

FUTURE ISLAND: ENHANCING ANTICIPATORY COMPETENCE OF CHILDREN AGED 7 TO 11 IN ESD THROUGH GAME- BASED LEARNING.

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GAME-BASED LEARNING (GBL), BOARD GAME, COGNITIVE DEVELOPMENT**

ABSTRACT | This study grounded in game-based learning theory, developed a board game based on the Education for Sustainable Development (ESD) theory for fostering anticipatory competency in 7-11-year-old children. The „Future Island” board game is designed for collaborative play among four players, aiming to protect islands from being submerged due to environmental crises. The game design incorporates five core concepts of anticipatory competency: future orientation, scenario planning, strategic systems thinking, interpersonal competence, and environmental knowledge. Qualitative research was conducted in both Guangzhou and Shenzhen using observational and interview methods with 28 children over two experiments. The purpose was to validate whether children’s understanding of the game varies with age and whether the game effectively stimulates anticipatory competency in children. Analysis of the children’s gameplay results revealed that their understanding of the game increased with age, and the “Future Island” board game effectively mobilizes children’s anticipatory competency in the field of ESD.

1. Introduction

By 2022, the devastating impacts of climate change, biodiversity loss, pollution, and waste have become increasingly severe (UNEP, 2022). To enhance citizens' environmental awareness, the 2030 Sustainable Development Agenda explicitly integrates Education for Sustainable Development (ESD) principles into all educational category systems (UN, 2015). This article focuses on qualitative research using the Game-Based Learning method to explore the effectiveness of a board game to mobilize the anticipatory competence of children aged 7-11 in ESD.

ESD aims to develop competencies that empower individuals considering current and future social, cultural, economic, and environmental impacts, both locally and globally (Tejedor et al., 2019). Researchers have identified the anticipatory competence of the cognitive domain as one key competence that ESD ought to promote (Barth, Godemann & Rieckmann, 2007). Anticipatory competence involves the person's ability to envision and construct coherent future scenarios (Arnim, Lauren & Charles, 2011). The current focus is on insufficient coverage of age groups, that is, most research on expected abilities is concentrated in higher education rather than early childhood education (Senan & Marco, 2016). However, children in middle childhood already have logical thinking, reasoning, debating, and problem-solving abilities, which are the basic abilities required to develop anticipatory competence (Andrew, 1984). Thus, this article fills the research gap by studying the anticipatory competence of children aged 7-11 years old.

Game-Based Learning (GBL) is a type of gameplay with defined learning outcomes (Rosemary, Robert & James, 2002). Future Island is a board game designed to improve the anticipatory competence of children aged 7-11 in ESD. Addressing the impact of global climate warming on rising sea levels; players collaboratively anticipate environmental crises to protect the island from submersion due to increasing seawater levels. The game enhances children's anticipatory competence through engaging mechanics. Firstly, it cultivates children's Scenario Planning skill and Future Orientation skill by defending the island (Wiek, Withycombe & Redman, 2011). Secondly, it improves children's Strategic Systems Thinking ability by predicting the impact of human behavior on environmental crises. Thirdly, the multiplayer collaborative format of the game fosters children's capacity to connect with stakeholders. Lastly, the game promotes an understanding of environmental conservation through the presentation of diverse environmental crisis cards. Overall, the author posits Hypothesis 1: Children aged 7-11 years differed in their understanding level of the board game content developed in this study by age. And Hypothesis 2: This board game can effectively mobilize children's anticipatory competency in the field of ESD.

This study primarily involves qualitative research to validate these hypotheses, including board game experiments under GBL methods, Observation, interviews, etc. The team invited 7-11-year-old participants from Guangzhou and Shenzhen to participate in Future Island trials. The effectiveness of the model is measured by observing and analyzing children's performance in the game. Future work involves iterative optimization of the game model and incorporating Game-Based learning (GBL) to enhance various ESD capabilities, further advancing children's environmental awareness.

2. Literature Review

2.1 Anticipatory Competence in Education for Sustainable Development (ESD)

ESD is an educational approach that integrates the principles of sustainable development into teaching and learning practices. It aims to empower individuals to make informed decisions and take responsible actions for environmental integrity, economic viability, and a just society (UNESCO, 2014). ESD can be divided into three domains: Cognitive domain, Socio-emotional domain and Behavioral domain, and Anticipatory is one of the key competences in cognitive domain. A pivotal aspect of ESD is the development of anticipatory competence, which enables individuals to engage with future dimensions, anticipate potential outcomes, and craft visions for a sustainable future (Ojala, 2012). In the context of global environmental challenges, where the ability to think ahead and prepare for various future scenarios is crucial for effective decision-making and problem-solving.

Table 1. Key competencies in “ESD” can be divided into three domains.

	Cognitive domain	Socio-emotional domain	Behavioral domain
Key Competency	1 Systems thinking	5 Collaboration	7 Strategic
	2 Anticipatory	6 Self-awareness	8 Integrated problem-solving
	3 Normative		
	4 Critical thinking		

Anticipatory competence in ESD can be broken down into several components:

1. **Future Orientation:** This component involves the ability to think beyond the present and consider the long-term implications of current actions and decisions. It requires an understanding of the temporal scale and the ability to work across different time horizons, which is particularly important when dealing with sustainability issues that often have delayed consequences (Rieckmann, 2012).
2. **Scenario Planning:** Anticipatory competence includes the capacity to create and analyze alternative future scenarios, both desirable and undesirable. This allows individuals to identify potential risks and opportunities, and to develop strategies to achieve preferred outcomes while avoiding or mitigating negative ones (Ojala, 2012).
3. **Strategic Systems Thinking:** This combined component encompasses the capacity to create and analyze alternative future scenarios, both desirable and undesirable, and to understand the interconnectedness of systems. It allows individuals to identify potential risks and opportunities, develop strategies to achieve preferred outcomes, and navigate the complex feedback loops and unintended consequences that can arise from sustainability-related actions (Barth et al., 2007; Ojala, 2012).
4. **Interpersonal Competence:** Anticipatory competence is also about the ability to collaborate effectively with others. This includes the capacity to communicate, negotiate, and work in diverse teams to achieve common sustainability objectives (Wiek et al., 2011).
5. **Environmental Knowledge:** Environmental knowledge is essential for anticipatory competence as it provides the foundational understanding of ecological systems, natural resource management, and the impact of human activities on the environment. This knowledge enables individuals to make informed decisions that are grounded in scientific evidence and contribute to the conservation and restoration of ecosystems (Tschakert & Dietrich, 2010).

