. Hungerford, and A. N. Tomera, 1987, *Journal of Environmental Education*, *18*(2), p. 7.

Nevertheless, knowledge and skills alone are insufficient to lead to the intention to perform responsible environmental behaviour (Hines et al., 1987). There are personality factors that play a crucial role in forming behaviours. That factors include "attitudes, locus of control, and personal responsibility" (p. 7). Individuals with strong environmental attitudes, strong perception of their ability to achieve change via their action, and powerful sense of responsibility for the environment, would presumably establish the intention to act. The final variables are situational factors, including "economic constraints, social pressures and opportunities to choose different actions" (p. 7), that may increase or decrease the occurrence of responsible environmental behaviour. An individual who has economic difficulties would not donate to the environmental protection fund despite having the knowledge, skills, and opportunity. However, a person would conserve energy at home merely for the sake of saving money. This person might have the knowledge and skills to conserve energy; however, personality factors might be absence.

CHAPTER 3

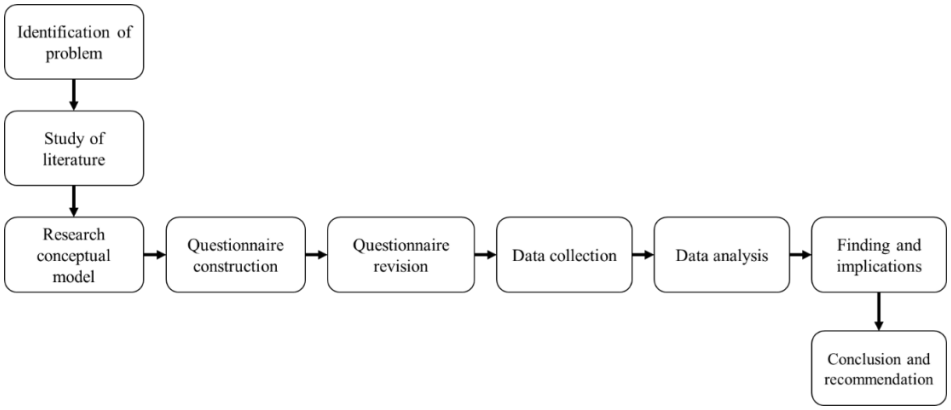
METHODOLOGY

3.1. Research flow

The flow of the research in this study is illustrated in Figure 17. This study started by identifying fundamental issues related to CCE and climate change conceptions in Japanese context. Next, the study of literature was done to identify existing studies and gaps related to the topic and to construct the conceptual framework of the study. Two types of data collection were initially proposed for this study, namely questionnaire survey and semi-structured interview both targeting early adolescents. However, only questionnaire survey could be conducted as result of cancelled interview appointments due to technical difficulties faced by the participants and strict privacy policy of Japanese schools. Questionnaire was built and further revised based on consultations with schools regarding level of difficulty and wording of the questions. Questionnaire survey was conducted online through Microsoft Form from 28 September 2021 to 16 November 2021. After acquiring the data, analyses were undertaken, then findings and possible implications of the study were outlined. Finally, conclusion and recommendation were compiled to summarise the study.

Figure 17

Research flow



3.2. Study area

Permission letters for conducting survey were sent to 17 junior high schools in Japan listed in Table 8. The modes of communication used to reach out those schools were indirect contact through the Board of Education in the area, and/or direct contact via email and telephone that information was obtained from the schools' websites. After approximately three months of communication, out of 17 schools that had been contacted, three schools (highlighted in green) eventually expressed their willingness to participate in the study. One school (Kashiwa Matsuba Junior High School) was located in Kashiwa City, Chiba Prefecture, and two schools (Oita Wasada Nishi Junior High School and Oita Kaku Junior High School) were located in Oita City, Oita Prefecture. The intention was to compare the results acquired from schools in metropolitan area and countryside area.

Table 8

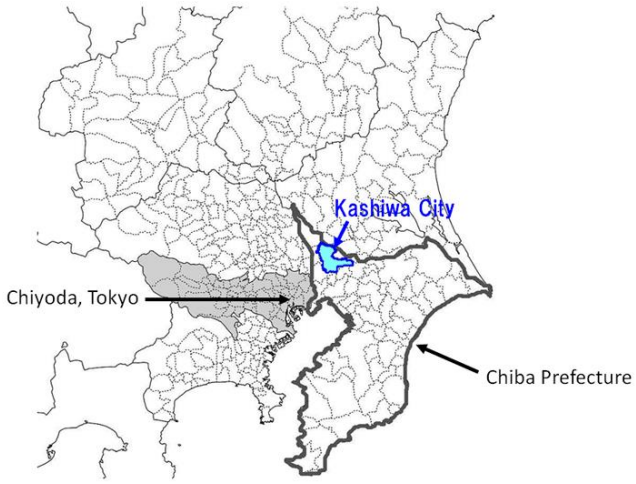
List of contacted schools

School	Location	Type
Kashiwanoha Junior High School	Kashiwa, Chiba	Public
Kashiwa Tanaka Junior High School	Kashiwa, Chiba	Public
Kashiwa Daigo Junior High School	Kashiwa, Chiba	Public
Kashiwa Matsuba Junior High School	Kashiwa, Chiba	Public
Kashiwa Nishihara Junior High School	Kashiwa, Chiba	Public
Tokyo Metropolitan Hakuo Junior-Senior High School	Tokyo	Public
Tokyo Metropolitan Ryougoku Junior-Senior High School	Tokyo	Public
Tokyo Fuji Junior-Senior High School	Tokyo	Public
Tokyo Metropolitan Musashi Junior-Senior High School	Tokyo	Public
Tokyo Metropolitan Oizumi Junior-Senior High School	Tokyo	Public
Ritsumeikan Uji Junior-Senior High School	Uji, Nara	Private
Oita Wasada Junior High School	Oita	Public
Oita Wasada Minami Junior High School	Oita	Public
Oita Wasada Nishi Junior High School	Oita	Public
Oita Jonan Junior High School	Oita	Public
Oita Kaku Junior High School	Oita	Public
Minami Oita Junior High School	Oita	Public

Depicted by Figure 18, Kashiwa City is located within the Tokyo Metropolitan Area—approximately 30 kilometres away from the heart of Tokyo. In recent years, the municipality has shown its interest in the phenomenon of global warming and climate change. In response, it established the Global Warming Countermeasure Plan that consists of explanation of the issue and action strategies to combat the issue globally and locally (Kashiwa City, 2021). Inside the 120 pages report, the municipality also puts emphasis on the importance of environmental education and collaboration. It includes education for the next generation, support for instructors and provision of teaching materials, citizen volunteer activities, and courses about recycling.

Figure 18

Kashiwa City on map of Kanto area



Note. From "Senior citizens' new career model in the community", by RISTEX, 2016, (https://www.jst.go.jp/ristex/korei/en/02project/prj_h22_04.html).

Meanwhile, the other target area, Oita City, is the capital city of Oita Prefecture in Kyushu Island. Its location in Japan's map with respect to Tokyo can be seen in Figure 19. Similarly, the prefectural government and municipality have been putting much effort onto their EE. They established the Environmental Education Advisor System in which schools or other organisations can reserve free lectures, workshops, nature observations and experiential learnings organised by 71 experts and practitioners (Oita Prefectural Government, 2021). The

provided topics include global warming, energy conservation, eco-energy, environmental pollution and health, nature conservation, garbage and recycling, nature observation and hands-on learning, and astronomy, weather and disaster prevention. In formal education setting, the municipality provides the Supplementary Reading for Environmental Education for grade 4, 5, and 6 in elementary school as illustrated in Figure 20 (City of Oita, 2021). Particularly, three pages are dedicated to discussing global warming.

Figure 19

Oita Prefecture on map of Japan

Note. From “The Glint of Lights on The Water”, by Kyushu x Tokyo, n.d., (https://www.kyushuandtokyo.org/route_3/)

Figure 20

Supplementary reading for environmental education of Oita City

Note. From “Kankyō kyōiku fukudokuhon `watashi-tachi to kankyō' o sakusei shimashita! [We have created supplementary reading for environmental education, "We and the Environment"!]”, by City of Oita, 2021, (http://www.city.oita.oita.jp/o141/machizukuri/kankyo/1475193271329.html).

3.3. Sample

The participants in the study were students in grade 1 and 2 at junior high school ranging from 12 to 14 years of age. Schools were requested to distribute the link to the online questionnaire to all students in grade 1 and 2 without paying any special attention to socio-cultural backgrounds, academic ability, prior learning experience related to climate change, etc. Author had zero influence on how schools conducted their teaching activities prior to the questionnaire survey period. Moreover, author did not deliver any forms of intervention as the objective of this study was to obtain a current and actual state of conceptions of the selected sample. In terms of the necessary sample size, 384 sample sizes was required for confidence level of 95%, standard deviation of 0.5 and margin of error of +/- 5% (Taherdoost, 2017).

3.4. Questionnaire construct

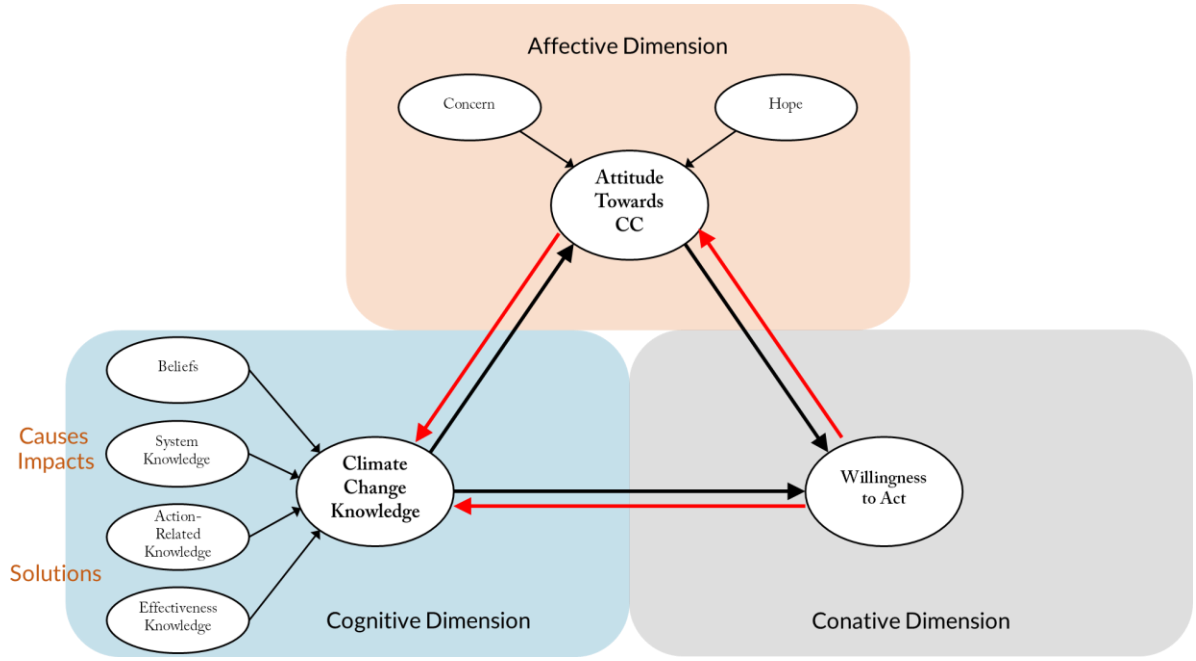
The questionnaire used in the study was built based on the hypothetical conceptual framework shown in Figure 21. The conceptual framework was constructed with the consideration of UNESCO's (2020) learning dimensions for ESD and the trilogy of mind (Hilgard, 1980) which explained that mental activities involve 3 parts of mind, namely cognition (knowledge), affect (socio-emotion), and conation (behaviour). Within the framework, cognitive domain involved climate change knowledge that was mainly affected by beliefs about climate change occurrence and factual knowledge about climate change's causes, impacts, and solutions. Affective/socio-emotional domain handled attitude towards climate change which was affected by concern and hope. Finally, conative/behavioural domain dealt with the willingness to take actions for combating climate change.

The framework also considered previous behavioural models, such as the Hines model of responsible environmental behaviour (Hines et al., 1987) and Ajzen's (1991) Theory of Planned Behaviour. However, in opposed to the traditional unidirectional behavioural models and considering the complex and unclear relationships among the dimensions (Dijkstra &

Goedhart, 2012), this study hypothesised that the Willingness to act may reversely affect Attitude and Knowledge, and Attitude may affect Knowledge as depicted by red arrows in the model. Moreover, all causal relationships among variables were hypothesised to be positive and significant.

Figure 21

Conceptual model



The questionnaire used in the study was composed of 42 items that were divided into 5 sections excluding the section of consent, demographic information, and knowledge source. Majority of the items are closed-ended questions, ranging from true/false/don't know format for knowledge test, to 7 point-Likert-type scale for most of the remaining variables. The "don't know" options were added to reflect respondent's knowledge more accurately by preventing them from guessing at the right answer (Tasquier & Pongiglione, 2017). Questions were compiled and adjusted from previous peer-reviewed studies on pro-environmental behaviour and climate change conceptions listed in Table 9.

Table 9

Questionnaire composition

Dimension	Variable	Number of items	Scale type	Source
Cognitive	System knowledge	6	True/false/don't know	Dijkstra & Goedhart, 2012
	Action knowledge	1	Ranking	Kirk, 2018
	Effectiveness knowledge	7	True/false/don't know	Roczen, 2011; Taddicken et al., 2018
	Belief	2	Yes/no/don't know, 7 point-Likert-type	Leiserowitz et al., 2011
Affective	Concern	5	7 point-Likert-type	Kuthe et al., 2019; Stevenson et al., 2016
	Hope	6	7 point-Likert-type	Ojala, 2012
	Attitude	7	7 point-Likert-type	Dijkstra & Goedhart, 2012; Kuthe et al., 2019; Trott, 2021
Conative	Willingness to act	8	7 point-Likert-type	Boyes & Stanisstreet, 2012; Skamp et al., 2013

3.5. Data analysis

In this study, 4 main analyses were conducted. First, one-way ANOVA (analysis of variance) test was conducted to compares the means of two or more independent groups to determine whether there is statistical evidence that the associated population means are significantly different. When a study includes three or more groups for one dependent variables, one-way ANOVA is required (Kim, 2017; Ross & Willson, 2017). The software used for this analysis was IBM SPSS Statistics 26.0.0.

Second, factor analysis using principal component analysis (PCA) method was performed to reduce dimensionality of the data and increase its interpretability as there might be overlapping or weak variables among the 30 variables involved in the model. The software used to perform this analysis was IBM SPSS Statistics 26.0.0. PCA attempts to simplify complex data by reducing the number of observed variables to a smaller number of principal

components while maintaining maximum total variance of the observed variables (Alavi et al., 2020; Suhr, 2005).

Third, Structural Equation Modelling (SEM) was performed to identify interrelations and causal relationships among variables within the multivariate model. The software used for this analysis was IBM SPSS Amos (Analysis of Moment Structures) 26.0.0. SEM has the capacity to evaluate a complex theoretical model based on the consistency between the model and the actual data (Zhang et al. 2015). SEM helps the analysis of latent variables which are impossible to observe directly. SEM can be considered as an amalgam between factor analysis and path analysis (Weston & Gore, 2006). Like factor analysis, SEM provides a summary of interconnections among variables. Meanwhile, identical to path analysis, hypothesised relationships between statistical concepts can be evaluated with SEM.

Finally, cluster analysis was conducted to classify results based on distinct profiles. The software used to perform this analysis was IBM SPSS Statistics 26.0.0. Analysis visualisation was performed by using JMP 16.2.0. Hierarchical cluster analysis was first performed to estimate the possible number of clusters (Hennig et al., 2015). Then, K-means cluster analysis was conducted to validate the selected cluster numbers and form the clusters. The K-means method is “the most widely used clustering algorithm that uses an explicit distance measure to partition the data set into clusters” (IBM, 2021a).

CHAPTER 4

FINDINGS AND ANALYSIS

4.1. Data overview

Out of 451 responses, 425 (94.24%) agreed to participate in the study. Two responses were invalid due to unsuitability for the target age group and dishonest or inattentive input of information. At the end, 423 responses (93.79%) were valid. The average time taken to finish the questionnaire was 14 minutes 46 seconds. The respondents' demographic information is summarised in Table 10. The proportion of sex was comparatively balanced with male = 50.8% and female = 48.0%. Response from respondents with the age of 13 was dominant with 59.1%, meanwhile the percentage of other age groups is moderately balanced with 20.8% and 20.1% respectively for age 12 and 14. In terms of grade, 56.7% of respondents were in 7th grade and 43.3% belonged to grade 8. Finally, 42.1% respondents came from Kaku Junior High School, 40.7% came from Matsuba Junior High School, and solely 17.3% were from Wasada Nishi Junior High School.

Table 10

Summary of respondent's demographic characteristics

Demographic attribute	Frequency (n)	Percentage (%)
Sex		
Male	215	50.8
Female	203	48.0
Unanswered	5	1.2
Age		
12	88	20.8
13	250	59.1
14	85	20.1
Grade		
7	240	56.7
8	183	43.3

School		
Wasada Nishi Junior High School	73	17.3
Kaku Junior High School	178	42.1
Matsuba Junior High School	172	40.7

4.2. Contribution of demographic variables

One-way analysis of variance (ANOVA) was performed to identify whether demographic variables show statistically significant variance on the investigated variables, namely *knowledge*, *concern*, *hope*, *attitude*, and *willingness to act*. The demographic variables were statistically significant when the *p*-value is less than .05 (Ross & Willson, 2017; Zhang et al., 2015). Table 11 shows the statistical influence of the demographic variables on climate change conceptions' variables. Only *grade* [F (1, 421) = 21.383, $p < 0.001$] and *school* [F (2, 420) = 12.652, $p < 0.001$] demonstrated statistically significant impacts on *knowledge* alone. Grade 1 (Mean = 40.94) possessed higher *knowledge* value compared to grade 2 (Mean = 34.26). Kaku Junior High School (Mean = 41.35) had the higher *knowledge* value, followed by Kashiwa Matsuba Junior High School (Mean = 37.56) and Wasada Nishi Junior High School (Mean = 31.16). Other demographic variables, namely age, sex, and area, did not display statistically significant variance on any of the investigated variables.

