Practical impact of school-age children using digital games to learn environmental education

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Abstract. This electronic document is a "live" template and already defines the components of your paper [title, text, heads, etc.] in its style sheet. With the advancement of technology, the publicity of environmental protection decrees presents the different types from school education to the multiple digital media, such as social media, animation, films or mobile games, let people to learn the correct knowledge about environmental protection. Middle and senior grade students are learning social normal to build self-awareness, and interesting in games. Using participatory observation method to explore the changes of environmental protection awareness and behavior practices in 12 middle and senior children before and after playing two games. The study found that through mobile game education, children have an improvement rate of about 60% in the implementation of environmental awareness knowledge and practice. The cute characters are more attracted. For middle grade children, they prefer action types of games because the experience of fighting monsters is exciting. Comparing to them, senior grade children prefer knowledge types of games because they consider that can learn more new environmental knowledge. In terms of gender, boys prefer action games and girls prefer knowledge games. This research hopes to improve the effectiveness of existing environmental protection publicity, and cultivate children's knowledge, literacy and practical ability of environmental protection through game-based learning, so as to facilitate the sustainable development of environmental education.

1 Introduction

Modern people generally understand the importance of environmental education. With the advancement of science and technology of the times, the promotion of environmental protection education has changed from traditional classroom paper to now. Including: board games, animation, film and television, and even digital games, etc.

The forms are quite diverse. However, according to the statistics of the Environmental Protection Agency, the amount of garbage produced in Taiwan from 2014 to 2019 not only

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did not decrease but increased year by year, it means that with the rising environmental awareness and advocacy, the garbage has not decreased, also continued to increase. This study considers that environmental protection education starts with school-age children. At this stage, children already could take care of themselves and are learning the norms of group life, with high plasticity. Moreover at the age of loving digital games, Positive games can help players strengthen their learning ability, make faster judgments in the face of problems, and cultivate correct attitudes through digital games (Jong & Shang, 2015).

Accordingly, this study intends to explore The impact of elementary school children using digital games to learn environmental protection education, including the player's game experience and practice, Through school-aged children before playing digital games.

Finally, the degree of understanding and practice of environmental protection knowledge can effectively cultivate children's literacy and practical ability to practice environmental protection.

2 Literature review

2.1 Environmental Education promotion type

In order to transform environmental protection education policies into concrete actions, improve the environmental literacy of the whole people, practice responsible environmental behaviors, and create a sustainable society with cross-generational well-being and resource recycling, according to environmental education pointed out by the Comprehensive Planning Office of the Environmental Protection Agency of the Executive Yuan of the Republic of China Articles 5 and 6 of the National Environmental Education Act and the National Environmental Education Program formulated the "National Environmental Education Action Plan" on March 5, 2013, urging all agencies (institutions) and schools to promote their business under the principle of environmental sustainability and accelerate Popularization of environmental protection education.

Environmental education is advancing with the times. In addition to traditional literature and textbook education, the learning mode of environmental education tends to be digital., networking, and there are multiple ways such as films, animations, and games to allow the public to learn correct environmental protection knowledge (Zhou & Xu, 2010; Kalenova et al., 2020).

However, not all digital methods will be paid for by the public. Judging from the official YouTube account Of the Environmental Protection Agency of the Executive Yuan, The Number of Channel Subscribers is Nearly. Although the Highest Number of a Single V. IDEO is 200,000, most of the videos have only a thousand views. People, the results still have grown. If you search for related videos on YOUTUBE with the two Chinese characters of "environmental protection", you can find that the video with the highest number of views is 3.91 million times, but it is more of a craft creation and has less relevance to learning about environmental protection. Internet celebrity publicity is about 1.5 million person-times, for example: used to be The popular online program" Muyao 4 Super Play" once filmed an inspector of the Environmental Protection Bureau for a day. A lot of environmental protection education knowledge was incorporated into the film, and the number of viewers reached 1.51 million. In addition to video promotion, there are also a number of environmental education game apps. For example, "Baby Environmental Protection Little Guardian" has been downloaded more than 5 million times, far exceeding the viewing rate of videos. Interactive games may be the future of environmental protection education promotion. new style.

2.2 Gamified Learning

Gamification was proposed by British engineer Nick Pelling in 2002, Gamification is to disassemble the interesting and addictive elements in the game and apply them in the real world to improve behavioral motivation and give participants a sense of accomplishment. The more fun the more attractive it is (Chou, 2015; Ushakov et al., 2022).