Anticipatory competence enables individuals to navigate these uncertainties by considering a range of possible futures, evaluating the plausibility and consistency of different scenarios, and making informed decisions that align with sustainability principles. Moreover, anticipatory competence supports the development of a proactive and adaptive mindset, which is crucial for addressing the ‘wicked problems’ of sustainability (Rittel & Webber, 1973). In conclusion, anticipatory competence in ESD is essential because it equips learners with the tools to actively shape their future rather than passively accept it (Gardiner & Rieckmann, 2015).

2.2 Anticipatory Competence in 7-11-Year-Old Children

Despite the recognized importance of anticipatory competence in ESD, the majority of research and educational initiatives have focused on adolescents and young adults (Taimur & Sattar, 2019). This demographic is often at the forefront of discussions surrounding sustainability, as they are the ones who will inherit the consequences of current environmental policies and practices. However, there is a notable absence of research and targeted educational strategies for children aged 7-11 years, a critical period in their cognitive and social development according to Piaget’s theory of cognitive development (Piaget,

1952). This age group is in the concrete operational stage, where they begin to understand the reversibility of operations and can think logically about concrete events (Piaget, 1952). This stage is particularly suitable for introducing sustainability concepts and fostering anticipatory thinking, as children at this age can grasp the implications of their actions on the environment and society (Ojala, 2017).

The lack of focus on children in this age group in ESD research and practice is concerning, as this demographic represents the future stewards of the planet. By not engaging them in anticipatory thinking, we miss the opportunity to instill the foundational skills and values necessary for sustainable living from an early age. The importance of fostering anticipatory thinking in children is multifaceted. Firstly, it enhances their cognitive development by encouraging them to think critically and systematically about the future (Withycombe, 2010). This includes understanding cause and effect relationships, considering multiple perspectives, and evaluating potential risks and benefits. Secondly, it supports their social and emotional development by fostering empathy, collaboration, and a sense of responsibility towards the environment and future generations. Lastly, it prepares them for active citizenship, equipping them with the skills to participate in socio-political processes and contribute to sustainable development initiatives (Cebrián, Junyent, & Mulà, 2020).

In conclusion, the development of anticipatory thinking competencies in children aged 7-11 is a critical yet underexplored area within ESD. By integrating age-appropriate strategies into educational practices, educators can help shape a generation of children who are equipped to engage proactively with sustainability challenges and contribute to a more sustainable future. This requires a concerted effort from educators, policymakers, and researchers to create a more inclusive and holistic approach to sustainability education that reaches and empowers children from all backgrounds and cultures.

2.3 Game-Based Learning Approach and Board Game

Game-based learning refers to the utilization of certain gaming principles and their application in real-life scenarios to engage users (Trybus, 2015). Board Games as part of effective Game-Based Learning strategies, more and more researchers and producers are focusing on this area (Santos, 2017). Research including children aged 7 to 11 strongly suggests that board games are an effective tool for encouraging active learning and knowledge retention, and that board games can help children learn even better than traditional forms of teaching (Weisberg et al. 2015). Many game settings of board games are very useful in promoting children's learning, for example: teachers can ask open-ended questions to help children think more deeply; the introduction of dice helps reduce adult control and allows children to maintain a sense of control in the game; The mechanics of multiplayer games can help children enhance their social skills, etc. (Hassinger-Das et al. 2017). Therefore, as one of the important game forms of GBL, board games can well exercise children's independent learning ability.

Although board games have great benefits in promoting children's learning, there is currently a lack of board game designs for children in the field of ESD that enhance their expected abilities. The currently known training for expected competencies is the „The City of Phoenix” themed workshop designed for college students (Withycombe, 2010). Most of the board games in other ESD fields are simple environmentally themed games, such as the board game „Go, Goals” (SDG, 2020) designed by the United Nations Regional Information Center to help children understand the sustainable development goals. Therefore, there is currently a lack of environmentally themed children's serious board games in the research field, especially in the field of ESD ability training.

In conclusion, board games have the potential to promote children's learning more broadly (Sutton-Smith 1979; Singer, Golinkoff, and Hirsh-Pasek 2006). And anticipatory abilities as an important ability in the field of ESD, and one of the abilities that children aged 7-11 years old most need to cultivate, there competency are need some suitable board games as GBL materials to help children better master anticipatory.

2.4 Research Gap

Firstly, there is limited attention to young audiences: current expectations learning primarily targets university students, with a notable lack of research focused on children aged 7-11. Despite the crucial role of this age group in the development of anticipatory competency, they have largely been overlooked in game-based learning research.

Secondly, training on anticipatory abilities in Education for Sustainable Development (ESD) mostly concentrates on workshops, classroom lectures, etc., lacking game-based learning approaches, particularly important and effective board game training for children.

Therefore, this study will design a board game for cultivating anticipatory competency in ESD for children aged 7-11, and validate its reliability through a series of qualitative experiments.

3. Research Questions

RQ1: In this study, would the content of the board game developed lead to different levels of understanding among children aged 7-11 based on their age differences?

H1: Children aged 7–11 years differed in their understanding level of the board game content developed in this study by age.

RQ2: Does this board game have the potential to engage children’s anticipatory competency in the field of ESD?

H2: This board game can effectively mobilize children’s anticipatory competency in the field of ESD.