Table 11

Result of the one-way ANOVA test

Demographic variable	**Value of significance (*p*)**				
	Knowledge	Concern	Hope	Attitude	Willingness to act
Age	0.374	0.150	0.146	0.784	0.897
Grade	<0.001	0.969	0.452	0.872	0.645
Sex	0.281	0.266	0.693	0.892	0.315
School	<0.001	0.637	0.636	0.572	0.194
Area	0.579	0.492	0.842	0.554	0.222

4.3. Climate change knowledge test

4.3.1. Climate change knowledge score

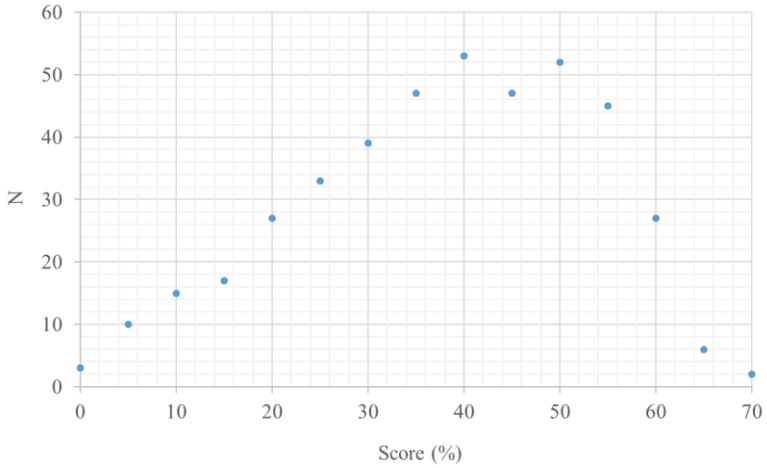
The first section of the questionnaire was climate change knowledge test to assess respondents' cognitive capacity about the issue of climate change in relation to its causes, impacts, and solutions. The test was divided into 3 categories following the 3 different forms of factual knowledge (Frick et al., 2004; Kaiser et al., 2008): system knowledge, action-related knowledge, and effectiveness knowledge. System knowledge is knowledge about the issue under discussion. Action-related knowledge is knowledge of behavioural options and possible courses of action. Effectiveness knowledge is knowledge of the relative gain or benefit that is associated with a particular behaviour. Moreover, visual aids, such as images and graphs, were utilised to boost respondents' understanding of the questions and increase their level of enthusiasm.

In the section of system knowledge and effectiveness knowledge, questions were compiled in a form of close-ended true-false quiz. Depending on the answer, the option "true" and "false" might give 1 point whereas the added "do not know" option gave 0 point. In the action-related knowledge section, respondents were given a list of 7 different actions and technologies and asked to rank them in order of how much greenhouse gases can be avoided. One point was given to every correct order.

Score result of the climate change knowledge test is illustrated in Figure 22. The y axis shows the number of respondents, and the x axis shows the climate change knowledge test in percentage. Out of a full score of 100, the lowest score was 0 (N = 3), and the highest score was 70 (N = 2). The score with the highest frequency was 40 with N = 53, followed by 50 with N = 52. Moreover, the overall average score was 38.05. Oita showed higher average score with 38.89 point, while Kashiwa's average score was 37.56.

Figure 22

Climate change knowledge test score

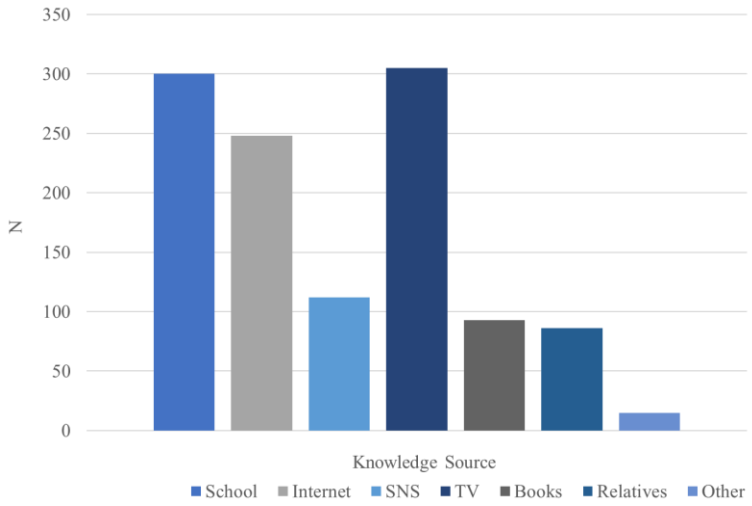


4.3.2. Knowledge source

At the end of climate change knowledge test, respondents were asked about their sources of knowledge. As illustrated in Figure 23, seven options were given, namely school, internet, SNS (Social Networking Service)—Instagram, Facebook, YouTube, etc.—television, books and magazines, friends and families, and other option that allows respondents to provide an answer that is outside of your predetermined list. Respondents were allowed to choose multiple options. Television was the top knowledge source, closely followed by school. The next top knowledge source was internet then followed by SNS, books and magazines, relatives and other. Other answers included game, cram school, own observation, and a Japanese YouTuber called Hiroyuki.

Figure 23

Climate change knowledge sources



4.3.3. Misconceptions

From the knowledge test, several scientific misconceptions possessed by respondents could be identified. Table 12 shows the detailed results for system and effectiveness knowledge test. In the system knowledge section, respondents were asked to answer correctness of the statement “climate change is a result of the ozone layer becoming thinner”. The answer should be “false”; however, 40% of the respondents answered “yes”, while 43% answered “don’t know”. The second scientific misconception was the statement “because of climate change, the water in seas and oceans will expand”. The answer should be “true”; however, 27% of the respondents answered “false”. Furthermore, in the effectiveness knowledge section, almost half of the respondents answered “don’t know” for greenhouse gas generated comparison between production of beef and wheat. Moreover, only 24% correctly answered for the average CO2 emission per capita on short haul versus long-haul flights.

Table 12

Detailed results for system and effectiveness knowledge

Question	Correct	Incorrect	"Don't know"
System knowledge			
Most of the current climate change is due to greenhouse gases generated by human activity.	69% (294)	7% (31)	24% (100)
Climate change is only defined as the rising of temperature of the earth's surface.	62% (265)	10% (41)	28% (119)
Climate change is a result of the ozone layer becoming thinner.	17% (73)	40% (170)	43% (182)
Rise in sea level and drought are some of the consequences of climate change.	80% (338)	7% (28)	14% (59)
Because of climate change, the water in seas and oceans will expand.	37% (156)	27% (114)	36% (155)
Because of climate change, certain plants and animals may become extinct.	87% (371)	3% (11)	10% (43)
Effectiveness knowledge			
Consuming domestic beef uses less energy than consuming imported beef.	55% (232)	18% (78)	27% (115)
It takes the same amount of energy to produce recycled paper as it takes to produce conventional paper.	44% (188)	22% (94)	34% (143)
Energy saving light bulbs consume less energy than conventional light bulbs with the same illuminating power.	61% (258)	16% (69)	23% (98)
A car's average CO2 emission per person and kilometre exceeds that of a train many times over.	52% (219)	19% (82)	29% (124)
The production of 1 kg of beef produces more greenhouse gases than the production of 1 kg of wheat.	34% (144)	19% (81)	47% (200)
On short-haul flights (e.g., within Japan) the average CO2 emission per person and kilometre is lower than on long-haul flights (e.g., Japan to America).	24% (103)	32% (137)	44% (185)
A diesel-engine vehicle causes more CO2 per person and kilometre than a comparable petrol-engine vehicle.	56% (239)	9% (39)	35% (147)

The final scientific misconception could be found in the action knowledge section where respondents were asked to rank a list of actions or technologies in order of how much greenhouse gases can be avoided. Table 13 shows the frequently answered order and the correct order according to Climate Literacy and Energy Awareness Network (CLEAN) (Kirk, 2018). "Family planning" should be on the top of the list; however, most of the respondents put it as the least important thing in greenhouse gas avoidance. On the other hand, "restoring tropical

forests" and "household recycling" were on top of the list ranked by respondents. Nonetheless, they do not have much impact on greenhouse gas emission avoidance compared to other options and should be on the bottom of the list (Kirk, 2018).

Table 13

Answers for action knowledge task

	Correct order	**Answered order**
1	Family planning	Restoring tropical forests
2	Wind energy	Household recycling
3	Wasting less food	Solar energy
4	Plant-based diet	Wasting less food
5	Solar energy	Wind energy
6	Restoring tropical forests	Plant-based diet
7	Household recycling	Family planning

4.4. Trends of climate change conceptions

The trends of other investigated variables are discussed in this sub-chapter. They include *belief*, *concern*, *hope*, *attitude*, and *willingness to act*. As 7 point-Likert-type scale was used to identify those variables, the answer "1", "2", "3" (dark red, orange, and tan in colour) is considered negative; "4" (grey in colour) is considered neutral; and "5", "6", "7" (blue-grey, blue, and dark blue in colour) is positive in trend.

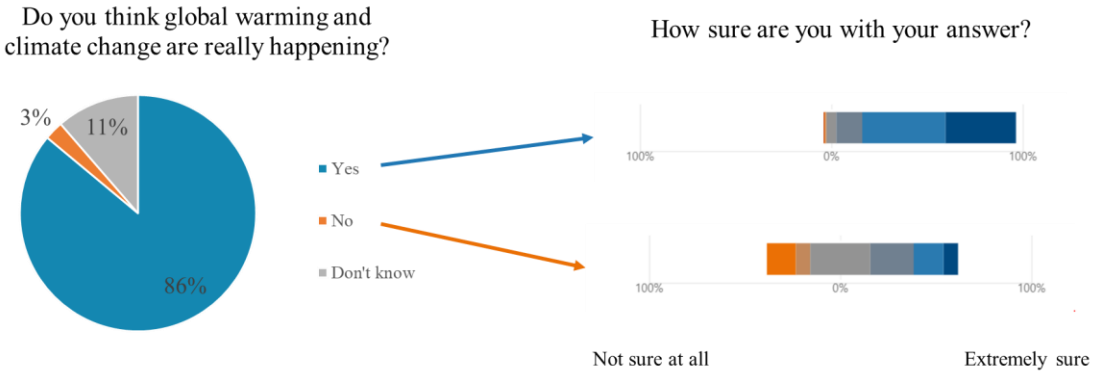
4.4.1. Belief

Respondents were asked whether they believed global warming and climate change were really happening. Figure 24 illustrates the proportion of trends in respondents' beliefs in the occurrence of climate change and their degree of sureness with their beliefs. An approximate of 86% respondents thought global warming and climate change were really happening whereas 11% did not know and 3% did not think they were really happening. After that, they were asked on their sureness with their answer in the previous question with 7 point-Likert-

type scale (1 = *not sure at all*, 7 = *extremely sure*). A staggering proportion of 93.7% of respondents who answered "yes" were sure with their answer to some extent. Meanwhile, only 46.2% of the respondents who answered "no" were sure with their answer to some extent.

Figure 24

Trends of belief



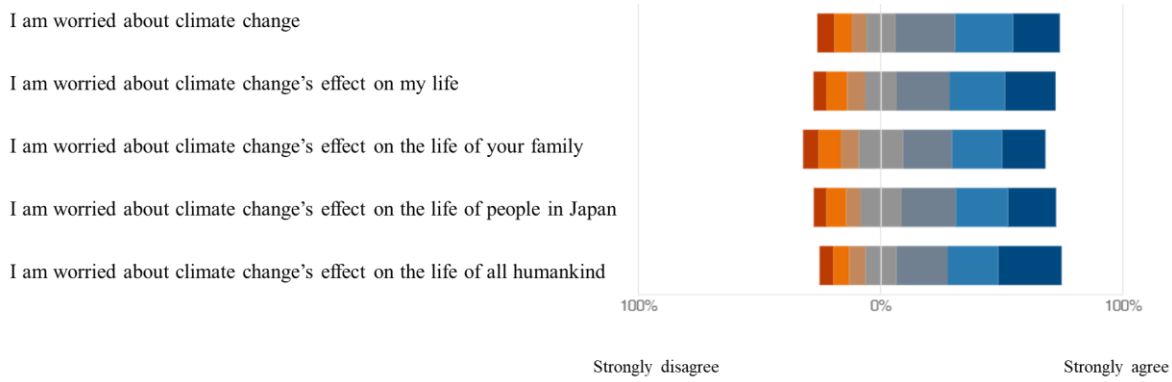
4.4.2. Concern

Concern section attempted to understand their degree of wariness towards climate change and its effects on their lives, lives of family, lives of people in Japan, and lives of all humankind. Figure 25 shows a diverging stacked bar chart that explains the trends of respondents' responses to every item about their concerns about climate change. Overall, around 65% of the responses were considered positive, while 21% were negative, 14% were neutral. Concerns about climate change in general and concerns about climate change's impacts on all humankind showed the highest positive trends. The statements in the questionnaire include:

- "I am worried about climate change".
- "I am worried about climate change's effect on your life".
- "I am worried about climate change's effect on the life of my family".
- "I am worried about climate change's effect on the life of people in Japan".
- "I am worried about climate change's effect on the life of all humankind".

Figure 25

Trends of concern



4.4.3. Hope

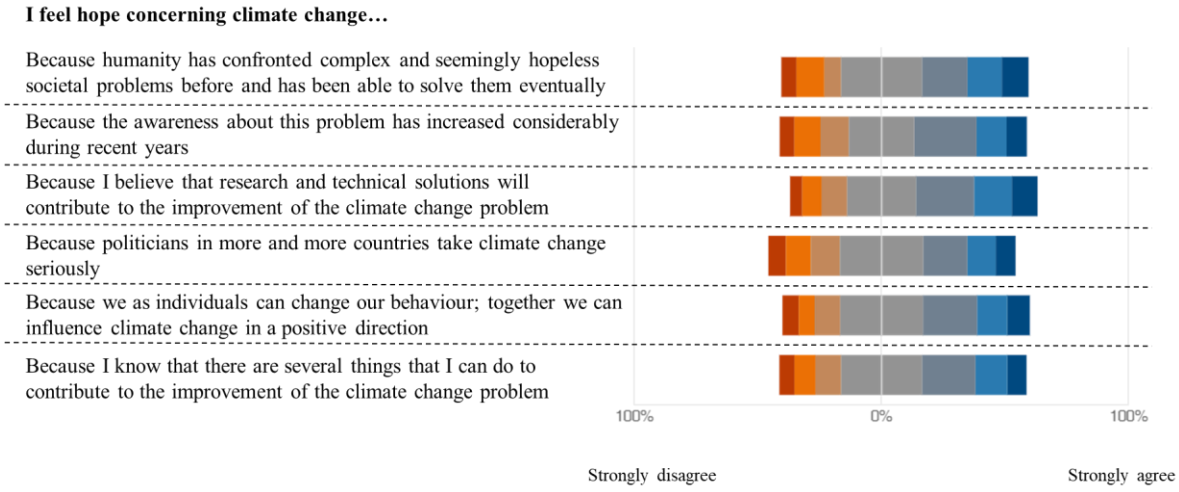
This section tried to identify respondents' degree of optimism or pessimism about the future reality involving climate change. Respondents were asked to answer whether they agreed with the statements that included three types of constructive hope, namely positive reappraisal, trust in others, and trust in self (Ojala, 2012). Figure 26 shows the proportion of responses describing respondents' hope on the future involving climate change. Although positive responses were still dominant with 44%, the proportion of positive, neutral, and negative responses was almost equally distributed. Compared to other factors, hope's proportion of positive responses was the lowest. Those statements include: "I feel hope concerning climate change…"

- "Because humanity has confronted complex and seemingly hopeless societal problems before and has been able to solve them eventually".
- "Because the awareness about this problem has increased considerably during recent years".
- "Because I believe that research and technical solutions will contribute to the improvement of the climate change problem".

- “Because politicians in more and more countries take climate change seriously”.
- “Because we as individuals can change our behaviour; together we can influence climate change in a positive direction”.
- “Because I know that there are several things that I can do to contribute to the improvement of the climate change problem”.

Figure 26

Trends of hope



4.4.4. Attitude

This section tried to identify whether respondents positively or negatively appraise the issue of climate change. Figure 27 shows the proportion of responses surrounding their attitude towards climate change. Positive responses were dominant with 56%, while neutral and negative ones were at 26% and 17% respectively. Respondents were asked for their agreement on the following statements:

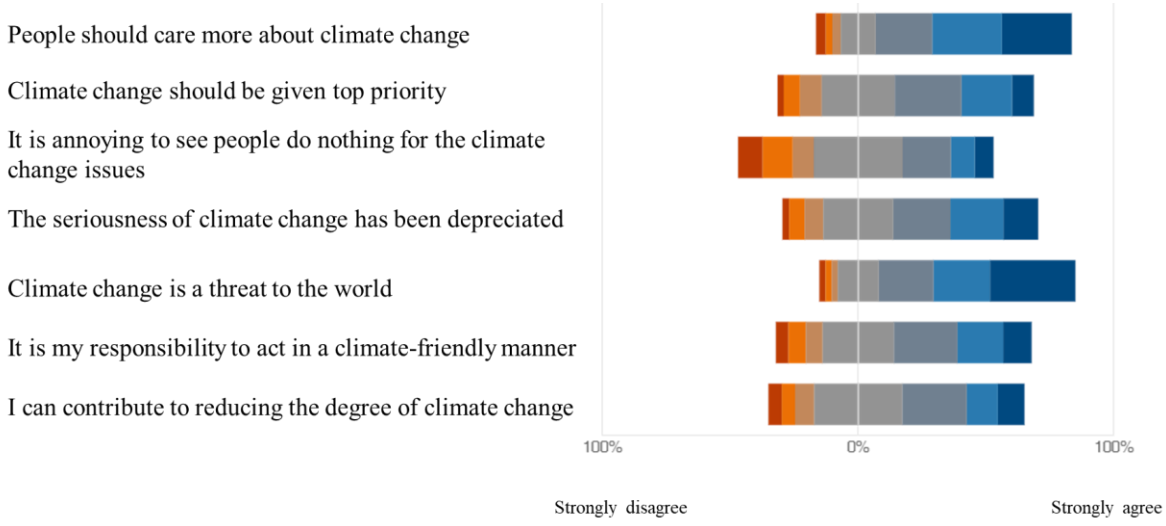
- “People should care more about climate change”.
- “Climate change should be given top priority”.
- “It is annoying to see people do nothing for the climate change issues”.
- “The seriousness of climate change has been depreciated”.