The most important thing about most games is the level design inside, how to keep players interested in the game through the gameplay mechanism or extend the life cycle of the game by solving tasks and forming alliances with teams. To put it simply, gamification is a kind of "humanity-centered design". According to why people do or don't do something, find incentives to strengthen people's feelings, motivation, and engagement. Therefore, when people want to develop a new habit, adding gamification elements can help people face challenges more easily, and even change people's behavior, stimulate motivation, let people enjoy fun, and re duce the pain of people learning new behavior patterns. To develop habits and change habits, there are still many layers of difficulties and obstacles in front of you before you really "do it". Gamification is a very good tool to help people reduce difficulties and obstacles.

Gamification learning has the following benefits:

1. Make faster judgments in the face of problems: Research by the University of Rochester in the United States shows that because images and objects in games will move or appear, players need to receive and adapt to sensory information in a timely manner. The player's ability to respond to game content, intangible Among them, people can make decisions and judge problems more quickly in real life.

2. Helping to strengthen learning ability: Research at University College London and Queen Mary University of London pointed out , two groups of people, one group playing a quick, real-time strategy game, and the other group playing a more time-consuming life simulation game , It was found that players of strategy games need to process more game information and think more, which enhances cognitive fitness and allows people to learn more efficiently. The more you know how to play games " purposefully", the stronger your resilience will be, and the less you will avoid yourself in the future.

For school-age children, at this stage, children could learn independently, are also learning social norms, are curious about everything, and are very playful (Hong & Fu, 2012; Ezhak et al., 2021; Kunasaraphan, 2020) be played I believe it can be a good form of education and publicity.

2.3 Analysis of digital games related to environmental protection

This research set out to investigate the game APP with the theme of environmental protection, and in accordance with the principle of the Chinese language commonly used by the test subjects, there were three environmental protection games collected on the two major mobile phone systems, each of which was developed by the Environmental Protection Bureau of Hualien County. ", PIXIO's "Earth Game!" and Zhi Yong Information Co., Ltd.'s "Baby Learns to Sorting Garbage". In addition, the knowledge-based environmental protection game developed by the research team is the fourth game, and the analysis is shown in Table 1.

Table 1. Analysis table of four existing environmental protection games (source: GOOGLE PLAY, researchers' compilation)

Game name	Environmental recycling alliance purification battle	Earth game!	Baby learns garbage sorting	Fish and birds

Game name	Environmental recycling alliance purification battle	Earth game!	Baby learns garbage sorting	Fish and birds
Game type	Action	Operate	Knowledge learning	Knowledge learning
Developer	Hualien county environmental protection bureau	Pixio	Zhi yong information co., ltd.	Researcher
Time required to play	About 25~30 minutes	About 30 minutes	About 20~30 minutes	About 20~30 minutes
Age orientation	6-12 years old	Over 15 years old	4~6 years old	6-12 years old
Feature	The 2d scrolling method is adopted, and the scene and character design are combined with environmental protection-related images. The game button icons are simple, and the levels are concise and clear.	The game content adds realistic elements, and the feedback in the game can be compared with real behavior. The game ending adopts an open result, compared to authentic.	The play method is simple and intuitive, and it is more for children. The level design and illustration style are also suitable for children.	3d games increase the sense of interaction with players.
shortcoming	Level design count It is more complicated, and the response to continuous clicks will be slow.	longer play time	longer play time	The difficulty of the topic is high

3 Research methods and steps

3.1 Research Methods and Objects

School-age children refer to those aged 7 to 12, who begin to learn formal group norms and are also a period of playfulness. school age (school age), according to According to the stage classification of cognitive development theory, it is in the concrete operational stage (Concrete Operational Stage). At this stage, children's thinking characteristics can already be reasoned from familiar experience and specific situations and can be classified according to two or more characteristics of objects (Li et al., 2018; Mezinova et al., 2022), but consider the limited literacy comprehension skills of younger children, And the game operation time is longer, so this study takes middle and senior students as the subjects (Right now three to six Grade), in terms of gender, there are 3 middle-grade boys and girls, 3 senior boys and 3 girls each. Research Participatory observation and questionnaire survey, Observe the actual playing conditions of the testers. The main contents of the questionnaire are as follows:
- Personal information: including grade, gender, awareness of environmental protection, and degree of implementation. The degree of environmental protection cognition and implementation is based on the subject's environmental awareness.
- Environmental awareness: divided into knowledge improvement, knowledge implementation, play expectations, etc. three parts.

3.2 Research Tools

In order to understand the effect of environmental games on subjects Influence, this study analyzes the characteristics of four game types, which are divided into action type, management type, and knowledge type. Based on the above age considerations, the most end Two environmental protection games of the action type (Purification Battle of the Recycling Alliance) and the knowledge type (Fish and Bird Stories) were selected as the research tools.