4. Methodology

4.1 GBL Method: Board Game Design Background and Conceptual Structure

The method used in this study is the board game in game-based-learning, and the name of the board game is „The future island”. The game was designed based on the principles of ESD, specifically targeting the development of anticipatory competence. The game’s mechanics were crafted to simulate environmental challenges and encourage strategic decision-making, reflecting the cognitive, socio-emotional, and behavioral domains of ESD, etc.

The background of the board game is that four players must take on the roles of an artist, an engineer, a marine biologist, and a renewable energy scientist, respectively. Through teamwork and playing skill cards, they aim to prevent sea level rise and the submergence of islands to win the game. The rules of this board game are designed entirely around the five components of anticipatory competency:

1. **Future Orientation:** Players need to judge in each round whether the impact of human behavior on environmental crisis events will be exacerbated, weakened, or have no impact. In this process, players need to think about the dimension of time, focus on the present, and consider the impact of human behavior on the environment in the future. Therefore, children’s Future Orientation ability can be developed.
2. **Scenario Planning:** Players need to reasonably analyze the environmental crisis events that occur in each round, then think about which skill card in their hand is most suitable for solving the current event. In the process of thinking, players naturally adapt solutions to environmental crisis scenarios, which exercises children’s Scenario Planning abilities.

3. **Strategic Systems Thinking:** During the game, players need to constantly calculate which character skill cards are needed to solve the current environmental crisis. At the same time, it is also necessary to predict in advance what impact the drawn human behavior cards will have on the environmental crisis. Sometimes players need to give up staged victories in exchange for final victory. These combination thinking can effectively exercise children's Strategic Systems Thinking ability.
4. **Interpersonal Competence:** The game is a group cooperation mode. Players need to communicate multiple times to determine which character skill cards the entire group should play in this round to solve the current environmental crisis. What kind of choices need to be made when the interests of the team and the interests of the individual are put in front of you? This is the Interpersonal Competence that players can develop while playing games.
5. **Environmental Knowledge:** The environmental crisis cards in this game include events such as melting glaciers, and extreme heat waves; the human behavior cards include environmentally related events such as "the tourist group in Future Island litters garbage"; the character skill cards include „monitoring the rate of sea level rise" and so on. In the process of playing the game, players will gradually master the knowledge related to the environment.

4.2 GBL Method: Cards, Rules and Steps of the Board Game

1. Introduction of board game cards and other props:

Skill card: The skill cards are the available skills that players possess. There are a total of four roles and sixteen skill cards.

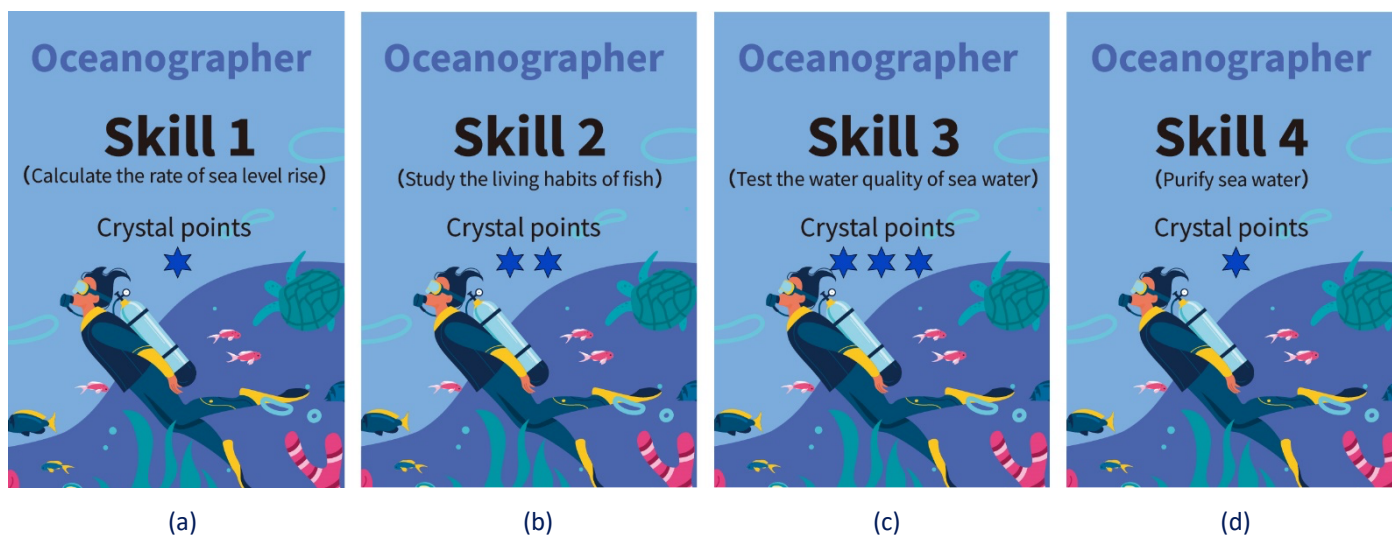


Figure 1. Examples of skill cards: (a) Oceanographer Skill Card 1; (b) Oceanographer Skill Card 2; (c) Oceanographer Skill Card 3; (d) Oceanographer Skill Card 4.