- “Climate change is a threat to the world”.
- “It is my responsibility to act in a climate-friendly manner”.
- “I can contribute to reducing the degree of climate change”.

“People should care more about climate change” and “climate change is a threat to the world” statements got the highest positive responses. Meanwhile, “it is annoying to see people do nothing for the climate change issues” got the most neutral and negative responses.

Figure 27

Trends of attitude



4.4.5. Willingness to act

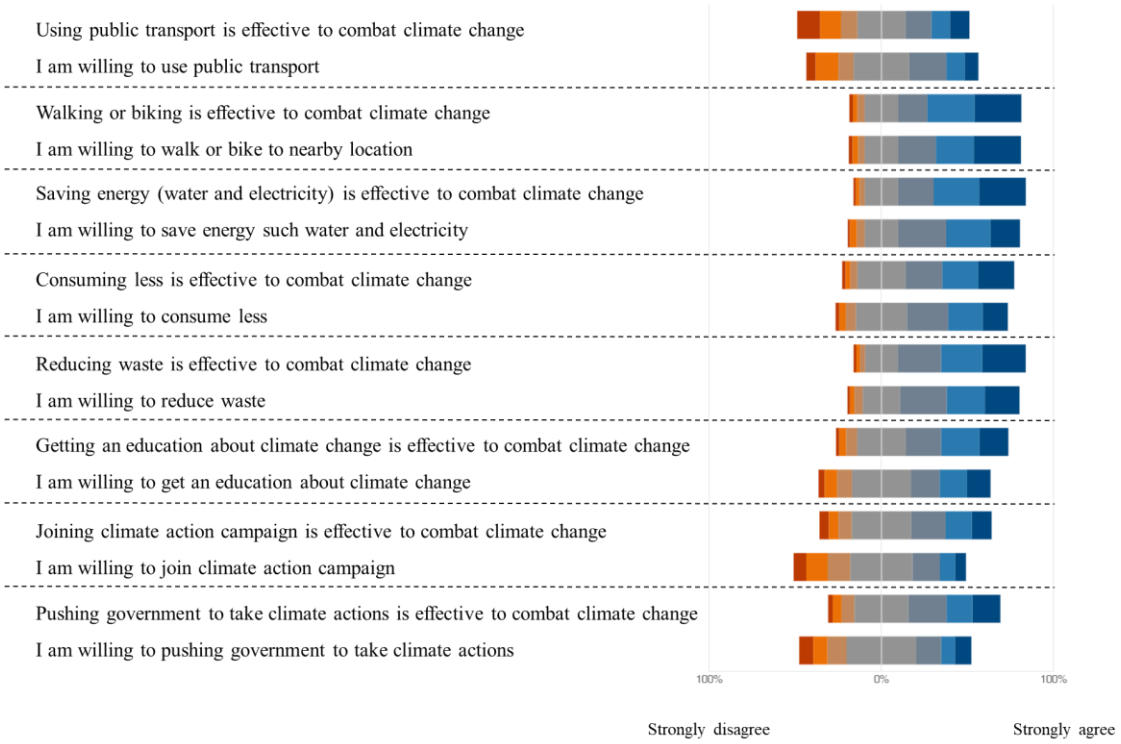
The section of willingness to act attempted to identify respondents’ willingness to take actions with the intention of combating climate change. Figure 28 shows the proportion of responses explaining respondents’ willingness to act against climate change. The proportion of positive responses was dominant with 56%, while neutral responses’ proportion was at 28% and negative responses’ proportion was at 16%. Respondents were asked about their perceived effectiveness of a set of actions and their willingness to take them. Statements in the questionnaire are as follows:

- “Using public transport is effective to combat climate change”, “I am willing to use public transport”.
- “Walking or biking is effective to combat climate change”, “I am willing to walk or bike to nearby location”.
- “Saving energy such water and electricity is effective to combat climate change”, “I am willing to save energy such water and electricity”.
- “Consuming less is effective to combat climate change”, “I am willing to consume less”.
- “Reducing waste is effective to combat climate change”, “I am willing to reduce waste”.
- “Getting an education about climate change is effective to combat climate change”, “I am willing to get an education about climate change”.
- “Joining climate action campaign is effective to combat climate change”, “I am willing to join climate action campaign”.
- “Pushing government to take climate actions is effective to combat climate change”, “I am willing to pushing government to take climate actions”.

Direct actions, such as saving energy and walking or biking got the most positive responses. On the other hand, indirect actions that involves political elements, such as joining climate action campaigns and pushing government for bolder climate action, got the most negative responses.

Figure 28

Trends of willingness to act



4.5. Factor analysis

Factor analysis using PCA method was performed to identify weak and/or overlapping variables to remove them thereby reducing dimensionality and increasing interpretability of the data. The first step is to test whether the data set is suitable for factor analysis to be performed. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's test of Sphericity were conducted. High KMO values, which is close to 1.0, indicate that a factor analysis may be useful with the dataset (IBM, 2021b). At least a value of .7 is desirable (Watkins, 2018). Furthermore, small significance values of the Bartlett's test, which should be less than .05, indicate that a factor analysis may be useful with the dataset (IBM, 2021b). As shown in Table 14, the results affirmed the suitability of the dataset for factor analysis with the KMO values of .932 and the Bartlett's test's significance value of $p < .001$.

Table 14

Result of KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.932
Bartlett's Test of Sphericity	
Approx. Chi-Square	8484.686
df	406
Sig.	.000

Next, the analysis was run using a promax rotation as the items were assumed to be correlated (Brown, 2009). As shown in Table 15, five components were intentionally extracted to represent 5 main variables investigated in the study—*knowledge* (K), *concern* (C), *hope* (H), *attitude* (A), *willingness to act* (W)—that accounted for 65% of the common variance among the responses. Items with loadings below .55 or that loaded on multiple components were removed. Highlighted in red, the removed items were action knowledge, A1 (attitude 1), A2 (attitude 2), and W1 (willingness to act 1). After the removal of weak and overlapping items, component 1 contains 6 items belong to H; component 2 contains 5 items belong to C; component 3 contains 7 items belong to W; component 4 contains 5 items belong to A; and component 5 contains 3 items belong to K.

Table 15

Pattern matrix

	Component				
	1	2	3	4	5
System					.885
Action			.445		
Effect					.852
B					.552
C1		.837			
C2		.958			
C3		.980			
C4		.961			
C5		.882			
H1	.778				
H2	.843				
H3	.841				
H4	.878				

H5	.793				
H6	.831				
A1				.399	
A2				.639	
A3				.833	
A4				.781	
A5				.524	
A6				.609	
A7				.657	
W1			.527		
W2			.571		
W3			.752		
W4			.802		
W5			.777		
W6			.662		
W7			.738		
W8			.773		

4.6. Structural model

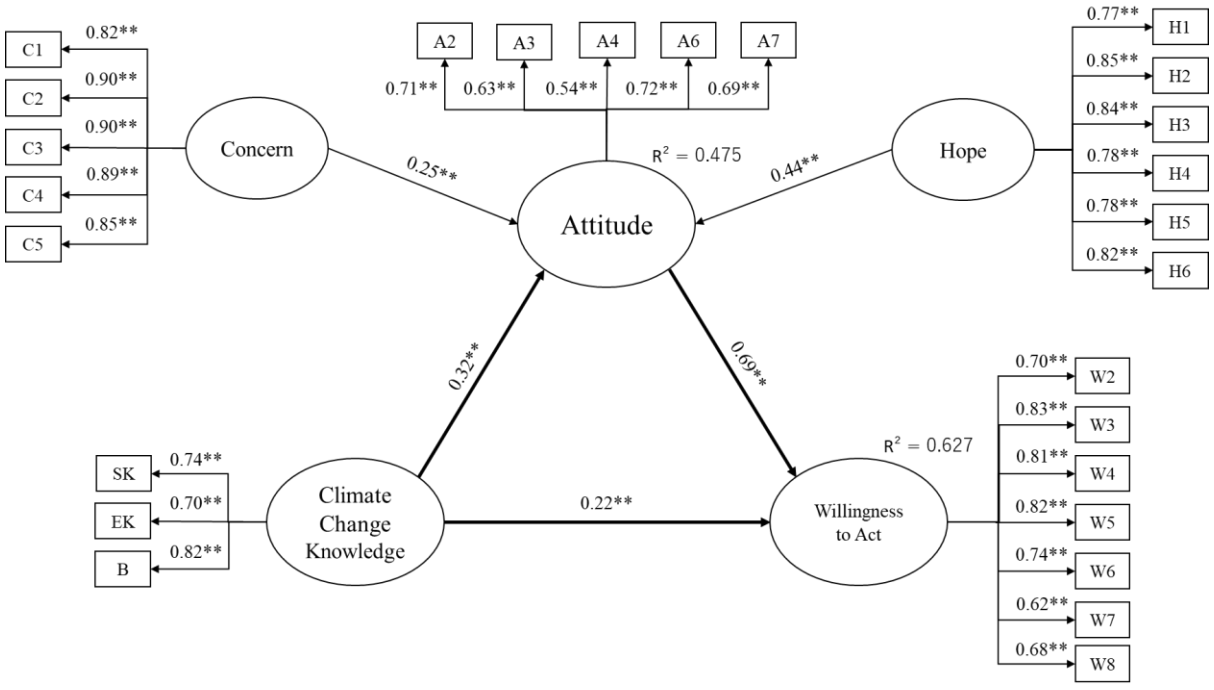
Using the updated data from the factor analysis, SEM was conducted to evaluate the strength of the relationships among variables in the model, especially the interrelationships among *knowledge*, *attitude*, and *willingness to act*. Figure 29 and Figure 30 illustrate the results of SEM analysis for both the conventional model 1 and the opposite model 2. Two-model analysis was conducted due to the limitation of the software in calculating non-recursive models with multiple feedback loops and complex relationships (Arbuckle, 2012). Correlations between two latent variables—known as direct effect or path coefficient—are symbolised as arrows. According to Suhr (2006), standardized path coefficients with values less than .10 may indicate a "small" effect, values around .30 indicate a "medium" effect, and values greater than .50 indicate a "large" effect.

Shown in Figure 29, model 1 (chi-square = 1174.373; df = 292; $p < 0.001$) considered W as the end destination of the model. The results indicated that all causal relationships were positive and significant. K had moderate effect on both A and W. For each unit added to K, .32 units of A and .22 units of W were added. Meanwhile, A showed an outstandingly large effect on W at .69 units. A was moderately influenced by C with .25 units and H with .44 units where

H showed stronger effect on A compared to C. The squared multiple correlation of a variable, symbolised by R^2, indicates the percentage of its variance that is explained by its indicators (Arbuckle, 2012). According to Chin (1998), R^2 values of .67, .33, or .19 for latent variables can be described as substantial, moderate, or weak, respectively. C, H, and K explained 47.5% of the variance of A, which was considered moderate explanatory power. Meanwhile, K and A accounted for 62.7% of the variance of W, which was considered as moderate explanatory power.

Figure 29

SEM model 1



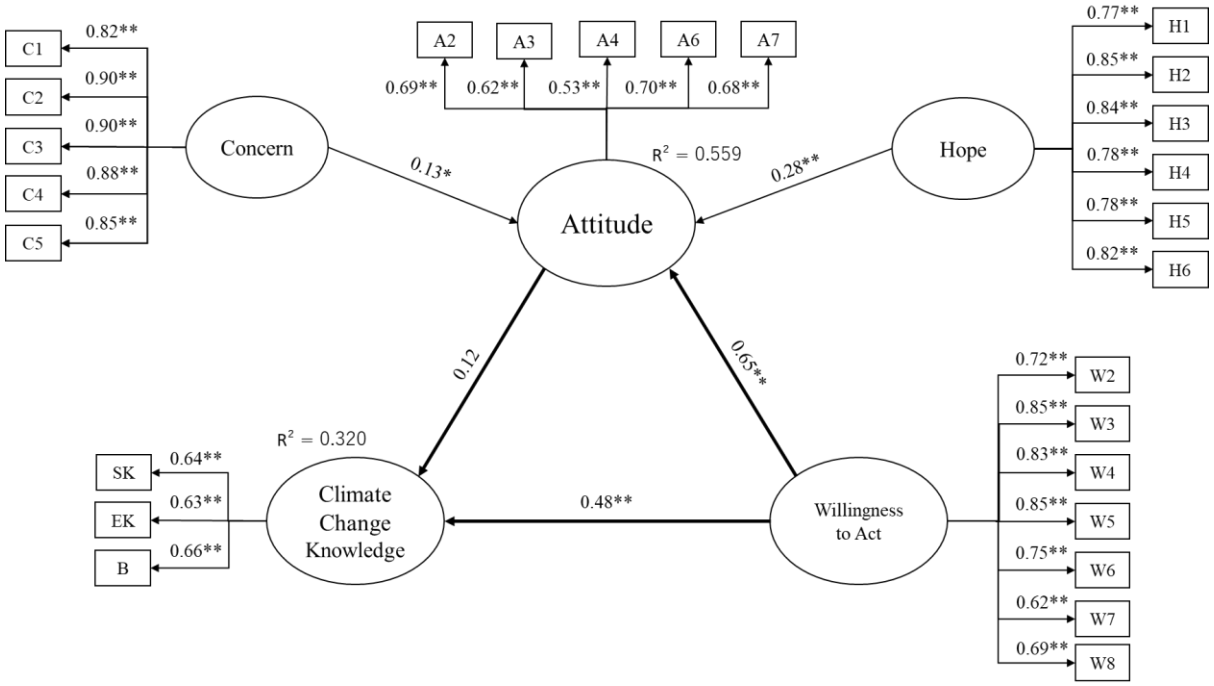
Note. ** p < .001; R^2 = Explained variance

Illustrated in Figure 30, model 2 (chi-square = 1306.230; df = 293; $p < 0.001$) considered K as the end destination of the model. All causal relationships were positive, and except for A→K, significant. W showed a remarkably large effect on A with .65 units and moderate effect on K with .48 units. However, the influence of A on K was not significant although positive. Compared to model 2, the effects of C and H on A were smaller. C's influence on A was

positive and significant but almost exceeded the small-effect threshold with .13 units. Whereas H moderately affected A with .28 units. W, H, and K explained 55.9% of the variance of A, which was considered as moderate explanatory power. Meanwhile, W and A accounted for 32% of the variance of K, which was considered as weak explanatory power just a little below moderate threshold level.

Figure 30

SEM model 2



Note. * p < 0.05; ** p < .001; R² = Explained variance

Next, the goodness-of-fit test was performed with the objective of evaluating how well the model reflects the observations (Weston & Gore, 2006). As shown in Table 16, seven indicators were tested to confirm the fitness of the model, namely Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), Adjusted Goodness of Fit Index (AGFI), relative chi-square (CMIN/DF), Root Mean Square Error of Approximation (RMSEA), Incremental Fit Index (IFI), and Normed Fit Index (NFI). GFI values should be greater than .9, while CFI values should be greater than .95 (Hu & Bentler, 1999). AGFI values of greater than .8, CMIN/DF

values of less than 3 (Moss et al., 2015), and RMSEA values of less than .08 (MacCallum et al., 1996) are required. Finally, IFI and NFI values should be greater than .9 (Hu & Bentler, 1999; Shadfar & Malekmohammadi, 2013). Both model 1 and model 2 met all the model fit requirements.

Table 16

Results of goodness of fit test

GOF measure	GFI	CFI	AGFI	CMIN/DF	RMSEA	IFI	NFI
Acceptable threshold	≥.9	≥.95	≥.8	≤0-3	≤.08	≥.9	≥.9
Model 1	.903	.960	.877	2.036	.050	.960	.925
Model 2	.903	.955	.877	2.213	.054	.955	.921
Conclusion	Good fit	Good fit	Good fit	Good fit	Good fit	Good fit	Good fit

4.7. Construct validity and reliability

The other assignment task working with SEM was to check the reliability and validity of the construct using confirmatory factor analysis. Reliability indicates the consistency of the results, while validity implies the accuracy of result interpretations (Karakaya-Ozyer & Aksu-Dunya, 2018). Reliability test can be performed by evaluating internal consistency and composite reliability of the construct. Meanwhile, validity test consists of two categories, namely convergent validity and discriminant validity. Table 17 shows the elements that are needed for reliability and validity test, such as factor loadings, average variance extracted (AVE) and composite reliability (CR) for each item, and Cronbach's alpha for each construct.

Table 17

SEM measurement results

Construct	α	Model 1			Model 2		
		Factor Loading	CR	AVE	Factor Loading	CR	AVE
Knowledge (K)	.673		.814	.563		.708	.413
SK: System knowledge		.702			.633		
EK: Effectiveness knowledge		.736			.637		
B: Beliefs		.809			.658		
Attitude (A)	.816		.792	.435		.781	.419
A2: Top priority		.710			.693		
A3: Annoyance at inaction		.630			.620		
A4: Depreciation of seriousness		.536			.525		
A6: Personal responsibility		.717			.704		
A7: Personal contribution		.689			.678		
Concern (C)	.940		.941	.760		.941	.760
C1: Climate change		.823			.823		
C2: Own life		.903			.903		
C3: Family life		.896			.896		
C4: People in Japan		.885			.886		
C5: Humankind		.849			.849		
Hope (H)	.918		.919	.655		.919	.655
H1: Experienced with complex issues		.769			.767		
H2: Increased awareness		.853			.853		
H3: Trust in research and technology		.840			.841		
H4: Trust in politicians		.783			.785		
H5: Behaviour change		.785			.785		
H6: Trust in personal ability		.823			.823		
Willingness to act (W)	.906		.897	.557		.907	.584
W2: Walking/biking		.696			.722		
W3: Saving energy		.829			.851		
W4: Consuming less		.813			.835		
W5: Reducing waste		.823			.846		
W6: Getting an education		.740			.747		
W7: Joining campaign/event		.615			.625		
W8: Pushing government		.682			.692		

Note. α = Cronbach's alpha; CR = Composite Reliability; AVE = Average Variance Extracted

4.7.1. Internal consistency and composite reliability

The first reliability test was to check the internal consistency of the constructs by evaluating their Cronbach's alpha. Therefore, Cronbach's alpha values for each construct were measured and listed in Table 17. The generally accepted values for Cronbach's alpha are between .6 and .7, and values of .8 or greater indicate a satisfactory level (Heale & Twycross, 2015; Ursachi et al., 2015). Values below the accepted threshold may be caused by "a low number of questions, poor interrelatedness between items or heterogeneous constructs" (Tavakol & Dennick, 2011, p. 54). However, values greater than .95 might indicate redundancy (Ursachi et al., 2015). In this study, Cronbach's alpha values of A, C, H, and W were satisfactory, while K's values were in acceptable level. The second reliability test was to measure CR for each construct through factor loading analysis. According to Hair et al. (2017), CR values greater than .7 suggest satisfactory level of internal consistency reliability. The CR values for all constructs exceeded the recommended level. Therefore, all constructs were admittedly established with satisfactory internal consistency reliability.