3.3 Pre-Test

In Order to Improve the Accuracy and Appropriateness of the Words Use in The Questionnaire, A Third-Grade teacher was invited tester. Content of the questionnaire. and phonetic notation should be added to the questionnaire questions to facilitate children's reading comprehension. In addition, to reduce the problems that may arise when answering the questionnaire, a fourth-grade student was invited to take a pre-test of the questionnaire fire before the formal experiment. Questions are used as questionnaire modification indicators.

3.4 Formal Experiment

Using the method of school entrance interview and participant observation, the participating school is Taitung County Elementary School. At the beginning of the experiment, the researcher explained the purpose of the study, the process of the experiment and the items to be filled in, emphasizing the confidentiality of the data.

4 Research Results and Discussion

A total of 12 questionnaires were recovered in this study, and no invalid questionnaires were found after inspection. 12 subjects by year. The statistics of grade and gender are shown in the Table 2.

Table 2. Data of subjects in this study (unit: person)

Grade / Gender	Middle grade		Senior grades		Total
	Third grade	**Fourth grade**	**Fifth grade**	**Sixth grade**	
Girl	1	1	2	1	5
Boy	2	2	1	2	7
Subtotal	3	3	3	3	
Total	6		6		12

4.1 Consciousness of environmental protection concept

Gender: please self-assessment by subjects of different genders "I feel that I have the concept of environmental protection", the following adopts" Consciousness of environmental protection concept" call it. Girl, I feel that I have a common concept of environmental protection. There is 1 person, accounting for 8%; I know very well that there are 4 people, accounting for 34% ; I know 1 person very well, accounting for 8%. Boys, I feel that I have a common concept of environmental protection.

There are 3 people, accounting for 25% ; I know 1 person very well, accounting for 8% ; There are 2 people who know very well, accounting for 17%.

Year level: please self-assessment by testers of different year levels "I think I have the concept of environmental protection."

There are 2 middle-grade subjects, average, very understanding and very understanding, each accounting for 17% ; Very do not understand, do not understand average 0 people. Senior subjects generally know 2 people, accounting for 17%; Know 3 people well, accounting for 24% ; Know 1 person very well, accounting for 8% ;the remaining 0 people.

4.2 Self-examination of environmental protection implementation

Gender: Ask subjects of different genders to examine themselves "Whether we are serious about implementing environmental protection at ordinary times", this article uses " Self-examination of environmental protection implementation ". Girls self-assess the implementation of the general degree of environmental protection accounted for 3 people, accounting for 24%, self-examination is the same as meaning Conscientiously implement environmental protection accounted for 3 people, accounting for 24%. 4 males accounted for 34% of the average degree of self-examination and implementation of environmental protection, and self-examination was the same as meaning Conscientiously implement environmental protection 2 people, accounting for 17%.

Year level: among the middle-grade subjects, 0 disagreed with the degree of implementation, accounting for 0%, 3 ordinary subjects, accounting for 24%, and 3 agreed, accounting for 24%. Among the senior subjects, 0 disagreed with the degree of implementation, accounting for 0%, 4 ordinary subjects, accounting for 34%, and 2 agreed, accounting for 17%.

4.3 Environmental concept analysis

This study explores the concept of environmental protection, which includes three items: knowledge improvement, knowledge implementation, and play expectations. Based on the analysis of observation results and questionnaire results, it shows that there are slight differences between boys and girls and grades in terms of environmental protection., The key analysis results are listed below.

Knowledge improvement: After playing, 25% of the people improved, 50% of the people remained the same, especially middle-grade girls grew the most; 25% of the subjects answered correctly, and 50% of the subjects' made mistakes in the pre-test The questions were corrected correctly, and only 25% of the questions were answered incorrectly by more than 5 people. It shows that the environmental protection education in the school has been promoted very well, and it has also grown after playing the game.

Knowledge Implementation: Based on the average of 42 added before and after the game, the questions are all classification problems that are usually encountered; before the game, 75% of them applied the environmental protection knowledge they learned. Among the 10 questions, only 3 questions are selected by the number of people who agree very much, and the number of people exceeds 6, and the general willingness to implement is low; After playing, original Apply what you have learned about environmental protection 75% of Among the subjects, there is another 75% increase in the willingness to implement, In the 10 questions, choose to agree very much and the number of people More than 6 people, increase to 7 questions, There was a significant increase in willingness to implement, showing that the game In addition to improving the willingness of the subjects to implement, the implementation of environmental protection will start from the small details in daily life.

Play expectation: Based on the average of 45.5 before and after the play; before the play, 75% of the subjects Very Looking forward to playing the game, Among the 10 questions, 9 questions choose the number of people who are very looking forward to and the number of people exceeds 6. The subjects all have high expectations for the game ; After playing, Before playing very 75% of the subjects who look forward to playing Among them, 50% will continue to improve, and among the 10 questions, choose very looking forward to play And the number of people is more than 6, then reduce to 7 questions , showing that the subjects were very much looking forward to the game before playing, and after playing Because both are immature games, there are many lacks in the gameplay, which aroused the expectations of the game , But the difference between the average number before and after the game is not that big, It also indirectly shows that the use of games to teach subjects at this age will be more effective than verbal reminders.