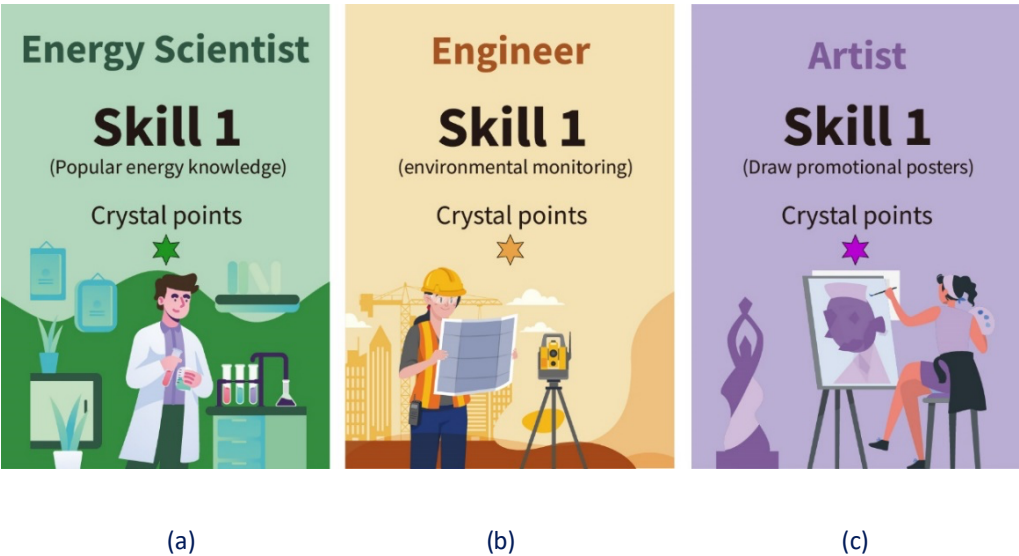


Figure 2. Examples of skill cards: (a) Energy Scientist Skill Card 1; (b) Engineer Skill Card 1; (c) Artist Skill Card 1.

Environmental crisis card: Environmental crisis cards are environmental crisis events that need to be resolved in each round. There are six environmental crisis cards in total.

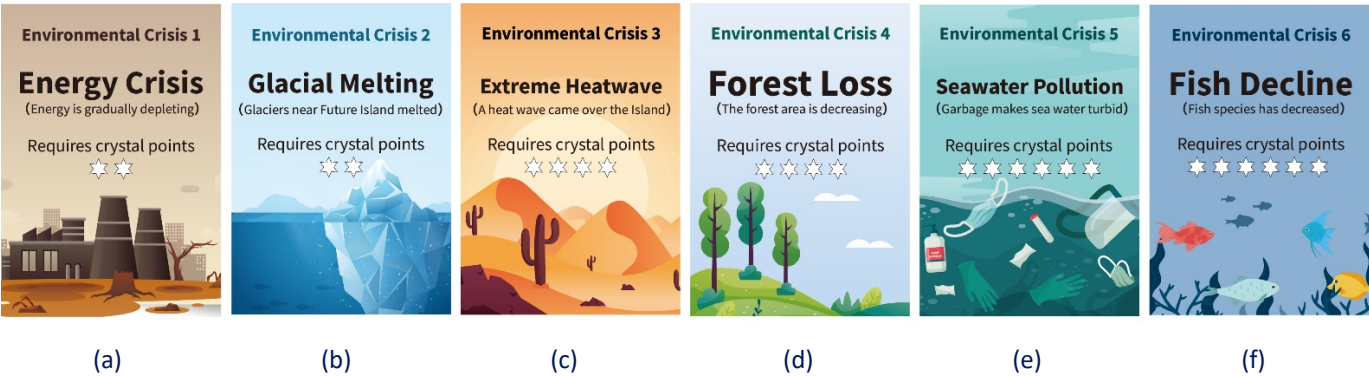


Figure 3. Examples of Environmental crisis cards: (a) Energy Crisis Card; (b) Glacial Melting Card; (c) Extreme Heatwave Card; (d) Forest Loss Card; (e) Seawater Pollution Card; (f) Fish Decline Card.

Human Behavior Card: Human behavior cards are human behaviors that will have different impacts on the environment. There are 9 human behavior cards in total.



Figure 4. Example of Human Behavior Card.

Table 2. Example for what impact does human behavior have on different environmental crisis events.

	Energy Crisis	Glacial Melting	Extreme Heatwave	Forest Loss	Seawater Pollution	Fish Decline
	Event	Event	Event	Event	Event	Event
In order to develop new projects, Future Island tourism has severely damaged the natural ecological reserve on the island.	No effect	Double crystals	Double crystals	Double crystals	Double crystals	Double crystals

Ocean Card: The ocean card is a scoring item, and each player initially has three ocean cards. For each round lost, a player must place one ocean card near the island, representing a rise in sea level by one unit.

Crystal: The crystal is a scoring item, and each player initially has 4 crystals representing their own character’s color. White crystals are the ones that need to be spent to resolve the events on the environmental crisis cards.

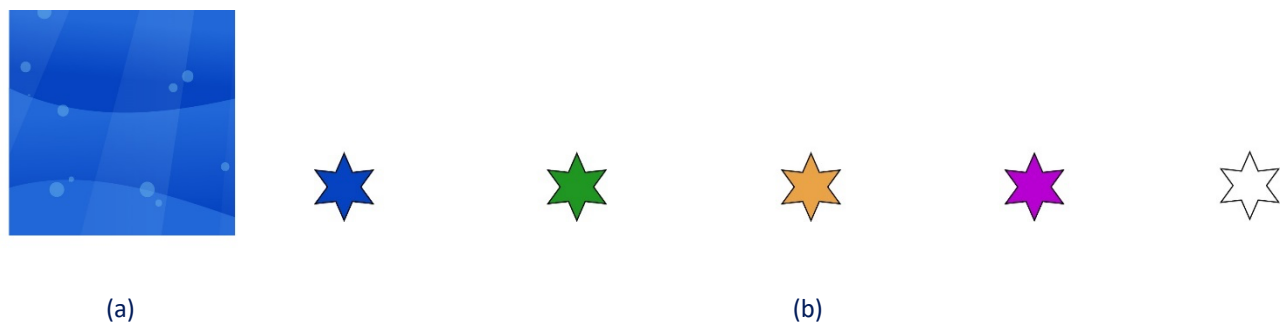


Figure 5. (a) Examples of the Ocean Card; (b) Examples of the Crystal.