4.7.2. Convergent validity

Convergent validity is "the degree of confidence that a trait is well measured by its indicators" (Alarcón et al., 2015, p. 3). It is measured by evaluating AVE of each item that can be calculated from their factor loadings. According to Hair et al. (2017), AVE values greater than .5 suggest satisfactory convergence level of the constructs. However, Fornell and Larcker (1981) claim that when CR is greater than .6, AVE values less than .5 but higher than .4 still indicate an adequate convergent validity of the construct. As shown in Table 17, except for A in model 1, and K and A in model 2, AVE of all constructs were greater than .5. As the CR values of A in model 1 and 2, as well as K in model 2 exceeded .6, it could be concluded that all constructs were established with an acceptable level of convergent validity.

4.7.3. Discriminant validity

Discriminant validity is “the degree to which measures of different traits are unrelated” (Alarcón et al., 2015, p. 3). Discriminant validity assessment is needed to indicate whether the model have multicollinearity issues (Ab Hamid et al., 2017; Heale & Twycross, 2015). A model has multicollinearity issues when several constructs measuring different variables within the model are strongly correlated. To evaluate the discriminant validity of the model, the heterotrait-monotrait (HTMT) ratio of correlations approach was used (Henseler et al., 2015). HTMT ratio of correlations is “the average of the heterotrait-heteromethod correlations (i.e., the correlations of indicators across constructs measuring different phenomena), relative to the average of the monotrait-heteromethod correlations (i.e., the correlations of indicators within the same construct)” (p. 121). Compared to the traditional Fornell-Larcker criterion method, the HTMT approach has high sensitivity rate therefore detects the issues of discriminant validity more accurately and reliably.

According to Henseler and colleagues (2015), the strictest threshold is .85, and the liberal threshold is .9 for every HTMT criterion. Exceeding the threshold values means that there is a discriminant validity issue or multicollinearity issue. Table 18 shows the results of the HTMT. The strict threshold value of .85 was used in this study. All criterions were below the threshold value, meaning there is no discriminant validity issue detected in the model. Another way to detect multicollinearity issue is by looking at the correlations among constructs as shown in Table 19. The correlations problematic threshold value is .85 (Weston & Gore, 2006). Correlations higher than .85 might indicate multicollinearity between the two constructs. None of the correlations exceeded the threshold values. It could be concluded that the model passed discriminant validity test, and no multicollinearity issue detected.

Table 18

HTMT results

	Knowledge	Attitude	Concern	Hope	Willingness
Knowledge					
Attitude	.473				
Concern	.507	.551			
Hope	.279	.576	.512		
Willingness	.558	.789	.560	.553	

Table 19

Correlation matrix

Correlation			Estimate
Knowledge	↔	Attitude	.519
Knowledge	↔	Hope	.312
Hope	↔	Attitude	.588
Hope	↔	Willingness	.528
Concern	↔	Attitude	.542
Concern	↔	Knowledge	.539
Concern	↔	Hope	.512
Attitude	↔	Willingness	.775
Willingness	↔	Concern	.555
Willingness	↔	Knowledge	.606

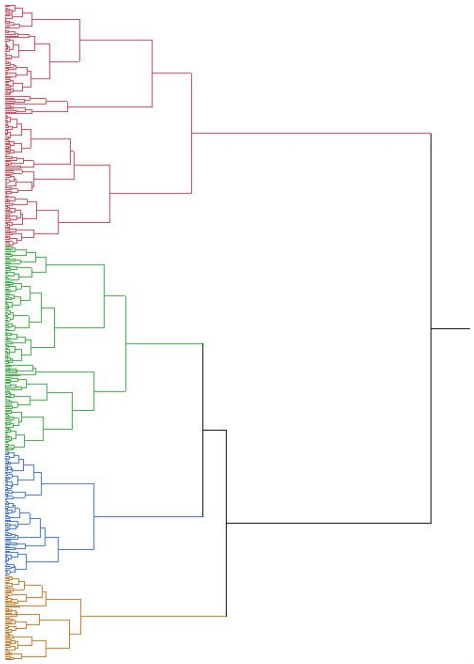
4.8. Cluster analysis

Cluster analysis was performed in the study to classify respondents based on their distinct profiles in terms of cognition, affect, and conation. Cluster analysis attempts to categorise objects into different clusters so that objects in the same cluster share maximum homogeneity while sharing maximum heterogeneity with objects in other clusters (Hair et al., 2010). Hierarchical cluster analysis using the Ward's method and squared Euclidean distance measures was conducted for cognitive, affective, and conative dimension that were calculated using the means of all variables predicting them (maximum value = 7). Figure 31 shows the dendrogram acquired from hierarchical cluster analysis from which the number of clusters was

decided. Differentiated by colours, four clusters were identified to be consistent. Cross-validation was performed to validate the cluster solution by randomly splitting the sample into two and checking whether the cluster solution of each sample share consistent number of clusters and characteristics (Hair et al., 2010).

Figure 31

Dendrogram of cluster analysis



Cluster 1 (N = 156, red) accounted for 37% of the population, made it the largest cluster. Out of the maximum values of 7, this group had cognition mean of 2.15, affect mean of 3.56, and conation mean of 2.32. Compared to other clusters, cluster 1 had relatively lower values for all indicators. Cluster 2 (N = 132, green), the second largest cluster, accounted for 31% of the total population. Compared to cluster 1, this cluster had slightly higher cognition with 2.28 and showed a remarkable increase in affect and conation with 5.22 and 4.01 respectively. Cluster 3 (N = 80, blue) represented 19% of the total respondents. This cluster had the highest cognition with 3.73 among all clusters. However, affect and conation were slightly lower than the ones in cluster 2, with 4.91 for affect and 3.54 for conation. Finally, the smallest group was

cluster 4 (N = 55, yellow), accounting for 13% of the entire population. It had the second highest cognition with 3.48 after cluster 3. Moreover, it had the highest mean for both affect and conation, with 5.94 and 5.80. Figure 32 and Figure 33 illustrates the four clusters and their positions in correlations with their indicators.

Figure 32

3D and 2D scatterplot of clusters

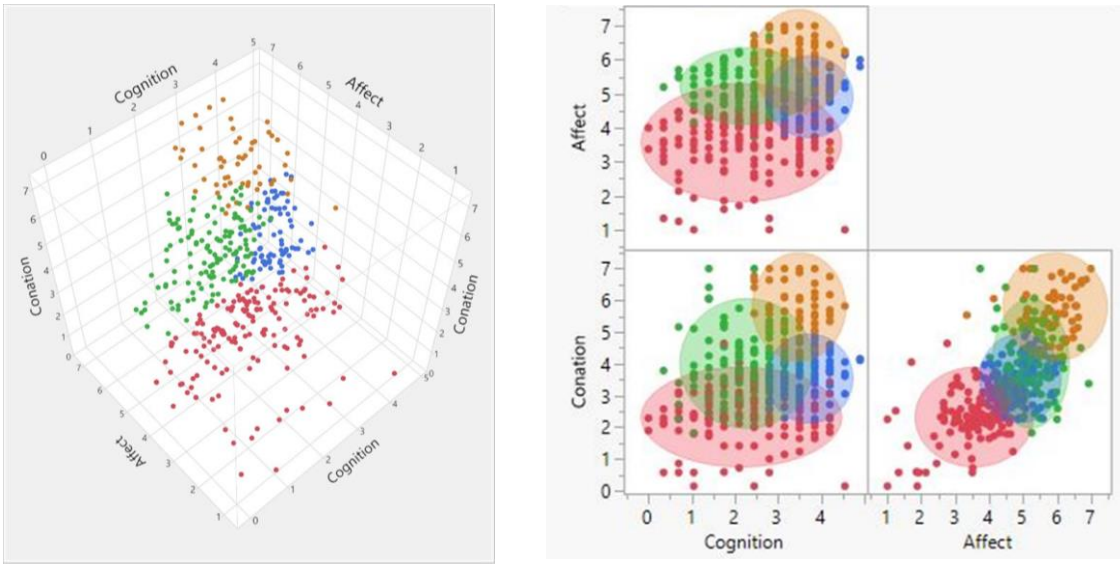
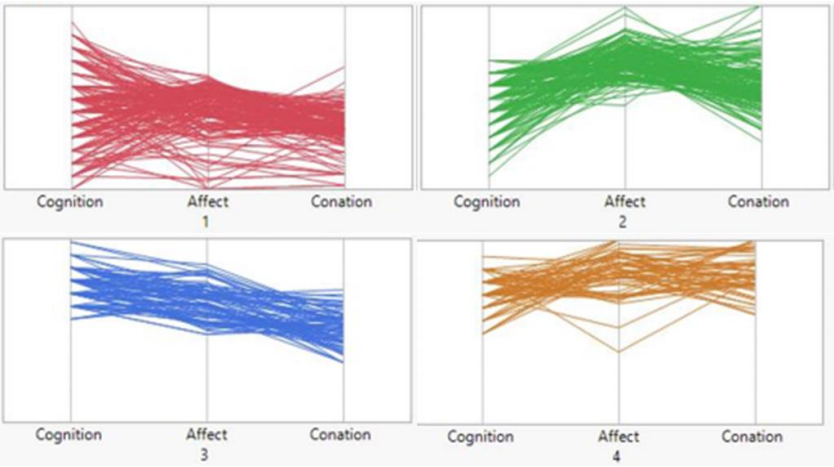


Figure 33

Parallel plot of clusters



CHAPTER 5

DISCUSSION AND IMPLICATIONS

This study, as an advocacy tool, attempts to contribute to improving climate change education in particular, and environmental education as well as Education for Sustainable Development in general by providing educators, educational institutions, and/or policy makers with insights about current cognitive, affective, and conative conditions of Japanese early adolescents in relation to climate change, that can be considered in the design of target-specific learning settings that comply with different preconditions of adolescents. In depth, this study attempts to identify trends and inconsistencies in Japanese early adolescents' knowledge about climate change, including investigating their scientific misconceptions about climate change. Second, this study aims to analyse cognitive, affective, and conative dimension and their correlations in relation to their conceptions of climate change's causes, impacts, and solutions. Finally, this study tries to examine different preconditions of early adolescents regarding climate change conceptions at the individual level, and how demographics affect the conceptions.

5.1. Trends and inconsistencies in knowledge of climate change

This study attempts to assess the level of knowledge of climate change possessed by Japanese early adolescents. The results identify unsatisfactory levels of knowledge of climate change in relation to its causes, impacts, and solutions among the respondents. The respondents got an average score of 38.05 out of 100 for climate change knowledge test, with only two people scored the highest score of 70. Moreover, their knowledge of climate change systems involving causes and impacts is slightly higher than knowledge about climate change solutions. For instance, reflected by their action and effectiveness knowledge test results, their

understanding of actions or technologies by which greenhouse gas emissions can be reduced or prevented seems to be limited. Nonetheless, approximately 86% of the respondents believe in the occurrence of climate change. That ranks Japan among the highest among the G7 countries: the United Kingdom and Italy with 86%, Canada, Germany, and France with 83%, and the United States of America with 75% (UNDP, 2021).

Furthermore, this study reveals a gap in the knowledge and some common misconceptions about climate change among Japanese early adolescents. In terms of system knowledge that involves their understanding of the mechanism of climate change, how it occurs, and what consequences it has, respondents seem to misinterpret that climate change is resulted by ozone layer becoming thinner. In terms of impacts of climate change on sea level rise, the results indicate that understanding of climate change-induced thermal expansion of water in seas and oceans is absent. These common scientific misconceptions are in line with the global trends (Leiserowitz et al., 2011; Monroe et al., 2017; Rebich & Gautier, 2005; Shepardson et al., 2011).

Regarding misconceptions about solutions of climate change, the results suggest that respondents appear to be unsure about mitigative impacts of certain actions and technologies. Actions such as “restoring tropical forests” and “household recycling” are thought to be effective to combat climate change although they should be the least effective ones on the list (Kirk, 2018). This insight supports Ichikawa (2016)’s conclusion on the three core subject matters in Japanese EE, namely beautification, flora and fauna, and recycling. On the other hands, respondents seem to disregard “family planning”, the option that is supposed to have the largest mitigative power on the list. Japan’s declining population might influence respondents’ understanding of this matter. This explains climate change as a *socio-scientific* issue (Stevenson et al., 2017) as opposed to pure scientific phenomenon. Socio-scientific issues do not only involve science and technology, but also implicate social and political situation

surrounding them, and often touch upon ethical and moral aspects (Monroe et al., 2017; Morris, 2014; Zeidler & Nichols, 2009).

In terms of knowledge sources, television (N = 305) is on the top, closely followed by school (N = 300) then internet (N = 248) and SNS (N = 112). This aligns with Aoyagi (2017)'s study on climate change communication that observes Japanese public's use of conventional mass media as a means of learning social issues, especially television's "news programmes, documentaries, and weather news" (p. 15). Moving onto formal education sector, the respondents seem to acquire some knowledge of climate change from science class or the period for integrated study (Glackin & Greer, 2021; Kodama, 2017; MEXT, n.d.). Moreover, the internet and SNS seem to be influential on how Japanese early adolescents acquired information about climate change. Aoyagi (2017) supports that Japanese younger people prefer using the internet and SNS to get information. Finally, family members and friends (N = 86) also seem to play a vital role of climate change knowledge sharing as younger Japanese tend to believe in "word of mouth" and information from significant others (Aoyagi, 2017, p. 5).

Nevertheless, the results suggest that climate change knowledge of surveyed Japanese early adolescents are limited and incomplete regardless of the knowledge sources from which the respondents acquired their knowledge. The most prevalent knowledge source, mass media such television, do not have the responsibility for communicating climate change to public, especially with its complex scientific mechanisms (Aoyagi, 2017). Moreover, although school seems to be an extremely vital knowledge source, they insufficiently provide a complete set of knowledge of climate change. This might be caused by the absence of CCE's definition and frameworks within Japanese formal education system (Takahashi et al., 2016). Considering their massive influence, schools need to educate students about what is climate change, how it occurs, and what impacts it brings to the natural and social systems (Swim et al., 2011). The equally critical action domain of climate change needs to be more encouraged to increase sense

of empowerment among learners (Selby & Kagawa, 2013; Trott, 2019; UNESCO, 2017b; 2022). Learners should be informed on what possible actions and solutions should be taken to mitigate and adapt to climate change, and which actions or solutions are more effective in a given situation (Bofferding & Kloser, 2015).

5.2. Tridimensionality of climate change conceptions

Although the cognitive, affective, and conative dimension are thought to be connected (Brosch, 2021; Hilgard, 1980; Militello et al., 2006), their relationships are complex and unclear (Dijkstra & Goedhart, 2012). In this study, the results of SEM indicate positive interrelationships to some extent among all variables under investigation in opposed to conventional theories that claim cognition and affect unidirectionally result in conation then behaviour (Ajzen, 1991; Hines et al., 1987). *Knowledge* (cognitive dimension) shows moderate influence on both *attitude* (affective dimension) and *willingness to act* (conative dimension). *Attitude* has strong effect on *willingness to act*. In reverse, *willingness to act* (conative dimension) has strong effect on *attitude* (affective dimension) and moderate effect on *knowledge* (cognitive dimension). However, a*ttitude* does not show significant influence on *knowledge*. Overall, this study has noticed the interrelationships between cognitive dimension and conative dimension, as well as between affective dimension and conative dimension. Meanwhile, cognitive dimension unidirectionally influence affective dimension.

The results emphasise the importance of all dimensions in CCE. Especially, the focus is given to the substantially powerful bidirectional relationships between *attitude* and *willingness to act*. Individuals with positive attitudes towards climate change would likely have the will or desire to take actions. Similarly, individuals with high willingness to act would likely to exhibit positive attitudes towards climate change. Moreover, the possession of *knowledge* might act as a driver for increasing *attitude* and *willingness to act*. Meanwhile, *willingness to act* shows

moderate—almost strong—effect on *knowledge*. People with high motivation to actively engage in climate actions might display eagerness to gain more knowledge of climate change.

Furthermore, within the affective dimension, *concern* and *hope* show moderate effects on *attitude*. However, *hope* exhibits higher effects on *attitude* compared to *concern*. Although concern is crucial in proving a sense of urgency towards the issue of climate change (Arikan & Günay, 2021; Borsch, 2021; Stevenson et al., 2014), it seems that working on nurturing hope among students might be more effective in developing positive attitudes towards climate change. This aligns with studies that have indicated positive influences of positive emotions on the forming of pro-environmental behavioural intentions (Williamson et al., 2018; Schneider et al., 2021; Zelenski & Desrochers, 2021). Consequently, the *doom and gloom* narratives in CCE, media coverage, citizen debates, climate policy and literature, that still prevail in the society, might be counterproductive (Hinkel et al., 2020). Alternatively, Tabara et al. (2018) proposed the *transformative narratives* that emphasised on hopeful positive messages, future vision, and solutions. Nonetheless, the balanced between concern and hope should be maintained to prevent the emergence of *hope based on denial* (Ojala, 2012).