4.4 Analysis of game preferences and environmental protection

Knowledge type and action type are equally preferred by the subjects, divided by grade, the middle grades prefer the action type, and the senior grades prefer the knowledge type, divided by gender, boys prefer the action type, girls prefer the knowledge type; In terms of game liking, middle-aged and boys are more attracted to the stimulation of gameplay and the appearance of characters, while senior and girls are on the contrary. The small knowledge provided by knowledge-based games is more motivating for the subjects to implement in their daily life.; Both think that the game screen is good-looking and has a deeper understanding of environmental protection, and can also clearly put forward the environmental protection knowledge recognized in the game. In terms of game dislikes, middle-aged and boys are not easy to click on objects, and the game speed is too slow, which is less attractive to them. Senior grades and girls are not sensitive to button operations, learn less knowledge, and am not motivated after playing. Practice it daily. However, boys and girls in primary, middle and senior grades are willing to practice environmental protection in their daily lives after playing.

In summary, Environmental protection is not limited to school education and teaching. Gamification learning is also a promotional method that can be touched in daily life. According to the above analysis, it is found that regardless of grade or gender, knowledge-type and action-type games have their own favorite audiences. group. But in terms of the knowledge they have learned, those who prefer knowledge games have more answers than those who prefer action games, for example: do a good job of recycling and don't litter on the road; But only similar answers can be answered. The operation reflex speed of action games is relatively fast, and it is difficult for school-age children to learn environmental protection information. The details of the information are not fully understood, and the game is over, or the next level is on.

However, regardless of whether they like action games or knowledge games, school-age children understand that they should be responsible for environmental protection. The possible reason is that the long-term teaching of school education to the subjects has caused subtle influences. They all have a consensus on environmental awareness and do not need too much. It can also do a good job in the most basic recycling and classification and can also remind colleagues of mistakes.

To further improve the practice of environmental protection, this study suggests that we can compile knowledge transfer together with experts, and also stimulate the gameplay, so that it can be used as a game that can be played both in class and in leisure time. This extension can also be extended to kindergartens and junior high schools. In addition to deepening the awareness of environmental protection, it can also stimulate the

implementation of practice, and get rid of the need to broadcast documentaries or presentations to convey environmental protection concepts.

The purpose of environmental protection is to "Practice and Impact", if it can make Children's easy learning of environmental protection can allow them to implement daily garbage classification, and it can also affect their peers and family members to minimize the pollution of the environment. This study suggests combining games with classrooms to achieve the purpose of entertaining and teaching. Through fun games, children can learn about environmental protection and its impact on the environment, so that children can have a deeper sense of responsibility for the implementation of environmental protection and protect the existing ecological environment.

5 Research Conclusions and Recommendations

This study investigates the impact of environmental protection games on environmental protection awareness and practice with questionnaires to understand the impact of elementary school students in middle and senior grades on environmental protection awareness and practice after playing. After literature review and analysis of 12 valid questionnaires, the conclusions are as follows:

Overall, the game is very helpful for school-age children to understand new things. In addition to showing that the environmental protection education in the school has been promoted very well, what the subjects learned in the game has also grown, and the environmental protection they remember the amount of knowledge has also increased slightly, and I am more willing to practice environmental protection in my daily life after playing.

In-depth observation shows that knowledge-based and action-based games have appropriate grades and genders in terms of gameplay and content. For the subjects, it is better to imagine the benefits of implementing classification for the environment, and the effect of game teaching will be more direct than verbal reminder.

During the interview, none of the subjects disliked games, showing that if it is a game-style learning, middle-grade and senior-grade students are not against it, and they will choose the game that is more impressive and suitable for them out of the two games. My favorite game, even if both games have gameplay or there are still loopholes in the operation, but the player is at the stage of enjoying the game and is willing to learn more about environmental protection through playing.

This research is carried out using participatory observation method. The subjects are in elementary school, middle school, and senior grade. After the research, it is found that some special terms in the questionnaire titles in this research, such as: raw food waste, some children do not understand this term mean, or too shy to ask questions, which will inevitably affect the inference of the research results. It is recommended that follow-up researchers provide notes after special terms when designing the questionnaire, Improves research accuracy. Finally, due to geographical and time constraints, the questionnaire survey in this study only focused on 12 middle- and high-grade boys and girls in Taitung County and did not discuss primary education in other counties and cities, so it was impossible to explore urban Rural gap The impact on environmental awareness and practice, and then infer more possible impacts on education of difference.

6 Acknowledgment

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