- 2. Introduction of basic rules:** In “The Future Island” board game, four players form a team, and the team’s ultimate mission is to defend the island from rising sea levels. The game consists of six rounds in total. In each round, different environmental crisis events will occur. The team must cooperate to play skill cards to solve the current environmental crisis events. If the team can successfully solve three of the six environmental crisis events, the island will not be submerged.
- 3. Introduction of game steps:** The board game is divided into four phases: Events Step, Skills Step, Human Behavior Step, Resolution Step, and a brief description of each phase is provided below.
- Events Step:** There are a total of 6 environmental crisis cards, one card is played in each round, and the cards are played in the order of 1-6. As a group, discuss what happened, and how many crystals are needed to solve this incident.
- Skills Step:** Everyone decides whether to play a skill card and which card to play based on the crystal points in their hand. There is no limit to the number of people playing cards in each round. It should be noted that when children play a skill card, they should say how this skill card solves the current environmental crisis. After playing a skill card in each round, place the consumed crystals in the counting area according to the „Crystal points” marked on the skill card.
- Human Behavior Step:** Each round, a random Human Behavior card is drawn. The group discusses its impact: Positive halves Environmental Crisis card’s crystals, negative doubles, no

impact maintains. If the team's total skill card crystals match or exceed the Environmental Crisis card's, they win. Players using skill cards get 1 crystal each; most crystals on a card earn 1 extra. If not, team loses; each discards an Ocean card, raising sea level by 1.

Resolution Step: If three of the six rounds are won, the future island will not be submerged by the sea water and the defense will be successful! If the future island is successfully defended, the crystal points in the counting area will be counted, and the person with the most crystal points will win an additional personal championship victory. The game proceeds to the next round until the game's termination criteria are met.

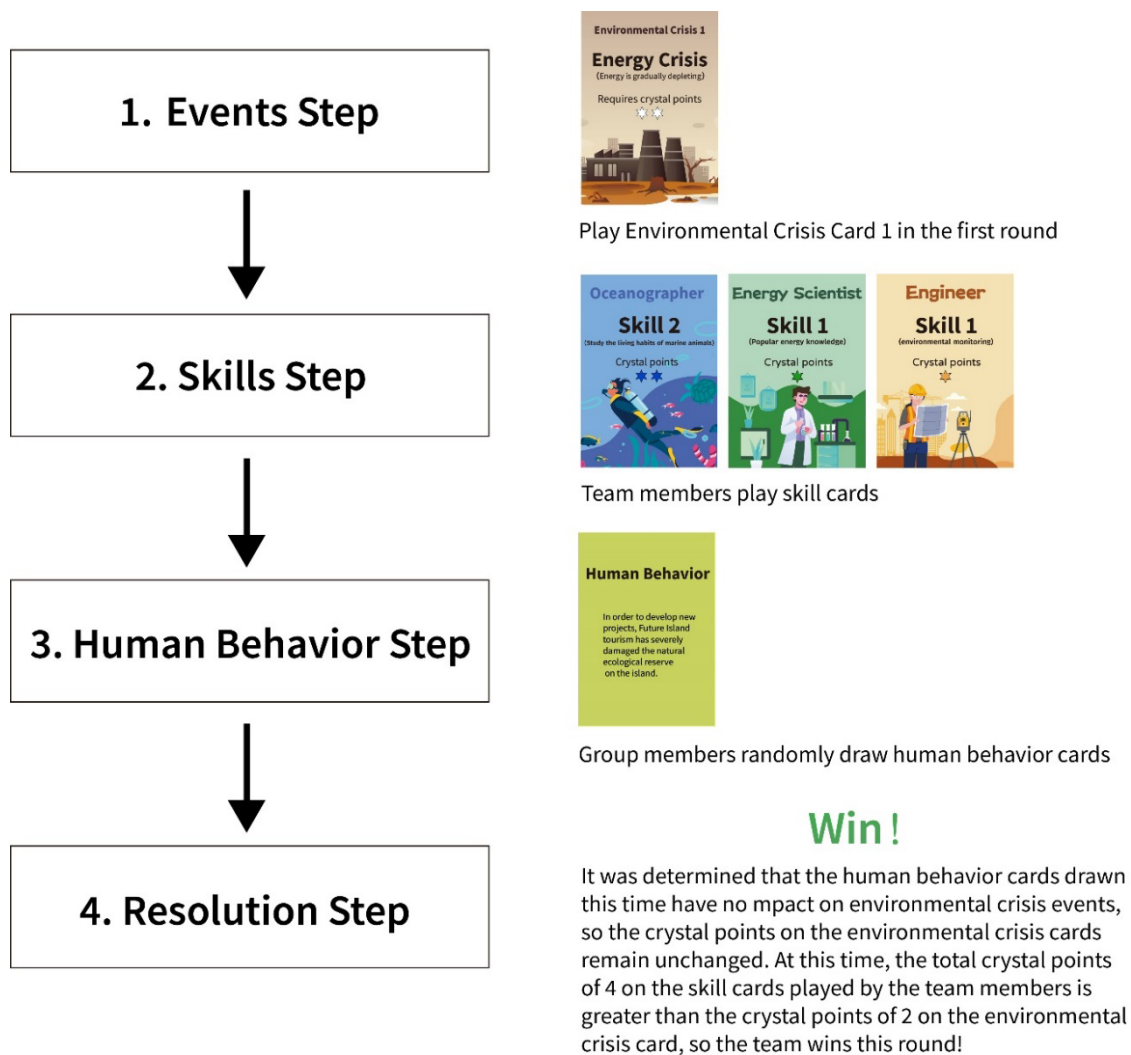


Figure 6. Game Process Overview and First Round Game Example.