Within conation dimension, more than half of respondents show willingness to take actions to combat climate change. They particularly exhibit willingness to take direct actions, such as walking or biking to places with reasonable distance, saving energy such water and electricity, and reducing waste. In contrast, there are actions that seem to be relatively unpopular among Japanese early adolescents. Using public transportation is not perceived to be effective in combating climate change, and the percentage of respondents who are willing to do it is low compared to other actions. Assumably, this is caused by the low frequency of public transportation use among respondents. In Japan, elementary and junior high school students usually walk or cycle to school daily, instead of being driven by their parents or using public transportation (Mori et al., 2012). In most of municipalities, elementary schools are

usually located within 2–4 kilometres from home, and the range is 3–6 kilometres for junior high schools.

In addition, respondents seem reluctant to take actions that are related to political activities, such as "joining climate action campaign" and "pushing government to take bolder climate action". This is not surprising as youth activism and protests are rare occurrences in the country (Rauner, 2020). This political passiveness has something to do with Japanese cultural context (Kotani, 2003). Today's Japanese young people seem to be satisfied with the current condition in the society, or reluctant to challenge status quo despite dissatisfaction. There is commonly held concept of *shikataganai* or *shōganai* that means "it cannot be helped" in the society. Also, people try not to stand out from the rest and cause inconvenience to others. Moreover, protest in Japan is often delegitimised and even labelled as anti-social behaviour by the government (Mesimäki, 2019; Prendergast et al., 2021). This, therefore, has demotivated even more youth political activism in the country.

5.3. Preconditions of Japanese early adolescents

The results of cluster analysis in this study suggest that there are four groups of Japanese early adolescents characterised by their conceptions of climate change within the three dimensions. These groups represent different preconditions of Japanese early adolescents associated with climate change conceptions. Meaningful effect of demographic variables on the overall conceptions was not identified. Inspired by Kuthe et al.'s (2019) study, the first cluster was named the "Apathetic", the second cluster was named the "Confused", the third cluster was named the "Promising", and the fourth cluster was named the "Advocate".

Cluster 1, the **Apathetic**, have heard of climate change and are somewhat concerned about climate change and its consequences, but not up to the level in which they are pressured to care and learn more about it. Initially, they do not have sufficient knowledge of climate change in relation to its impacts, consequences, and solutions. In addition, their willingness to

do something about it is minimal. It is assumed that they may have something else to focus on in their everyday lives that are perceived to be more urgent than climate change (Rudiak-Gould, 2013; Wullenkord & Reese, 2021). This group do not show much interest in climate change. Therefore, art-based learning can be selected as a start to develop interest through a creative process that can expand their imagination and deepen emotional engagement with climate change (Bentz, 2020; Jacobson et al., 2016; Lehtonen et al., 2018).

The second cluster, the **Confused**, are significantly concerned but hopeful about climate change at the same time. They also exhibit prominent level of attitude towards the issue. In terms of willingness to act, they do not mind putting more effort so that they can contribute to mitigating and adapting to climate change. However, this group do not possess much understanding of climate change. They might have heard of climate change from television or school and believe in its occurrence, but their knowledge might be either limited or disjointed (Aoyagi, 2017). Although they have high socio-emotional engagement with the issue and want to do something about it up to a certain level, they seem to be unsure about the set of actions they can take. That is why they have been named the Confused. Consequently, learning that focuses on action knowledge and effectiveness knowledge might be suitable for this group (Frick et al., 2004).

The third cluster, the **Promising**, have moderate understanding of climate change in relation to its causes, impacts, and solutions. Compared to other groups, this group have the highest level of cognition, indicating them as the most informed individuals in the population. Although not as high as cluster 2, they also show a certain level of emotional engagement with the issue. In terms of conation level, despite slightly lower compared to the previous group, they do not mind tolerating a bit of discomfort from taking actions for combating climate change, especially direct actions that are close to their everyday lives. This group seem to have a good starting point to achieve better level of cognition, affect, and conation. Hence, they have

been named the Promising. Phenomena-based collaborative learning that focuses on their local communities might suit this group (Lehtonen et al., 2018; Selby & Kagawa, 2013). By the holistic and interdisciplinary nature of phenomena-based learning, they would be able to meaningfully connect knowledge and reality (Monroe et al., 2017), therefore, improve their emotional and motivational levels in addition to cognitive learning.

The final cluster, the **Advocate**, consist of individuals with outstandingly high level of affect and conation. They display deep socio-emotional engagement with climate change through concerns, hope and attitude. They are worried about the impact of climate change on humanity as a whole, not only on themselves and their significant others (Kuthe et al., 2019; Stevenson et al., 2016). However, they are also hopeful that humanity can overcome this global issue through behaviour change, political and technological solutions (Ojala, 2012). Furthermore, this group show desire to behave in a climate-friendly manner. However, their level of knowledge is not up to the standard of their levels of affect and conation. Therefore, providing them with extensive and complete knowledge of climate change might be pivotal in nurturing their potential to become climate leaders and role models (Kuthe et al., 2019).

Almost 70% of respondents belong to the Apathetic and the Confused, and only 13% belong to the Advocate. The results can be considered from the perspective of worldviews (Lee et al., 2020; Stevenson et al., 2014). Kahan (2012) compiled two cultural cognition scales that can be used to measure worldviews—one was hierarchical-egalitarianism, and another was individualism-communitarianism. The former one involves power distance and how individuals accept the unequal distribution of power. The latter one encompasses individuals' orientation towards interdependency among members in the society (Hofstede, 2001). Compared to hierarchical individualists, egalitarian communitarian people are found to better perceive the seriousness of climate change risk (Stevenson et al., 2014) and show higher level of willingness to act (Lee et al., 2020). Individualists tend to dismiss climate change risk to

maintain their freedom of individual choices. Meanwhile, hierarchists would do the same to protect societal elites from condemnation (Kahan, 2012; Stevenson et al., 2014).

Overall, Japan is considered hierarchical and borderline collectivist society (Hofstede, 2001). Although not as hierarchical as other Asian countries, such as Malaysia or Indonesia, Japanese are always attentive towards their hierarchical position in any social circumstances and behave accordingly. Furthermore, Hofstede also labelled Japan as a borderline collectivistic society. Compared to its neighbouring countries—China and South Korea—Japan is not as collectivistic. Nevertheless, Japan is considered as a collectivistic society by Western standards. However, Sugimura (2020) indicates an increase in number of Japanese adolescents and young adults who adopt individualism, although collectivism that has been preserved for centuries still exists. The change from collectivistic society to more individualistic one can be witnessed as early as the 1960s. Japanese young people has become more comfortable with their own private life, and more appreciative of individual uniqueness. These worldviews might influence the results acquired from the analysis where only few respondents have satisfactory levels of cognition, affect, and conation associated with climate change.

In terms of sex's influence on the investigated variables, the results suggest there is no statistically significant difference made by sex on Japanese early adolescents' conceptions of climate change. In other words, their conceptions of climate change do not revolve around whether they are male or female. Nonetheless, several studies have indicated sex's influence on one's climate change conceptions and pro-environmental behaviour in general. McCright (2010) discovered that females displayed slightly higher levels of both knowledge and concern related to climate change, while Boyes and Stanisstreet (2012) claimed that females were more prepared to take environmentally friendly actions. Moreover, Kuthe et al. (2019) concluded

that males had the tendency to belong in more extreme classifications, either having very high or very low levels of climate change knowledge and concern.

5.4. Theoretical and practical implications

This study has been one of the first attempts to thoroughly examine conceptions of climate change among Japanese early adolescents that has not been investigated. Although similar studies have been done in many other countries—mainly European countries and the US—investigating a socio-scientific issue, studies about climate change should consider a specific social and cultural context (Monroe et al., 2017; Morris, 2014; Stevenson et al., 2017; Zeidler & Nichols, 2009). Therefore, studies in other countries might not be able to represent the unique Japanese characteristics of climate change conceptions. Additionally, previous studies on Japanese conceptions of climate change primarily focused on adults (Ohe & Ikeda, 2005; Shirai et al., 2014; Shirai et al., 2015). It is also imperative to understand the conceptions possessed by early adolescents, the future leaders, educators, and role models of sustainability.

As there is a distinct over-emphasis on cognitive dimension in studies about CCE globally (McKenzie, 2021; UNESCO, 2019), this study does not only focus on cognitive dimension, but also investigates on affective/socio-emotional and conative/behavioural dimension surrounding Japanese early adolescents' conceptions of climate change. The relationships among learning dimensions are also discussed in this study. The findings of this investigation complement those of earlier studies that claimed forming behaviour is influenced by cognitive and affective aspects (Ajzen, 1991; Hines et al., 1987). However, this study has also indicated that the relationships among the predictors of behaviour classified into cognitive, affect, and conation are not unidirectional and linear, supporting the claims made by Dijkstra & Goedhart (2012). The relationships between the tripartite classifications of mind are indeed complex and nonlinear.

More than just the scientific community, the findings of this study are significant to policy makers, as well as schools and educators. First, this study can be used as an advocacy tool that nudges policy makers to start paying more attention to defining, designing, and implementing CCE into the Japanese formal education where concept of CCE is still absent or inadequate (Takahashi et al., 2016). Alongside the future projections of more atrocious climate change consequences in the near future, the unsatisfactory levels of conceptions, especially knowledge, possessed by majority of the surveyed Japanese early adolescents indicate the urgency of CCE implementation in the country.

Second, this study also relevant to schools and educators as it provides insights on different preconditions of Japanese early adolescents in relation to their conceptions of climate change that can be used in the design of target-specific learning settings, complying to the recommended learner-centred approach (Selby & Kagawa, 2013; UNESCO, 2017b). The preconditions are categorised into groups based on their characteristics and how they can be addressed through suggestions of relevant CCE practices. Overall, to make CCE more impactful, there are several expectations that need to be met. First, CCE should touch upon cognitive, socio-emotional, and behavioural learning dimensions (UNESCO, 2020). Second, learning processes should nurture the key competencies for sustainability, such as systems thinking, collaboration, critical thinking, and integrated problem-solving competency (UNESCO, 2017b). Third, CCE should incorporate recommended pedagogical approaches: learner-centred approach, action-oriented learning, and transformative learning (UNESCO, 2017b). Finally, the practices of CCE should be personally significant for learners and maximising learners' engagement (Monroe et al., 2017) through, for instance, art-based learning and phenomena-based learning (Bentz, 2020; Lehtonen et al., 2018).

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The main purpose of the current study is to assess conceptions of climate change among Japanese early adolescents. The results indicate the existence of common misconceptions about climate change that are in line with the global trends found by previous studies, such as thermal expansion concept's absence and ozone layer depletion's causing climate change. However, Japanese early adolescents also exhibit a unique misconception about downplaying the role of "family planning" in mitigating climate change. This is understandable because the country is facing ageing and declining population, and it might deeply influence their understanding of the issue. Nonetheless, majority of the Japanese early adolescents do not have much knowledge about climate change and its causes, impacts, and solutions although exhibiting prominent levels of beliefs in the occurrence of climate change. Television, school, and the internet are the top sources of climate change related knowledge. However, the knowledge acquired from those sources seems to be incomplete and disjointed.

Furthermore, the conceptions investigated in this study did not only involve cognitive dimension, but socio-emotional or affective and behavioural or conative dimensions were also included. Socio-emotional dimension involves attitude towards climate change that is influenced by concern about climate change and hope for climate change resolutions. Although around 60% of the Japanese early adolescents show positive attitudes and deep concerns, less than half show hopefulness for climate change resolutions. From SEM results, it can be concluded that improving levels of hope might be crucial to improve their attitudes as hope shows larger influence on attitude than concern. In terms of conation dimension, more than 55% show willingness to take actions for climate change mitigation and adaptation, especially

actions that are perceived to be relevant to their everyday lives, including walking or cycling, saving water and electricity, and reducing waste. However, indirect actions that contain political elements, such as joining climate action campaigns and pushing government to take bolder climate action are not too popular. These dimensions are found to be correlated in a non-linear and bidirectional manner.

Based on the characteristics of climate change conceptions measured by the three dimensions, four clusters of Japanese early adolescents have been formed: the Apathetic, the Confused, the Promising, and the Advocate. The Apathetic, the largest group, consist of individuals with comparatively low levels of cognition, affect, and conation. The Confused, the second largest group, exhibit moderate levels of affect and conation but low levels of cognition. The Promising show moderate cognition, affect, and conation. Lastly, the Advocate, the smallest group, comprise of individuals with moderate cognition, and very high levels of affect and conation. Almost 70% belong to the Apathetic and the Confused. Overall, this indicates that there are diverse types of early adolescents that have distinctive characteristics and needs. These needs cannot be overlooked by CCE, and appropriate learning materials and methods should be tailored based on these preconditions.

The study aims to bring to light how Japanese early adolescents understand the concept of climate change including its causes, impacts, and solutions through the perspective of cognitive, affective, and conative dimensions. The results are expected to provide schools and educators insights on different preconditions of Japanese early adolescents in relation to their conceptions of climate change that can be used in the design of target-specific learning settings. Explanations on the expectations of CCE altogether with its key competencies, pedagogical approaches, and suggested teaching methods have also been covered. Moreover, this study also acts as an advocacy tool to inform policy makers about the urgency of CCE implementation in

Japanese context and encourage them to start defining, (re)designing, and incorporating CCE into Japanese formal education.

Resolutions to climate change tend to involve mitigation and adaptation strategies that do not only concern economic, technological, and political transformation (Bokova, 2012), but also require people that are well-informed to ensure their successful implementation (Cordero et al., 2020; Stevenson et al., 2014). Greater attention and efforts should be focused on young people, the adolescents, who will encounter the grand consequences of climate change. As future leaders, educators, policy makers, consumers, and citizens, young people will have to make informed decisions about climate change both today and in the future (Leiserowitz et al., 2011). Consequently, education's crucial role in preparing humanity for the consequences and uncertainties of climate change cannot be dismissed. CCE plays a vital role in increasing capacity of communities for climate change mitigation and adaptation. However, the very first step to designing CCE is to understand the preconditions of the learning subjects to maximise learning outcomes.

6.2. Research limitations

Several possible limitations in this study need to be acknowledged. First, the sample size might not be able to represent the phenomenon for the whole Japan or even the phenomena happening in Japanese metropolitan area and countryside area. The coronavirus pandemic was also preventing us from finding more schools to participate in the study. However, following Taherdoost (2017)'s method, it can be said that the sample size of this study sufficiently provides an exploratory insight about the issue under investigation. Moreover, the method utilised in the study can be used to further analyse conceptions of climate change among broader audience of Japanese young people, or even young people outside Japan.

The other limitation concerns the methodology of the study. Conducting in-depth interviews with the respondents was initially planned to analyse the influence of socio-cultural

elements on the results. However, the COVID-19 pandemic has hindered a direct visit to the participating schools to conduct those interviews on site. The plan was changed to online interviews, although it could not be realised due to technical complications and strict privacy policy of Japanese schools. According to the principals of schools in contact, students did not seem to be able to use online communication platform, such as Zoom, and had several complications, for instance, inability to create an account. Therefore, this study could not identify the correlation between respondents' conceptions of climate change and their socio-cultural backgrounds as intended.

6.3. Recommendation for future studies

In response to the limitations mentioned above, further studies could conduct similar research targeting a broader audience within Japan, or even outside the country, to improve representativeness of the results. It would be interesting to investigate how adolescents in different schools, cities, or regions understand the concept of climate change. Furthermore, studies on high school level might provide unique comparative insights on the characteristics of climate change conceptions possessed by junior high school—early adolescents—and high school students—late adolescents—considering age difference that may have an impact on development and learning processes in terms of quality and quantity.

Another recommendation would be incorporating socio-cultural backgrounds into further studies. It is unfortunate that the current study could not investigate the effect of socio-cultural backgrounds of respondents on their conceptions of climate change as initially planned. Social and cultural elements, such as religion and beliefs, economic level, past experience, local custom, family background, might have effect on an individual's understanding of climate change. Moreover, considering personality factors and external factors in future studies might be pivotal in investigating how young people adopt their understanding of climate change in a complete manner, although it would be extremely challenging to carry out such research.

Accordingly, further research should be undertaken to explore factors that determine an individual's membership in a specific climate change conception cluster.

REFERENCES

Aarnio-Linnanvuori, E. (2013). Environmental Issues in Finnish School Textbooks on Religious Education and Ethics. *Nordidactica*, *1*, 131–157. https://helda.helsinki.fi/bitstream/handle/10138/313880/FULLTEXT02.pdf?sequence=1

Ab Hamid, M. R., Sami, W., & Sidek, M. M. (2017). Discriminant validity assessment: Use of Fornell & Larcker criterion versus HTMT criterion. In *Journal of Physics: Conference Series*, *890*(1), 012163.

Aitken, C., Chapman, R., & McClure, J. (2011). Climate change, powerlessness and the Commons dilemma: Assessing New Zealanders' preparedness to act. *Global Environmental Change*, *21*(2), 752–760. https://doi.org/10.1016/j.gloenvcha.2011.01.002

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50*(2), 179–211.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology and Health*, *26*(9), 1113–1127.

Alarcón, D., Sánchez, J. A., & De Olavide, U. (2015, October). Assessing convergent and discriminant validity in the ADHD-R IV rating scale: User-written commands for Average Variance Extracted (AVE), Composite Reliability (CR), and Heterotrait-Monotrait ratio of correlations (HTMT). In *Spanish STATA meeting* (Vol. 39).

Alavi, M., Visentin, D. C., Thapa, D. K., Hunt, G. E., Watson, R., & Cleary, M. (2020). Exploratory factor analysis and principal component analysis in clinical studies: Which one should you use. *Journal of Advanced Nursing*, *76*(8), 1886–1889. https://onlinelibrary.wiley.com/doi/pdf/10.1111/jan.14377

American Psychological Association. (n.d.). *Conation*. https://dictionary.apa.org/conation

Anderson, A. (2012). Climate Change Education for mitigation and adaptation. *Journal of Education for Sustainable Development*, *6*(2), 191–206. https://doi.org/10.1177/0973408212475199

Ando, T., & Noda, M. (2017). Non-formal environmental education in Japan. *Japanese Journal of Environmental Education*, *26*(4), 4_39–44. https://doi.org/10.5647/jsoee.26.4_39

Aoyagi, M. (2017). Climate change communication in Japan. In *Oxford research encyclopaedia of climate science*.

Arbuckle, J. L. (2012). IBM SPSS Amos 21 user's guide. *Amos Development Corporation, SPSS Inc*. https://www.sussex.ac.uk/its/pdfs/Amos_20_User_Guide.pdf

Arikan, G., & Günay, D. (2021). Public attitudes towards climate change: A cross-country analysis. *The British Journal of Politics and International Relations*, *23*(1), 158–174.

Axelrod, R. (1973). Schema theory: An information processing model of perception and cognition. *American Political Science Review*, *67*(4), 1248-1266.

Babakr, Z. H., Mohamedamin, P., & Kakamad, K. (2019). Piaget's cognitive developmental theory: Critical review. *Education Quarterly Reviews*, *2*(3). https://doi.org/10.31014/aior.1993.02.03.84

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of environmental psychology*, *27*(1), 14–25.

Barber, J. S. (2011). The theory of planned behaviour: Considering drives, proximity and dynamics. *Vienna Yearbook of Population Research*, *9*(1), 31–35. https://doi.org/10.1553/populationyearbook2011s31

Bell, B. T., Toth, N., Little, L., & Smith, M. A. (2016). Planning to save the planet: Using an online intervention based on implementation intentions to change adolescent self-reported energy-saving behaviour. *Environment and Behaviour*, *48*, 1049-1072.

Bentz, J. (2020). Learning about climate change in, with and through art. *Climatic Change*, *162*(3), 1595–1612. https://doi.org/10.1007/s10584-020-02804-4

Boakye, C. (2015). Climate change education: The role of pre-tertiary science curricula in Ghana. *SAGE Open*, *5*(4), 215824401561461. https://doi.org/10.1177/2158244015614611

Bofferding, L., & Kloser, M. (2015). Middle and high school students' conceptions of climate change mitigation and adaptation strategies. *Environmental Education Research*, *21*(2), 275–294.

Bokova, I. (2012). *Opening Address by Irina Bokova, Director-General of UNESCO, on the occasion of the Educating for a sustainable future, Rio+20 side-event; RioCentro, Rio de Janeiro, Brazil, 21 June 2012*. https://unesdoc.unesco.org/ark:/48223/pf0000216708

Boyes, E., & Stanisstreet, M. (2012). Environmental education for behaviour change: Which actions should be targeted? *International Journal of Science Education*, *34*(10), 1591–1614.

Brosch, T. (2021). Affect and emotions as drivers of climate change perception and action: A review. *Current Opinion in Behavioural Sciences*, *42*, 15–21. https://doi.org/10.1016/j.cobeha.2021.02.001

Brown, J. D. (2009). Choosing the right type of rotation in PCA and EFA. *JALT testing & evaluation SIG newsletter*, *13*(3), 20–25. https://hosted.jalt.org/test/PDF/Brown31.pdf

Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1956). *A study of thinking*. John Wiley & Sons.

Brunk, C. G. (2006). Public knowledge, public trust: understanding the 'knowledge deficit'. *Public Health Genomics*, *9*(3), 178–183. https://www.jstor.org/stable/26679527

Burgess, J., Harrison, C. M., & Filius, P. (1998). Environmental communication and the cultural politics of environmental citizenship. Environment & Planning A, 30(8), 1445–1460. https://doi.org/10.1068/a301445

Buttel, F. H. (1992). Environmentalization: Origins, processes, and implications for rural social change. *Rural Sociology*, *57*(1), 1–27. https://doi.org/10.1111/j.1549-0831.1992.tb00454.x

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., & Upham, P. (2015). International trends in public perceptions of climate change over the past quarter century. *WIREs Climate Change*, *6*(1), 35–61.

Chang. C. H., & Pascua, L. (2016). Singapore students' misconceptions of climate change. *International Research in Geographical and Environmental Education*, *25*(1), 84–96. http://dx.doi.org/10.1080/10382046.2015.1106206

Chi, M. T., & Roscoe, R. D. (2002). The processes and challenges of conceptual change. In *Reconsidering conceptual change: Issues in theory and practice* (pp. 3–27). Springer, Dordrecht.

Chin, W. W. (1998). The partial least squares approach to structural equation modelling. *Modern Methods for Business Research*, *295*(2), 295–336.

City of Oita. (June 1, 2021). *Kankyō kyōiku fukudokuhon `watashi-tachi to kankyō' o sakusei shimashita!* [We have created supplementary reading for environmental education, "We and the Environment"!]. http://www.city.oita.oita.jp/o141/machizukuri/kankyo/1475193271329.html

Clayton, S. (2020). Climate anxiety: Psychological responses to climate change. *Journal of Anxiety Disorders*, *74*, 102263. https://doi.org/10.1016/j.janxdis.2020.102263

Clayton, S., & Karazsia, B. T. (2020). Development and validation of a measure of climate change anxiety. *Journal of Environmental Psychology*, *69*, 101434. https://doi.org/10.1016/j.jenvp.2020.101434

Climate Central. (2021). *IPCC 6th Assessment Report - The Physical Science Basis*. https://www.climatecentral.org/climate-matters/ipcc-6th-assessment-report-the-physical-science-basis

Cordero, E. C., Centeno, D., & Todd, A. M. (2020). The role of climate change education on individual lifetime carbon emissions. *PLOS ONE*, *15*(2), 0206266. https://doi.org/10.1371/journal.pone.0206266

Centre for Curriculum, National Institute for Educational Policy Research. (2014). *Kankyōkyōiku shidō shiryō (Yōchien/Shōgakkō hen)* [Teacher's Guide for

Environmental Education (Kindergarten/Elementary school edition)]. https://www.nier.go.jp/kaihatsu/pdf/kankyo_k_n_e.pdf

Centre for Curriculum, National Institute for Educational Policy Research. (2016). *Kankyōkyōiku shidō shiryō (Chūgakkō hen)* [Teacher's Guide for Environmental Education (Junior high school edition)]. https://www.nier.go.jp/kaihatsu/pdf/20161214.pdf

Deisenrieder, V., Kubisch, S., Keller, L., & Stötter, J. (2020). Bridging the action gap by democratizing climate: The case of k.i.d.Z.21 in the context of Fridays for Future. *Sustainability*, *12*(5), 1–19. https://doi.org/10.3390/su12051748

Dijkstra, E. M., & Goedhart, M. J. (2012). Development and validation of the ACSI: Measuring students' science attitudes, pro-environmental behaviour, climate change attitudes and knowledge. *Environmental Education Research*, *18*(6), 733–749.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Harcourt Brace Jovanovich College Publishers.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39–50.

Fortner, R. W., Lee, J. Y., Corney, J. R., Romanello, S., Bonnell, J., Luthy, B., ... & Ntsiko, N. (2000). Public understanding of climate change: Certainty and willingness to act. *Environmental Education Research*, *6*(2), 127–141.

Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behaviour: exploring prevalence and structure in a representative sample. *Personality and Individual Differences*, *37*(8), 1597–1613.

Gazzaz, N. M., & Aldeseet, B. A. (2021). Assessment of the level of knowledge of climate change of undergraduate science and agriculture students. *World Journal of Education*, *11*(5), 41. https://doi.org/10.5430/wje.v11n5p41

Gifford, R., & Comeau, L. (2011). Message framing influences perceived climate change competence, engagement, and behavioural intentions. *Global Environmental Change*, *21*, 1301–1307.

Gifford, R., Kormos, C., & McIntyre, A. (2011). Behavioural dimensions of climate change: drivers, responses, barriers, and interventions. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(6), 801–827.

Glackin, M., & Greer, K. (2021). Environmental education-related policy enactment in Japanese high schools. *Journal of Education for Sustainable Development*, *15*(2), 165–185. https://doi.org/10.1177/09734082211031325

Global Centre of Adaptation. (2019). *12 great examples of how countries are adapting to climate change*. https://gca.org/12-great-examples-of-how-countries-are-adapting-to-climate-change/

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis. A global perspective (7th ed.)*. Pearson Prentice Hall.

Hair, J. F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. *International Journal of Multivariate Data Analysis*, *1*(2), 107–123.

Harker-Schuch, I. (2019). Why is early adolescence so pivotal in the climate change communication and education arena?. In *Climate change and the role of education* (pp. 279–290). Springer.

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-based nursing*, *18*(3), 66–67.

Hennig, C., Meila, M., Murtagh, F., & Rocci, R. (Eds.). (2015). *Handbook of cluster analysis*. CRC Press.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modelling. *Journal of the academy of marketing science*, *43*(1), 115-135.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behaviour: A meta-analysis. *Journal of Environmental Education*, *18*(2), pp.1–8.

Hinkel, J., Mangalagiu, D., Bisaro, A., & Tàbara, J. D. (2020). Transformative narratives for climate action. *Climatic Change*, *160*(4), 495–506. https://doi.org/10.1007/s10584-020-02761-y

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviours, institutions and organizations across nations*. Sage publications.

Hu, J., Tang, K., Qian, X., Sun, F., & Zhou, W. (2021). Behavioural change in waste separation at source in an international community: An application of the theory of planned behaviour. *Waste Management*, *135*, 397–408.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1–55.

Ichikawa, S. (2016). Zenkokuchōsa ni miru shō/chūgakkō no kankyōkyōiku no genjō to henka: 2014 nendo chōsa wo chūshin to shite [Current situation and changes in environmental education in elementary/junior high schools as seen in nationwide survey: Based on 2014 survey]. *Shiga daigaku kyōiku gakubu kiyō*, *65*, 129-140. https://shiga-u.repo.nii.ac.jp/?action=repository_uri&item_id=1842&file_id=19&file_no=1

Imamura, M. (2017). Beyond the limitations of environmental education in Japan. *Educational Studies in Japan*, *11*(0), 3–14. https://doi.org/10.7571/esjkyoiku.11.3

Indonesia Ministry of Environment and Forestry of Indonesia. (2021, March 21). *Internalisasi Perubahan Iklim dalam Kurikulum Pendidikan*. https://www.menlhk.go.id/site/single_post/3729/internalisasi-perubahan-iklim-dalam-kurikulum-pendidikan

Intergovernmental Panel on Climate Change. (n.d.). *Headline statements*. https://www.ipcc.ch/sr15/resources/headline-statements/

Intergovernmental Panel on Climate Change. (2021). Summary for policymakers. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. 10.1017/9781009157896.001.

International Business Machines. (2021a). *K-means clustering*. https://www.ibm.com/docs/en/db2woc?topic=procedures-k-means-clustering

International Business Machines. (2021b). *KMO and Bartlett's Test*. https://www.ibm.com/docs/en/spss-statistics/27.0.0?topic=detection-kmo-bartletts-test

Jacobson, S. K., Seavey, J. R., & Mueller, R. C. (2016). Integrated science and art education for creative climate change communication. *Ecology and Society*, *21*(3). https://doi.org/10.5751/es-08626-210330

Kagawa, F., & Selby, D. (Eds.). (2010). *Education and climate change: Living and learning in interesting times*. Routledge.

Kahan, D. M. (2012). Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin, & M. Peterson (Eds.), *Handbook of Risk Theory: Epistemology, Decision Theory, Ethics, and Social Implications of Risk* (pp. 725–760). Springer.

Kaiser, F. G., Roczen, N., & Bogner, F. X. (2008). Competence formation in environmental education: Advancing ecology-specific rather than general abilities. *Umweltpsychologie*, *12*(2), 56–70.

Karakaya-Ozyer, K., & Aksu-Dunya, B. (2018). A Review of Structural Equation Modeling Applications in Turkish Educational Science Literature, 2010-2015. *International Journal of Research in Education and Science*, *4*(1), 279–291.

Kashiwa City. (2021, February 26). *Daisanki Kashiwashi chikyūondankataisaku keikaku*. https://www.city.kashiwa.lg.jp/kankyoseisaku/shiseijoho/keikaku/sonota/4714.html

Kilinc, A., Stanisstreet, M., & Boyes, E. (2008). Turkish students' ideas about global warming. *International Journal of Environmental and Science Education*, *3*(2), 89–98.

Kim, T. K. (2017). Understanding one-way ANOVA using conceptual figures. *Korean journal of anesthesiology*, *70*(1), 22–26.

Kirk, K. (2018). Solutions to climate change. Climate Literacy and Energy Awareness Network. https://cleanet.org/details/images/188832.html

Kitamura, Y. (2017). Education for Sustainable Development (ESD) in Asia. In *Oxford Research Encyclopaedia of Education*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.12

Kodama, T. (2017). Environmental education in formal education in Japan. *Japanese Journal of Environmental Education*, *26*(4), 4_21–26. https://doi.org/10.5647/jsoee.26.4_21

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behaviour?. *Environmental education research*, *8*(3), 239–260.

Kotani, S. (2003). Why are Japanese youth today so passive?. In G. Mathews & B. White (Eds.), *Japan's changing generations*. Routledge.

Kuthe, A., Keller, L., Körfgen, A., Stötter, H., Oberrauch, A., & Höferl, K.-M. (2019). How many young generations are there? – A typology of teenagers' climate change awareness in Germany and Austria. The Journal of Environmental Education, 50(3), 172–182. https://doi.org/10.1080/00958964.2019.1598927

Kyushu x Tokyo. (n.d.). *The glint of lights on the water*. https://www.kyushuandtokyo.org/route_3/

LaMorte, W. W. (2019). *The Theory of Planned Behaviour*. https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html

Lee, K., Gjersoe, N., O'Neill, S., & Barnett, J. (2020). Youth perceptions of climate change: A narrative synthesis. *WIREs Climate Change*, *11*(3). https://doi.org/10.1002/wcc.641

Lehtonen, A., Salonen, A. O., & Cantell, H. (2018). Climate Change Education: A New Approach for a World of Wicked Problems. In Sustainability, Human Well-Being, and the Future of Education (pp. 339–374). Springer International Publishing. https://doi.org/10.1007/978-3-319-78580-6_11

Leiserowitz, A., Smith, N., & Marlon, J. R. (2011). American teens' knowledge of climate change. *Yale University. New Haven, CT: Yale project on climate change communication*, *5*. http://environment.yale.edu/uploads/american-teens-knowledge-of-climate-change.pdf

Lorenzini, P. (2005). A Second Look at Nuclear Power. *Issues in Science and Technology*, *21*(3). https://issues.org/lorenzini/#.YrVZjC_9gVk.link

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological methods*, *1*(2), 130.

McCaffrey, M. S., & Buhr, S. M. (2008). Clarifying Climate Confusion: Addressing Systemic Holes, Cognitive Gaps, and Misconceptions Through Climate Literacy. *Physical Geography*, *29*(6), 512–528. https://doi.org/10.2747/0272-3646.29.6.512

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, *32*(1), 66-87.

McGinn, M. (2019, December 27). 2019's biggest pop-culture trend was climate anxiety. *Grist Magazine*. https://grist.org/politics/2019s-biggest-pop-culture-trend-wasclimate-anxiety/

McKenzie, M. (2021). Climate change education and communication in global review: tracking progress through national submissions to the UNFCCC Secretariat. *Environmental Education Research*, *27*(5), 631–651. https://doi.org/10.1080/13504622.2021.1903838

McLeod, S. A. (2022, April 6). Jean Piaget's theory of cognitive development. *Simply Psychology*. https://www.simplypsychology.org/piaget.html

Mead, E., Roser-Renouf, C., Rimal, R. N., Flora, J. A., Maibach, E. W., & Leiserowitz, A. A. (2012). Information seeking about global climate change among adolescents: The role of risk perceptions, efficacy beliefs and parental influences. Atlantic Journal of Communication, 20, 31–52.

Meneses, G. D., & Palacio, A. B. (2005). Recycling behaviour: A multidimensional approach. Environment and Behaviour, 37, 837–860. doi:10.1177/ 0013916505276742

Mesimäki, S. (2019, December 18). Where are Japan's climate strikers?. *Tokyo Review*. https://www.tokyoreview.net/2019/12/japan-climate-strike/

Mezirow, J. (1997). Transformative learning: Theory to practice. *New directions for adult and continuing education*, *1997*(74), 5–12. https://www.ecolas.eu/eng/wp-content/uploads/2015/10/Mezirow-Transformative-Learning.pdf

Militello, L.G., Gentner, F.C., Swindler, S.D., & Beisner, G. (2006). Conation: Its Historical Roots and Implications for Future Research. *International Symposium on Collaborative Technologies and Systems (CTS'06)*, 240–247.

Ministry of Education, Culture, Sports, Science and Technology. (n.d.). *Shin gakushū shidō yōryō ni okeru `kankyō kyōiku' ni kakawaru omona naiyō* [Main contents related to "environmental education" in the New Course of Study]. https://www.mext.go.jp/b_menu/shingi/chousa/shisetu/013/003/shiryo/attach/1299713.htm

Ministry of Education, Culture, Sports, Science and Technology. (2016). *Heisei 28-nendo yunesukosukūru nenji ankēto kekka* [Results of the Annual UNESCO School Survey 2016]. https://uskir.net/wp-content/uploads/2020/11/%E5%B9%B3%E6%88%9028%E5%B9%B4%E5%BA%A6.pdf

Ministry of the Environment of Japan. (1998). *Chikyū ondanka taisaku no suishin ni kansuru hōritsu* [Act on Promotion of Global Warming Countermeasures]. https://elaws.e-gov.go.jp/document?lawid=410AC0000000117

Ministry of the Environment of Japan. (2018). *Climate Change in Japan and Its Impacts*. https://www.env.go.jp/earth/tekiou/pamph2018_full_Eng.pdf

Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., & Chaves, W. A. (2017). Identifying effective climate change education strategies: a systematic review of the research. *Environmental Education Research*, *25*(6), 791–812. https://doi.org/10.1080/13504622.2017.1360842

Mori, N., Armada, F., & Willcox, D. C. (2012). Walking to school in Japan and childhood obesity prevention: new lessons from an old policy. *American journal of public health*, *102*(11), 2068-2073.

Morris, H. (2014). Socioscientific issues and multidisciplinarity in school science textbooks. *International Journal of Science Education*, *36*(7), 1137–1158.

Moss, T. P., Lawson, V., & White, P. (2015). Identification of the underlying factor structure of the Derriford Appearance Scale 24. *PeerJ*, *3*, e1070.