4.3 Research Method: Qualitative Research Method

The main purpose of this study is to answer the two hypotheses mentioned above. H1: Children aged 7–11 years differed in their understanding level of the board game content developed in this study by age; H2: This board game can effectively mobilize children's anticipatory competency in the field of ESD. In this study, the experimenters will use qualitative analysis to analyze the experimental results. Qualitative research is a research method focused on thoughts, concepts, or experiences (American University, 2020). There are many qualitative methods, with the most common types being interviews and observations (Creswell, 2007).

Observational method is described as a technique of observing and describing subjects’ behavior, involving simply observing phenomena until some form of intuition or insight is gained (Kumar, 2022). Children’s thinking and behavior patterns are very different from adults, and we cannot get the complete information we want by asking. Therefore, observation method is necessary in this study, and these observations can serve as the basis for subsequent analysis. Additionally, interviewing is another specific type of interaction, typically involving researchers asking questions to interview participants and participants responding to those questions (Brinkmann, S., & Kvale, S., 2018). Therefore, in this experiment, interviews are used as a complement to the observational method to help researchers obtain the necessary information.

To sum up, in this study, researchers will conduct two experiments using board games as props to verify H1 and H2. Specifically, Experiment 1 used the observation method, and Experiment 2 used the observation method and interviews.

5.Experiment

5.1 Experiment 1 Observation: Context and Procedure

In Experiment 1, the authors will test H1: Children aged 7–11 years differed in their understanding level of the board game content developed in this study by age. The study conducted its first qualitative survey on 8 children at the Another Art Museum in Guangzhou, Guangdong Province, China on May 19, 2023 (Guangzhou Group). A second qualitative survey was conducted on 12 children at the First Store Life Festival in Futian District, Shenzhen City, Guangdong Province, China on November 17, 2023 (Shenzhen Group). There are 20 qualitative experimenters in Experiment1, covering various age groups from 7 to 11 years old, and there are 4 experimenters in each age group. Both experiments used an open-ended board game experience workshop format, with participants randomly assigned to groups to ensure a mix of age and gender. The independent variables of this experiment are children of different ages, the control variables are the same game steps and the same number of children of each age group, and the dependent variable is whether the children can understand the rules of the game. The experimenters used observational methods to analyze whether children in the target age group’s understanding of the game differed by age. In this experiment, the experimenter followed the following steps to conduct the observation experiment.

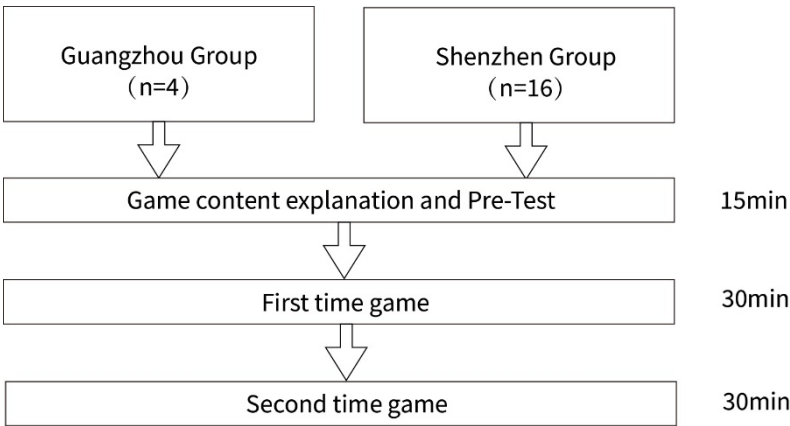


Figure 7. Experiment 1 Procedure.

1. Game content explanation and Pre-Test: Before the game starts, staff will explain the game content to each group and conduct pre-tests to ensure that the game-related information delivered to each child at the beginning is consistent.

2. First and second time Game: Observers use observation methods during the game to observe the children's understanding of the game. Children's understanding of game content can be divided into three dimensions: understanding of card text, understanding of game rules, and understanding of the way to victory. During the game, observers will carefully observe each player's choices, actions, judgments, and interactions with other players. Each dimension is rated on a seven-point scale and details low, medium, and high behaviors, with higher scores indicating greater understanding of the game content for that dimension. Ratings include the quality and frequency of observed behavior, and the scores are not mutually exclusive; for example, a child might simultaneously demonstrate understanding of card text, understanding of game rules, and understanding of winning in two rounds of play.



(a)



(b)

Figure 8. (a) Game scene photo of the Guangzhou group; (b) Game scene photo of the Shenzhen group.

5.2 Experiment 1: Analysis and Summary

Firstly, in the observation phase, observers are asked to write down examples of relevant behaviors for each dimension. Then during the scoring phase, observers refer to “The Future Island” instruction manual and compare the descriptions of children's behavior it provides with their own observation notes to determine scores for each dimension. For example, a sign of a high score in the „Understanding of card text” dimension is that the child can read the text on the card fluently and conduct reasonable analysis of the text. Observers arrive at a final numerical score by determining how well the description matches the observed behavior. For example, a child whose behavior fully fits the description of „Completely understand the text on the card” would receive 5 points, while a child who mostly fits the description in the high range, but has some behaviors in the middle range, would receive 4 points. A child who fully fits the mid-range description will receive a 3, while a child who mostly fits the mid-range description but has some low-range behaviors will receive a 2. Finally in the calculation phase, the observers averaged the data for each age group to obtain a final score.

Table 3. Example for Score calculation for 7 years old age group.