Nagata, Y. (2017). A critical review of education for sustainable development (ESD) in Japan: Beyond the practice of pouring new wine into old bottles. *Educational Studies in Japan*, *11*(0), 29–41. https://doi.org/10.7571/esjkyoiku.11.29

Nigbur, D., Lyons, E., & Uzzell, D. (2010). Attitudes, norms, identity and environmental behaviour: Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme. *British Journal of Social Psychology*, *49*(2), 259–284.

North Carolina Department of Environmental Quality. (2017). *Methods of Teaching Environmental Education Participant's Guide*. https://files.nc.gov/deqee/motee_-_participants_guide_2017_compressed.pdf

O'Brien, K., Selboe, E., & Hayward, B. M. (2018). Exploring youth activism on climate change. *Ecology and Society*, *23*(3). https://www.jstor.org/stable/pdf/26799169.pdf?refreqid=excelsior%3Aca1cbe4b8dbb6007c360fcd4e7196674&ab_segments=&origin=&acceptTC=1

Ohe, M., & Ikeda, S. (2005). Global Warming: Risk Perception and Risk-Mitigating Behaviour in Japan. *Mitigation and Adaptation Strategies for Global Change*, *10*(2), 221–236. https://doi.org/10.1007/s11027-005-6138-6

Oita Prefectural Government. (2021, March 22). *Ōita kenkankyō kyōiku adobaizā*. https://www.pref.oita.jp/soshiki/13060/kankyoukyouikuadobaizar.html

Ojala, M. (2012). Hope and climate change: the importance of hope for environmental engagement among young people. *Environmental Education Research*, *18*(5), 625–642. https://doi.org/10.1080/13504622.2011.637157

Ojala, M. (2015). Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation. The Journal of Environmental Education, 46(3), 133–148. https://doi.org/10.1080/00958964.2015.1021662

Ojala, M., & Bengtsson, H. (2018). Young People's Coping Strategies Concerning Climate Change: Relations to Perceived Communication with Parents and Friends and Proenvironmental Behaviour. *Environment and Behaviour*, *51*(8), 907–935. https://doi.org/10.1177/0013916518763894

Piaget, J. (1937). *Origins of intelligence in the child*. Routledge & Kegan Paul.

Piaget, J. (1952). *The origins of intelligence in children.* (M. Cook, Trans.). W W Norton & Co. https://doi.org/10.1037/11494-000

Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, *2*(3), 176–186. https://doi.org/10.1002/tea.3660020306

Prendergast, K., Hayward, B., Aoyagi, M., Burningham, K., Hasan, M. M., Jackson, T., ... & Yoshida, A. (2021). Youth Attitudes and Participation in Climate Protest: An International Cities Comparison Frontiers in Political Science Special Issue: Youth Activism in Environmental Politics. *Frontiers in Political Science*, 107.

Ramsey, C. E., & Rickson, R. E. (1976). Environmental knowledge and attitudes. *The Journal of Environmental Education*, *8*(1), 10–18.

Ranney, M. A., & Velautham, L. (2021). Climate change cognition and education: Given no silver bullet for denial, diverse information-hunks increase global warming acceptance. Current Opinion in Behavioural Sciences, 42, 139–146. https://doi.org/10.1016/j.cobeha.2021.08.001

Rauner, R. (2020, October 11). Climate Crisis Sparks a Revival of Youth Activism in Japan. *Kyoto Journal*. https://www.kyotojournal.org/society/climate-crisis-sparks-a-revival-of-youth-activism-in-japan/

Rebich, S., & Gautier, C. (2005). Concept mapping to reveal prior knowledge and conceptual change in a mock summit course on global climate change. *Journal of geoscience education*, *53*(4), 355–365.

Reid, A. (2019). Climate change education and research: Possibilities and potentials versus problems and perils? *Environmental Education Research*, *25*(6), 767–790. https://doi.org/10.1080/13504622.2019.1664075

RISTEX. (2016). *Senior citizens' new career model in the community*. https://www.jst.go.jp/ristex/korei/en/02project/prj_h22_04.html

Roczen, N. (2011). *Environmental competence: the interplay between connection with nature and environmental knowledge in promoting ecological behaviour*. Technische Universiteit Eindhoven. https://doi.org/10.6100/IR719557

Roczen, N., Kaiser, F. G., Bogner, F. X., & Wilson, M. (2014). A competence model for environmental education. *Environment and Behaviour*, *46*(8), 972–992. https://doi.org/10.1177/0013916513492416

Rönkkö, M., & Cho, E. (2020). An updated guideline for assessing discriminant validity. Organizational Research Methods, 25(1), 6–14. https://doi.org/10.1177/1094428120968614

Ross, A., & Willson, V. L. (2017). One-way anova. In *Basic and advanced statistical tests* (pp. 21–24). SensePublishers.

Rudiak-Gould, P. (2013). "We have seen it with our own eyes": Why we disagree about climate change visibility. *Weather, Climate, and Society*, *5*(2), 120–132. https://doi.org/10.1175/wcas-d-12-00034.1

Santoso, A. N., & Farizal. (2019). Community Participation in Household Waste Management: An Exploratory Study in Indonesia. In *E3S Web of Conferences* (Vol. 125, p. 07013). EDP Sciences. https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/51/e3sconf_icenis2019_07013.pdf

Schauss, M., & Sprenger, S. (2021). Students' conceptions of uncertainties in the context of climate change. *International Research in Geographical and Environmental Education*, *30*(4), 332–347. https://doi.org/10.1080/10382046.2020.1852782

Schneider, C. R., Zaval, L., & Markowitz, E. M. (2021). Positive emotions and climate change. *Current Opinion in Behavioural Sciences*, *42*, 114–120.

Selby, D., & Kagawa, F. (2013). *Climate Change in the Classroom.* UNESCO. http://unesdoc.unesco.org/images/0021/002197/219752e.pdf

Shadfar, S., & Malekmohammadi, I. (2013). Application of Structural Equation Modelling (SEM) in restructuring state intervention strategies toward paddy production development. *International Journal of Academic Research in Business and Social Sciences*, *3*(12), 576.

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2011). Students' conceptions about the greenhouse effect, global warming, and climate change. *Climatic Change*, *104*(3–4), 481–507. https://doi.org/10.1007/s10584-009-9786-9

Shi, J., Visschers, V. H., Siegrist, M., & Arvai, J. (2016). Knowledge as a driver of public perceptions about climate change reassessed. *Nature Climate Change*, *6*(8), 759–762.

Shirai, N., Baba, K., & Tanaka, M. (2014). Kikō hendō no eikyō jikkan to kanwa tekiō ni kakaru ishiki kōdō no kankei: Naganoken Iidashi jūmin no bunseki [Relationships between realisation of the effects of climate change, consciousness and behaviour related to mitigation adaptation: Analysis of residents in Iida City, Nagano Prefecture]. *Kankyō-ka Gakkaishi*, *27*(3), 127–141. https://www.jstage.jst.go.jp/article/sesj/27/3/27_127/_pdf/-char/ja

Shirai, N., Tanaka, M., & Aoki, E. (2015). Kikō hendō e no kanwa tekiō kōdō no ishiki kōzō no bunseki - chiiki ni okeru kikō hendō gakushū no tame ni [Analysis of consciousness structure of mitigative and adaptive behaviour to climate change: For learning about

climate change in the region]. *Kankyō kyōiku, 25*(2), 2_62–71. https://www.jstage.jst.go.jp/article/jsoee/25/2/25_2_62/_pdf/-char/ja

Sinatra, G. M., Kardash, C. M., Taasoobshirazi, G., & Lombardi, D. (2012). Promoting attitude change and expressed willingness to take action toward climate change in college students. *Instructional Science*, *40*(1), 1–17.

Skamp, K., Boyes, E., & Stanisstreet, M. (2013). Beliefs and willingness to act about global warming: Where to focus science pedagogy? *Science Education*, *97*(2), 191–217.

Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). Time to retire the theory of planned behaviour. *Health psychology review*, *8*(1), 1–7.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human ecology review*, 81–97. https://humanecologyreview.org/pastissues/her62/62sternetal.pdf

Stevenson, K. T., Peterson, M. N., & Bondell, H. D. (2016). The influence of personal beliefs, friends, and family in building climate change concern among adolescents. *Environmental Education Research*, *25*(6), 1–14.

Stevenson, K. T., Nils Peterson, M., & Bondell, H. D. (2018). Developing a model of climate change behaviour among adolescents. Climatic Change, 151(3), 589–603. https://link.springer.com/content/pdf/10.1007/s10584-018-2313-0.pdf

Stevenson, K. T., Peterson, M. N., Bondell, H. D., Moore, S. E., & Carrier, S. J. (2014). Overcoming skepticism with education: interacting influences of worldview and climate change knowledge on perceived climate change risk among adolescents. *Climatic change*, *126*(3), 293–304. https://kathrynstevenson.wordpress.ncsu.edu/files/2014/08/Stevenson_etal_2014_climaticchange.pdf

Stevenson, R. B., Nicholls, J., & Whitehouse, H. (2017). What is climate change education? *Curriculum Perspectives*, *37*(1), 67-71. https://doi.org/10.1007/s41297-017-0015-9

Strife, S. J. (2012). Children's environmental concerns: Expressing ecophobia. *The Journal of Environmental Education*, *43*(1), 37–54. https://doi.org/10.1080/00958964.2011.602131

Sugimura, K. (2020). Adolescent identity development in Japan. *Child Development Perspectives*, *14*(2), 71–77.

Suhr, D. (2006). The basics of structural equation modelling. *Presented: Irvine, CA, SAS User Group of the Western Region of the United States (WUSS).*

Suhr, D. D. (2005). Principal component analysis vs. exploratory factor analysis. *SUGI 30 proceedings*, *203*, 230. https://support.sas.com/resources/papers/proceedings/proceedings/sugi30/203-30.pdf

Sulistyawati, S., Mulasari, S. A., & Sukesi, T. W. (2018). Assessment of Knowledge regarding Climate Change and Health among Adolescents in Yogyakarta, Indonesia. *Journal of environmental and public health*, *2018*, 9716831. https://doi.org/10.1155/2018/9716831

Swim, J. K., Stern, P. C., Doherty, T. J., Clayton, S., Reser, J. P., Weber, E. U., ... & Howard, G. S. (2011). Psychology's contributions to understanding and addressing global climate change. *American psychologist*, *66*(4), 241. https://www.apa.org/pubs/journals/releases/amp-66-4-241.pdf

Symeonidis, V., & Schwarz, J. F. (2016). Phenomenon-Based Teaching and Learning through the Pedagogical Lenses of Phenomenology: The Recent Curriculum Reform in Finland. *Forum Oświatowe*, *28*(2), 31–47. http://forumoswiatowe.pl/index.php/czasopismo/article/view/458

Tàbara, J. D., Frantzeskaki, N., Hölscher, K., Pedde, S., Kok, K., Lamperti, F., ... & Berry, P. (2018). Positive tipping points in a rapidly warming world. *Current Opinion in Environmental Sustainability*, *31*, 120–129.

Taddicken, M., Reif, A., & Hoppe, I. (2018). What do people know about climate change — and how confident are they? On measurements and analyses of science related knowledge. *Journal of Science Communication*, *17*(03), A01. https://doi.org/10.22323/2.17030201

Taherdoost, H. (2017). Determining sample size; how to calculate survey sample size. *International Journal of Economics and Management Systems*, *2*, 237–239.

Takahashi, K., Sato, M., & Hijioka, Y. (2016). Trends and issues of climate change education in japan. In *Climate Change Management* (pp. 303–320). Springer International Publishing.

Tan, C. L., Gan, V. B., Saleem, F., & Hassali, M. A. (2016). Building intentions with the Theory of Planned Behaviour: the mediating role of knowledge and expectations in implementing new pharmaceutical services in Malaysia. *Pharmacy Practice (Granada)*, *14*(4).

Tasquier, G., & Pongiglione, F. (2017). The influence of causal knowledge on the willingness to change attitude towards climate change: results from an empirical study. *International Journal of Science Education*, *39*(13), 1846–1868.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International journal of medical education*, *2*, 53.

The Psychology Notes Headquarters. (n.d.). *The Jean Piaget Stages of Cognitive Development*. https://www.psychologynoteshq.com/piagetstheory/

Trott, C. D. (2019). Reshaping our world: Collaborating with children for community-based climate change action. *Action Research*, *17*(1), 42–62. https://doi.org/10.1177/1476750319829209

Trott, C. D. (2021). Climate change education for transformation: Exploring the affective and attitudinal dimensions of children's learning and action. *Environmental Education Research*, 1-20.

United Nations. (n.d.a). *Global issues: youth*. https://www.un.org/en/global-issues/youth

United Nations. (n.d.b). *#YouthStats: Environment and Climate Change*. Retrieved from https://www.un.org/youthenvoy/environment-climate-change/

United Nations. (1992). *United Nations Framework Convention on Climate Change*. https://unfccc.int/resource/docs/convkp/conveng.pdf

United Nations. (2015). *Paris Agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

United Nations Children's Fund. (2011). *The State of the World's Children 2011: Adolescence - An age of opportunity*. https://data.unicef.org/resources/the-state-of-the-worlds-children-2011-adolescents-an-age-of-opportunity/

United Nations Children's Fund. (2022). *Adolescents*. https://data.unicef.org/topic/adolescents/overview/

United Nations Development Programme. (2021). *Peoples' Climate Vote: Results*. https://www.undp.org/publications/peoples-climate-vote

United Nations Environment Programme. (2007). *Global Environment Outlook: Environment for Development*. http://www.unep.org/geo/geo4/media

United Nations Environment Programme. (1978). *Intergovernmental Conference on Environmental Education, Tbilisi, USSR, 14-26 October 1977: Final report*. https://unesdoc.unesco.org/ark:/48223/pf0000032763

United Nations Educational, Scientific and Cultural Organization. (2017a). *Changing Minds, not the Climate: The Role of Education*. https://www.gcedclearinghouse.org/sites/default/files/resources/190248eng.pdf

United Nations Educational, Scientific and Cultural Organization. (2017b). *Education for Sustainable Goals: Learning Objectives*. https://unesdoc.unesco.org/ark:/48223/pf0000247444/PDF/247444eng.pdf.multi.page=60

United Nations Educational, Scientific and Cultural Organization. (2019). *Country progress on climate change education, training and public awareness: An analysis of country submissions under the United Nations Framework Convention on Climate Change*. https://unesdoc.unesco.org/ark:/48223/pf0000372164

United Nations Educational, Scientific and Cultural Organization. (2020). *Education for Sustainable Development: A Roadmap*. https://www.gcedclearinghouse.org/sites/default/files/resources/200782eng.pdf

United Nations Educational, Scientific and Cultural Organization. (2022). *Climate change education*. https://www.unesco.org/en/education/sustainable-development/climate-change

United Nations Educational, Scientific and Cultural Organization, & United Nations Framework Convention for Climate Change. (2016). *Action for Climate Empowerment: Guidelines for accelerating solutions through education, training and awareness*. https://unfccc.int/sites/default/files/action_for_climate_empowerment_guidelines.pdf

Ursachi, G., Horodnic, I. A., & Zait, A. (2015). How reliable are measurement scales? External factors with indirect influence on reliability estimators. *Procedia Economics and Finance*, *20*, 679-686.

Wals, A. E. J. (2012). *Shaping the Education of Tomorrow: 2012 Full-length Report on the UN Decade of Education for Sustainable Development*. UNESCO. https://edepot.wur.nl/246667

Wang, Z., Zhang, B., & Li, G. (2014). Determinants of energy-saving behavioural intention among residents in Beijing: Extending the theory of planned behaviour. *Journal of Renewable and Sustainable Energy*, *6*(5), 053127.

Watkins, M. W. (2018). Exploratory factor analysis: A guide to best practice. *Journal of Black Psychology*, *44*(3), 219–246. https://doi.org/10.1177/0095798418771807

Weber, E. U. (2020). Seeing is believing: Understanding & aiding human responses to global climate change. *Dædalus*, *149*(4), 139-150. http://dx.doi.org/10.1162/daed_a_01823

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist*, *66*(4), 315-328. https://doi.org/10.1037/a0023253

Weston, R., & Gore Jr, P. A. (2006). A brief guide to structural equation modelling. *The counseling psychologist*, *34*(5), 719–751.

Williamson, K., Satre-Meloy, A., Velasco, K., & Green, K. (2018). Climate change needs behaviour change: Making the case for behavioural solutions to reduce global warming. *Rare*. https://rare.org/wp-content/uploads/2019/02/2018-CCNBC-Report.pdf

World Health Organization. (2022). *Older adolescent (15 to 19 years) and young adult (20 to 24 years) mortality*. https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-older-adolescent-(15-to-19-years)-and-young-adult-(20-to-24-years)-mortality

World Meteorological Organisation. (2021). *State of the Global Climate 2020*. https://library.wmo.int/index.php?lvl=notice_display&id=21880#.YNQYj2gzZPb

Wray-Lake, L., Flanagan, C. A., & Osgood, D. W. (2010). Examining trends in adolescent environmental attitudes, beliefs, and behaviours across three decades. *Environment and behaviour*, *42*(1), 61-85.

Wullenkord, M. C., & Reese, G. (2021). Avoidance, rationalization, and denial: Defensive self-protection in the face of climate change negatively predicts pro-environmental

behaviour. *Journal of Environmental Psychology*, *77*(101683), 101683. https://doi.org/10.1016/j.jenvp.2021.101683

Xie, B., Brewer, M. B., Hayes, B. K., McDonald, R. I., & Newell, B. R. (2019). Predicting climate change risk perception and willingness to act. *Journal of Environmental Psychology*, *65*(101331), 101331. https://doi.org/10.1016/j.jenvp.2019.101331

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of elementary science education*, *21*(2), 49–58.

Zelenski, J. M., & Desrochers, J. E. (2021). Can positive and self-transcendent emotions promote pro-environmental behaviour? *Current Opinion in Psychology*, *42*, 31–35. https://doi.org/10.1016/j.copsyc.2021.02.009

Zhang, D., Huang, G., Yin, X., & Gong, Q. (2015). Residents' Waste Separation Behaviours at the Source: Using SEM with the Theory of Planned Behaviour in Guangzhou, China. *International Journal of Environmental Research and Public Health*, *12*, 9475–9491.