Participant number	Participant age	The understanding of game content can be divided into three sub-items			Overall score	Average score
		Understanding of card text	Understanding of game rules	Understanding the way to victory		
1	7	4	5	4	13	10.25
2	7	4	4	4	12	
3	7	2	3	2	7	
4	7	2	3	4	9	

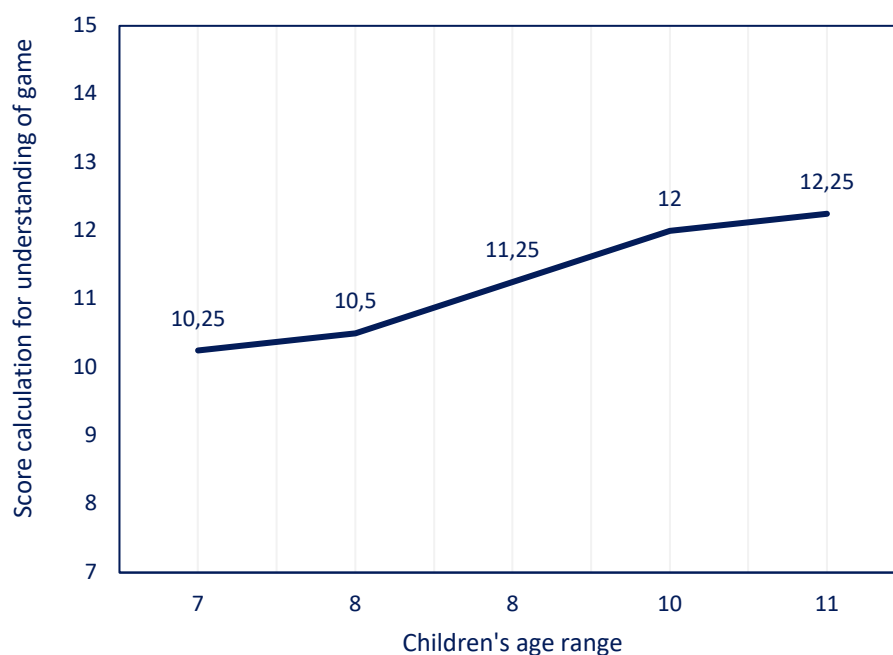


Figure 9. Line chart of scores for children of different ages on their level of understanding of the game.

Through data analysis, the author believes that hypothesis 1 is provable, that is, Children aged 7–11 years differed in their understanding level of the board game content developed in this study by age. And as age increases, children's understanding of the rules of the game gradually rises. In addition, it can be found that children aged 7-8 years old have a low understanding of the game, so the researcher made some modifications to the game rules, that is, simplifying the text content and game rules, so that children aged 7-8 years can better understand the game.

5.3 Experiment 2: Context and Procedure

In Experiment 2, the author will verify H2: This board game can effectively mobilize children's anticipatory abilities in the field of ESD. According to the results of the first experiment, the experimenters found that children aged 7-8 years old had a lower understanding of the content of board games. After improving the content of the board game, the experimenters will focus on selecting the age group of children aged 7-8 for E2 test. The study conducted a qualitative survey among 8 children on January 28, 2024, at the Futian District Library in Shenzhen, Guangdong Province, China (Shenzhen group2). Before starting the survey, each parent signed an informed consent form. The experiment used an open-ended board game

experience workshop format, with participants randomly assigned to groups to ensure a mix of age and gender. The research methods of Experiment 2 were observation and interview. In this experiment, the experimenter followed the following steps to conduct the experiment:

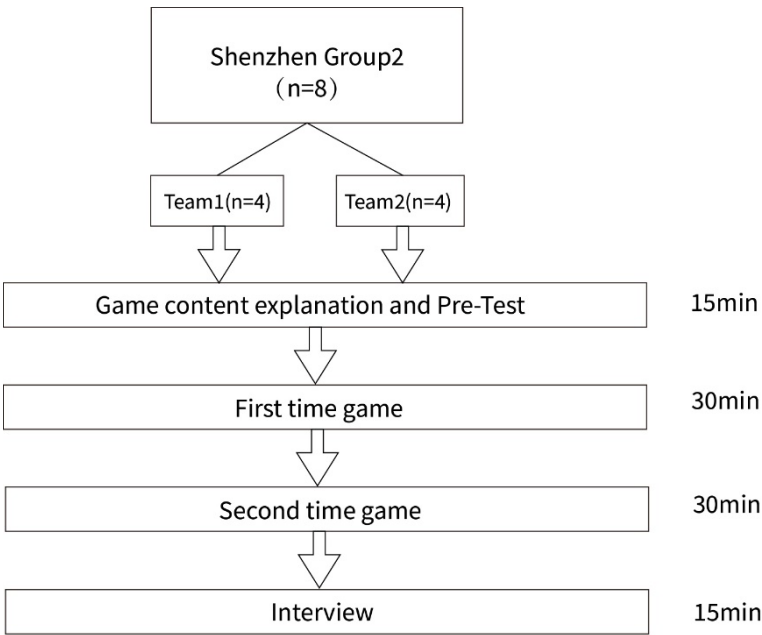


Figure 10. Experiment 2 Procedure.

1. First and second time Game: Observers used observation methods during the game to observe whether the children’s expected abilities were mobilized by the board game. The observer will use the child’s speech, decision-making, reaction speed and other information during the board game to judge the child’s expected ability level in this round of the game. The researchers focused on the following questions and their corresponding abilities in the two-round game:

- Scenario Planning:** Can children understand the scenarios in the environmental crisis card and human behavior cards?
- Future Orientation:** Can children correctly judge the impact of human behavior cards after they are drawn?
- Strategic Systems Thinking:** How many times did children win the game and what strategies did they develop?
- Interpersonal Competence:** Do children communicate frequently with group members?

2. Interview: Observation methods will be supplemented by interview sessions, in which researchers will communicate directly with the children after the game. The interview session will help researchers obtain more information about whether children’s predictive abilities are mobilized. The researchers focused on the following questions and their corresponding competencies during the interviews:

- Strategic Systems Thinking:** Do you know the methods that can both lead to team victory and individual victory?
- Interpersonal Competence:** What do you think your role is within the team? What efforts did you make to win?
- Environmental Knowledge:** What environmental knowledge did you learn after playing this game?



Figure 11. Game scene photo of the Shenzhen group 2.

5.4 Experiment 2 Analysis and Summary

The researchers obtained information about whether children's expected abilities were mobilized through observation and interviews, and sorted them out according to the framework of the five basic abilities of expected abilities:

- 1. Scenario Planning:** After the second time of play, most children were able to accurately describe the scenarios on the environmental crisis cards and were able to provide diverse solutions to fixed events. For example, when Timmy, a 7-year-old boy who played the role of an oceanographer, encountered an energy crisis, he played a skill card for purifying seawater and explained that purified seawater can be used as a new energy source to solve the energy crisis. Therefore, the researchers believe that the game mechanism of this board game, which invites children to take their own roles into the situation and solve the current environmental crisis by providing a variety of scenario cards, can effectively mobilize children's scenario planning ability in anticipatory abilities.
- 2. Future Orientation:** During the first time of play, children's judgments about human behavior cards were limited to whether they were good or bad behavior. However, in the second time of the game, most children were able to use the current human behavior cards to further think about how these behaviors will affect the environment in the future. For example, an 8-year-old boy named Duoduo was able to deduce that human fishing of large quantities of fish may have a negative impact on ocean biodiversity in the future. Therefore, researchers believe that this board game effectively mobilizes children's Future Orientation ability in anticipatory abilities by setting up human behavior cards and guiding children to think about the impact of these behaviors in the future.
- 3. Strategic Systems Thinking:** During the observation phase, researchers discovered that neither team won in the first time of the game and that their crystals had been exhausted early in the game. In the second time of the game, they re-formulated their game strategy, allocated crystal points reasonably and won the game. During the interview phase, the researcher asked children what strategies could help the team win. Duoduo said: „In the early game, skill cards with fewer crystal points should be produced, and in the late game, skill cards with more crystal points should be produced, so that there are enough crystal points. „ Therefore, by observing and interviewing children as they developed different play strategies, the researchers determined that children's strategic systems thinking in anticipatory abilities was mobilized.
- 4. Interpersonal Competence:** During the observation phase, the researcher found that children on the same team had almost no communication in the first time of the game. However, the frequency of communication between the two teams increased significantly in the second time of the game. For example: A girl named Xuanxuan explained the meaning of environmental crisis

cards to her teammates and discussed with her teammates what skills should be played. Her positive communication helped the team win consecutively. During the interview phase, the researcher asked what role did the children play in the team? Xuanxuan replied that she acted as translator and strategist. Therefore, researchers determined that the game mechanics of this board game can mobilize children's Interpersonal Competence in expected abilities.

5. Environmental Knowledge: During the interview session, the researchers asked the children what environmental knowledge they had gained through board games, and each child was able to answer more than two answers, such as: not throwing garbage into the sea, not wasting food, protecting forests, saving energy, etc. The researchers therefore determined that children's knowledge of environmental protection in their anticipatory abilities can be mobilized through this board game.

After analyzing the observation records and interview records, the author believes that hypothesis 2 can be proved, that is the board game can effectively mobilize children's anticipatory abilities in the field of ESD. Children can exercise the five details of anticipatory abilities when playing board games.

6. Contribution

6.1 Theoretical Contribution

Firstly, this study extends the research on anticipatory competence in the ESD field to the board game field, providing new insights into the application of this important capability in the ESD field in game-based-learning. It explores how the unique characteristics of board games influence children's Anticipatory Competence, thereby broadening the theoretical scope of ESD competency systems in contemporary learning environments. Moreover, this study addresses a significant gap in the literature on competency-based board games in the field of ESD. The study contributes to a deeper understanding of how board game design contributes to educational outcomes for children aged 7-11 years. Finally, the study refines board game design by unearthing a theoretical framework of expected abilities and provides a holistic view by linking it to qualitative insights into player experience. This approach enriches the academic conversation in ESD education and game research, providing an understanding of the interplay between game-based learning and ESD competency development.

6.2 Practical Implications

The results of this study provide valuable guidance for the development of board game designs. By studying how to translate theories that are difficult for children to understand into fun and accessible games, game designers can create more educational and effective learning tools. Furthermore, the results of this study can serve as a resource for educators by providing evidence-based strategies for integrating low-cost board games into educational curricula. This can increase student engagement and improve learning outcomes, especially in terms of expected competencies in the environmental field. Finally, the results of this study may help policymakers develop guidelines for the inclusion of board games as a learning tool in educational settings. By leveraging these insights, education policies can be better adapted to optimize the benefits of GBL in promoting student development and learning effectiveness.

7. Limitation and Future Work

Regarding the game design, children have reported that there are too few environmental crisis cards, which leads to a lack of variety and can result in boredom. Additionally, the initial quantities of crystals and positive human behavior cards are limited, causing the game to become more challenging in later rounds as players are more likely to lose. Moreover, about the experimental research: The sample size of the qualitative survey is too small, resulting in incomplete feedback from children. And there is a lack of quantitative research and control groups to determine whether children's anticipatory abilities have improved after playing the game.

Moving forward, the author plans to add more environmental crisis and human behavior cards to enhance the richness of the game. The study will also continue to investigate whether other competencies within the ESD field, beyond anticipatory abilities, can be adapted into game formats. In the experimental domain, quantitative research will be conducted using larger sample sizes to assess the effectiveness of the games in improving children's anticipatory abilities. Additionally, follow-up studies will be considered to examine the long-term impact of board games on the development of children's expected competencies.

8. Conclusion

This study uses a board game called "The Future Island" to improve children's anticipatory abilities in the field of ESD. Through the literature review, it was learned that expected capabilities can be divided into five factors: scenario planning, future orientation, strategic systems thinking, interpersonal competence and environmental knowledge. The game mechanism of this board game is designed around these five factors. During the research phase, observations and interviews were used to verify children's understanding of the game and the effect of mobilizing expected abilities. The research results show that "The Future Island" board game can effectively mobilize the anticipatory abilities of children aged 7-11, and as the children's age increases, children's understanding of the content of the board game becomes higher. In the future, the author will further optimize the game design, conduct diversified experiments, and increase the sample size of the experiments.

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