APPENDICES

APPENDIX A

Proposal Letter in English

The University of Tokyo

School Survey on Conceptions of Climate Change

My name is Kelvin Tang, first-year master's student in the Graduate Program in Sustainability Science - Global Leadership Initiative (GPSS-GLI), Graduate School of Frontier Sciences, The University of Tokyo. I am doing research for my master's thesis entitled "Assessing conceptions of climate change: An exploratory study among Japanese early-adolescents".

This research aims to give insights to educators, educational institutions and policy makers about Japanese early-adolescents' climate change conceptions. It will contribute to the building of climate change education in Japanese context that comply with the preconditions of target students. The questionnaire and interview are designed to help us understand Japanese early adolescents' conception of climate change in 3 learning dimensions: cognitive, affective, and conative learning dimensions.

The targets of this school survey are first-year and second-year students at junior high schools. All information collected will be treated in strictest confidence and will be anonymised for statistical purposes. To protect the privacy of schools and respondents, the information will not be used for any purpose other than research.

I hope you will understand the purpose of this study and I truly appreciate your time and cooperation. If you have any questions or concerns about the study, please contact me at the address below.
We wish your school all the best. Thank you in advance for your cooperation.

Yours sincerely,

Kelvin Tang
Master's Student
Graduate School of Frontier Sciences, The University of Tokyo
Tel:
E-mail:

東京大学　大学院教育学研究科・教育学部
〒113-0033　東京都文京区本郷 7-3-1　Tel. 03-5841-0261

Graduate School of Education, The University of Tokyo
Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

The University of Tokyo

Implementation Guidelines

Target students	Questionnaire will be distributed to the first-year and second-year Junior High School students. Among the respondents who are willing to participate in the interview, several respondents will be randomly picked for the interview.
Questionnaire distribution	The questionnaire is planned to be done online. The survey link will be distributed in September 2021 through school.
Deadline for returns	It would be appreciated if the questionnaire could be done by the end of October 2021

東京大学　大学院教育学研究科･教育学部
〒113-0033　東京都文京区本郷 7-3-1　Tel. 03-5841-0261

Graduate School of Education, The University of Tokyo
Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

APPENDIX B

Proposal Letter in Japanese

気候変動の概念理解に関する学校調査

私は、東京大学大学院、新領域創成科学研究科、サステイナビリティ学グローバルリーダー養成大学院プログラム（GPSS-GLI）の修士 1 年のケルビン・タンと申します。「日本の中学生における『気候変動』という概念理解に関する評価」というタイトルで修士論文の研究を行っています。

この研究は、日本の中学生たちが「気候変動」という概念をどのように理解しているのかについて明らかにすることで、教育者や教育機関の関係者の方々に、このテーマに関する新たな知見を提供することを目的としています。アンケートとインタビューは、日本の中学生の「気候変動」という概念の理解に関して、認知的、感情的、および行動的な学習の 3 つの側面で導き出すように設計されています。

この学校調査の対象は、中学校の 1 年生と 2 年生です。調査を通して収集するデータは厳重に機密保持され、統計目的で匿名化されます。学校および回答者のプライバシーを保護するために、データは調査以外の目的で使用することはありません。

本調査の目的をご理解いただき、誠にありがとうございます。研究についての質問や懸念がある場合は、以下のアドレスまでご連絡ください。

末筆ながら、皆様のご多幸をお祈り申し上げます。どうぞよろしくお願いいたします。

Kelvin Tang / ケルヴィン タン
東京大学大学院 新領域創成科学研究科
携帯電話 :
E メール :

東京大学 大学院教育学研究科･教育学部
〒113-0033 東京都文京区本郷 7-3-1 Tel. 03-5841-0261

Graduate School of Education, The University of Tokyo
Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

The University of Tokyo

指導教員：
北村　友人　教授
東京大学　大学院教育学研究科・教育学部
E メール：

調査実装の詳細

対象者	アンケートは、中学 1 年生と 2 年生に配布していただきます。 インタビューに参加する意思のある回答者の中から、ランダムに数名を選び、個別インタビューを実施します。
サーベイの配布	アンケートは、グーグルクロームを使ってオンラインで行う予定です。質問用紙のリンクや QR コードは 2021 年 9 月上旬に学校を通じて配布されます。
回答の期限	2021 年 10 月末までにアンケートを実施していただければ幸いです。

東京大学　大学院教育学研究科･教育学部
〒113-0033　東京都文京区本郷 7-3-1　Tel. 03-5841-0261

Graduate School of Education, The University of Tokyo
Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

APPENDIX C

Questionnaire in English

Climate Change Conceptions

Questionnaire

Background variables:

Age

Gender

Name of school

Grade

Climate Change Knowledge

System Knowledge:

True | false | do not know

1. Most of the current climate change is due to greenhouse gases generated by human activity.
2. Climate change is only defined as the rising of temperature of the earth's surface.
3. Climate change is a result of the ozone layer becoming thinner.
4. Rise in sea level and drought are some of the consequences of climate change.
5. Because of climate change, the water in seas and oceans will expand.
6. Because of climate change, certain plants and animals may become extinct.

Action-Related Knowledge:

7. Many of us are already familiar with solutions to climate change. While there are many actions we can take every day, it is important to focus on the solutions with the biggest result. The list below contains 7 actions to reduce emissions. But which will save the most? Rank them in order of how much greenhouse gases can be avoided.

   Household recycling

   Plant-based diet

   Family planning

   Wind energy

   Solar energy

   Wasting less food

Restoring tropical forests

Effectiveness Knowledge:

8. Consuming domestic beef uses less energy than consuming imported beef.
9. It takes the same amount of energy to produce recycled paper as it takes to produce conventional paper.
10. Energy saving light bulbs consume less energy than conventional light bulbs with the same illuminating power.
11. A car's average CO2 emission per person and kilometre exceeds that of a train many times over.
12. The production of 1 kg of beef produces more greenhouse gases than the production of 1 kg of wheat.
13. On short-haul flights (e.g., within Japan) the average CO2 emission per person and kilometre is lower than on long-haul flights (e.g., Japan to America).
14. A diesel-engine vehicle causes more CO2 per person and kilometre than a comparable petrol-engine vehicle.

Information Source:

What sources did you get information about climate change? (Please select all that apply)

School
Internet
Social media
Television
Books or magazines
Family and friends
Other

Beliefs:

15. Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result. Do you think that global warming and climate change is happening?

    Yes | no | I do not know

16. (If “yes” was answered) How sure are you that global warming and climate change is happening?

    7-Likert-type scale (1 = *Not at all sure*, 7 = *Extremely sure*)

    (If “no” was answered) How sure are you that global warming climate change is not happening?

    7-Likert-type scale (1 = *Not at all sure*, 7 = *Extremely sure*)

Concern:

7 point-Likert-type scale (1 = *Not at all worried*, 7 = *Extremely worried*)

17. I am worried about climate change.
18. I am worried about climate change’s effect on your life.
19. I am worried about climate change’s effect on the life of your family.
20. I am worried about climate change’s effect on the life of people in Japan.
21. I am worried about climate change’s effect on the life of all humankind.

Hope:

7 point-Likert-type scale (1 = *Not at all*, 7 = *Very well*)

I feel hope concerning climate change…

8. Because humanity has confronted complex and seemingly hopeless societal problems before and has been able to solve them eventually (positive reappraisal).
9. Because the awareness about this problem has increased considerably during recent years (positive reappraisal).
10. Because I believe that research and technical solutions will contribute to the improvement of the climate change problem (trust-others).
11. Because politicians in more and more countries take climate change seriously’ (trust-others).
12. Because we as individuals can change our behaviour; together we can influence climate change in a positive direction (trust-self).
13. Because I know that there are several things that I can do to contribute to the improvement of the climate change problem (trust-self).

Attitude:

7 point-Likert-type scale (1 = *Extremely disagree*, 7 = *Extremely agree*)

28. People should care more about climate change.
29. Climate change should be given top priority.

30. It is annoying to see people do nothing for the climate change issues.
31. The seriousness of climate change has been depreciated.
32. Climate change is a threat to the world.
33. It is my responsibility to act in a climate-friendly manner.
34. I can contribute to reducing the degree of climate change.

Willingness to Act:

7 point-Likert-type scale (1 = *Extremely disagree*, 7 = *Extremely agree*)

35. a. Using public transport is effective to combat climate change.
    b. I am willing to use public transport.
36. a. Walking or biking is effective to combat climate change.
    b. I am willing to walk or bike.
37. a. Saving energy such water and electricity is effective to combat climate change.
    b. I am willing to save energy such water and electricity.
38. a. Consuming less is effective to combat climate change.
    b. I am willing to consume less.
39. a. Reducing waste is effective to combat climate change.
    b. I am willing to reduce waste.
40. a. Getting an education about climate change is effective to combat climate change.
    b. I am willing to get an education about climate change.
41. a. Joining climate action campaign is effective to combat climate change.
    b. I am willing to join climate action campaign.
42. a. Pushing government to take climate actions is effective to combat climate change.
    b. I am willing to pushing government to take climate actions.

APPENDIX D

Questionnaire in Japanese

「 日本の中学生における 『気候変動』という概念理解に関する 評価 」

質問用紙

私は、東京大学大学院、新領域創成科学研究科、サステイナビリティ学グローバルリーダー養成大学院プログラム（GPSS-GLI）の修士 1 年のケルビン・タンと申します。 「日本の中学生における『気候変動』という概念理解に関する評価」というタイトルで修士論文の研究を行っています。

この研究は、日本の中学生たちが「気候変動」という概念をどのように理解しているのかについて明らかにすることで、教育者や教育機関の関係者の方々に、このテーマに関する新たな知見を提供することを目的としています。アンケートとインタビューは、日本の中学生の「気候変動」という概念の理解に関して、認知的、感情的、および行動的な学習の 3 つの側面で導き出すように設計されています。

調査を通して収集するデータは厳重に機密保持され、統計目的で匿名化されます。学校および回答者のプライバシーを保護するために、データは調査以外の目的で使用することはありません。

ご協力どうぞよろしくお願いいたします。

上記の説明を読んで理解した上、自発的にこの調査に協力していただきますか。

・はい

・いいえ

デモグラフィック

年齢　　：

性別（任意）：　男性　・　女性

学校名　　：

学年　　：　中１　・　中２

気候リテラシー

システム知識

下記の文章が正しいかどうかお答えください。正しいと思うなら、「〇」を選んでください。正しくないと思うなら、「✕」を選んでください。知らない場合、「知らない」を選んでください。

1. 現在の気候変動は、主に人間の活動によって生成された温室効果ガスによるものだ。
   〇　・　✕　・　知らない
2. 気候変動は、地球の表面の温度上昇についてのみだ。
   〇　・　✕　・　知らない
3. 気候変動は、オゾン層が薄くなる結果だ。
   〇　・　✕　・　知らない
4. 海面上昇と干ばつは、気候変動の結果の一部だ。
   〇　・　✕　・　知らない
5. 気候変動により、海洋の水は膨張する。
   〇　・　✕　・　知らない
6. 気候変動により、特定の動植物が絶滅する可能性がある。
   〇　・　✕　・　知らない

行動知識

私たちはすでに気候変動の解決策をもうわかるかもしれない。 毎日実行できる行動はたくさんありますが、最大の結果が得られる解決方法に注目することが重要です。 以下のリストには、

温室効果ガスの排出量を削減するための７つのアクションがあります。その中、温室効果ガスを減らすのに効果がある順で１－７の順位を付けてください。

家庭のリサイクル	7	太陽エネルギー	5
植物ベースの食事	4	無駄な食べ物の削減	3
家族計画	1	熱帯林の回復	6
風力エネルギー	2		

有効性の知識

下記の文章が正しいかどうかお答えください。正しいと思うなら、「〇」を選んでください。正しくないと思うなら、「×」を選んでください。知らない場合、「知らない」を選んでください。

1. 国産牛肉を食べることは、輸入牛肉を食べるよりも少ないエネルギーを使う。
   〇　・　×　・　知らない
2. 再生紙の製造には、木から作られる紙と同じ量のエネルギーが必要だ。
   〇　・　×　・　知らない
3. 省エネ電球は、同じ照明力の従来の電球よりも多くのエネルギーを消費する。
   〇　・　×　・　知らない
4. 1 人 1 キロメートルあたりの自動車の平均 CO2 排出量は、電車のを何倍も上回っている。
   〇　・　×　・　知らない
5. 1 kg の牛肉の生産は、1kg の小麦の生産よりも多くの温室効果ガスを生成する。
   〇　・　×　・　知らない
6. 短距離フライト（日本国内）では、1 人 1 キロメートルあたりの平均 CO2 排出量は、長距離フライト（日本からアメリカ）よりも少ない。
   〇　・　×　・　知らない
7. ディーゼルエンジン車は、同等のガソリンエンジン車よりも 1 人 1 キロメートルあたりより多くの CO2 を発生させる。
   〇　・　×　・　知らない

気候変動に関する情報源

あなたは、気候変動についての情報を得られた源を教えてください。（いくつでも）

学校	✓
インタネット	
SNS	
テレビ	
本・雑誌	
友人・家族	
その他：	

信念

最近、地球温暖化がニュースなどで注目されていることに気づいたかもしれません。地球温暖化とは、世界の平均気温が過去150年間上昇しており、将来さらに上昇する可能性があります。その結果、世界の気候が変化すると予測されています。地球温暖化と気候変動が本当に起こっていると思いますか？

はい　・　いいえ　・　知らない

(「はい」と答えた場合)

気候変動が起こっていることをどの程度信じていますか？

全く信じない	信じない	少し信じない	どちらもいえない	少し信じる	信じる	全く信じる
1	2	3	4	5	6	7

(「いいえ」と答えた場合)

気候変動が起こっていないことをどの程度信じていますか？

全く信じない	信じない	少し信じない	どちらもいえない	少し信じる	信じる	全く信じる
1	2	3	4	5	6	7

懸念・心配

あなたの考えと最も近い番号を一つ選んでください。

		全くそうではない	そうでもない	ややそうでもない	どちらでもない	ややそうだ	そうだ	非常にそうだ
1	私は、気候変動について心配している。	1	2	3	4	5	6	7
2	私は、気候変動が私の生活に与える影響について心配している。	1	2	3	4	5	6	7
3	私は、気候変動が私の家族の生活に与える影響について心配している。	1	2	3	4	5	6	7
4	私は、気候変動が日本人の生活に与える影響について心配している。	1	2	3	4	5	6	7
5	私は、気候変動が全人類の生活に与える影響について心配している。	1	2	3	4	5	6	7

希望

あなたの考えと最も近い番号を一つ選んでください。

		全くそうではない	そうでもない	ややそうでもない	どちらでもない	ややそうだ	そうだ	非常にそうだ
1	人類が以前に複雑で解決法がなさそうな社会問題に直面し、最終的にそれらを解決することができたから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7
2	近年、この問題に対する意識が大幅に高まっているから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7
3	研究と技術的解決策が気候変動問題の改善に貢献するから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7
4	ますます多くの国の政治家が気候変動を真剣に受け止めているから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7
5	私たちは個人として、環境にやさしい行動に変えることができるから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7
6	気候変動問題の改善に貢献するために私にできることがいくつかあることを知っているから、私は気候変動が止められる希望を持っている。	1	2	3	4	5	6	7

気候変動に対する態度

あなたの考えと最も近い番号を一つ選んでください。

		強く同意しない	同意しない	少し同意しない	どちらでもない	少し同意する	同意する	強く同意する
1	人々は気候変動により注目すべきだ。	1	2	3	4	5	6	7
2	気候変動を最優先すべきだ。	1	2	3	4	5	6	7
3	人々が気候変動に対して何もしないことを見るのはイライラする。	1	2	3	4	5	6	7
4	気候変動の深刻さは軽く見られている。	1	2	3	4	5	6	7
5	気候変動は世界にとって危険だ。	1	2	3	4	5	6	7
6	環境や気候にやさしく行動することは私の責任だ。	1	2	3	4	5	6	7
7	私は気候変動の程度を減らすことに貢献することができる。	1	2	3	4	5	6	7

行動意図

あなたの考えと最も近い番号を一つ選んでください。

		全くそう思わない	そう思わない	ややそう思わない	どちらでもない	ややそう思う	そう思う	非常にそう思う
1a	気候変動と戦うには、バスや電車などの公共交通機関の利用が効果的だ。	1	2	3	4	5	6	7
1b	私はバスや電車といった公共交通機関を利用するつもりだ。	1	2	3	4	5	6	7
2a	気候変動と戦うには、歩いたり自転車に乗ったりすることが効果的だ。	1	2	3	4	5	6	7
2b	私は歩いたり自転車に乗ったりするつもりだ。	1	2	3	4	5	6	7
3a	気候変動と戦うには、水や電気などのエネルギーの節約が効果的だ。	1	2	3	4	5	6	7
3b	私は水や電気などのエネルギーを節約するつもりだ。	1	2	3	4	5	6	7
4a	気候変動と戦うには、消費量を減らすことが効果的だ。	1	2	3	4	5	6	7
4b	私は消費量を減らすつもりだ。	1	2	3	4	5	6	7
5a	気候変動と戦うには、ゴミを減らすことが効果的だ。	1	2	3	4	5	6	7
5b	私はゴミを減らすつもりだ。	1	2	3	4	5	6	7
6a	気候変動と戦うには、気候変動に関する教育を受けることが効果的だ。	1	2	3	4	5	6	7
6b	私は気候変動に関する教育を受けるつもりだ。	1	2	3	4	5	6	7
7a	気候変動と戦うには、気候変動対策キャンペーンやイベントへの参加が効果的だ。	1	2	3	4	5	6	7

7b	私は気候変動対策キャンペーンやイベントに参加するつもりだ。	1	2	3	4	5	6	7
8a	気候変動と戦うには、政府に気候変動対策を推進することが効果的だ。	1	2	3	4	5	6	7
8b	私は政府に気候変動対策を推進するつもりだ。	1	2	3	4	5	6	7

以上でアンケートは終わりです。

ご協力いただきまして、ありがとうございました。