PRATAMA WIDYA: Jurnal Pendidikan Anak Usia Dini
Volume 10, No. 1, (April 2025) 65-76
pISSN: 25284037 eISSN: 26158396
http://ojs.uhnsugriwa.ac.id/index.php/PW

DEVELOPMENT OF SMART APPS CREATOR-BASED EDUCATIONAL GAMES TO IMPROVING CHILDREN'S HEALTH LITERACY

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Received 04/02/2025, Accepted 13/02/2025, Published 30/04/2025

Abstract

Early childhood health literacy is an important skill that supports the formation of healthy living habits from an early age. However, health literacy learning is often less attractive to children because it is delivered passively. This research aims to develop a prototype of an interactive educational Game specifically designed to improve early childhood health literacy. The research method used is Research and Development (R&D) with the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). This study focuses on the Development stage, which includes a needs analysis through interviews with three early childhood education teachers, one pediatrician (as early childhood and health literacy expert), and one IT specialist (as game prototype development expert). The results of the study show that relevant health literacy themes include personal hygiene, healthy diet, and physical activity. The Game prototype "Clean and Healthy Adventure with Vivi and Vito" is designed with four interactive levels that use simple visual and narrative elements. Early validation by one IT expert showed the Game was exciting and suitable for early childhood with a few minor tweaks. The prototype is ready to be further tested to measure its effectiveness as an innovative and interactive and fun learning medium.

Keyword: Digital Game; Health Literacy

INTRODUCTION

Early childhood health literacy is a child's basic ability to understand and recognize various health concepts, including maintaining personal hygiene, a healthy diet, and the importance of physical activity (Dunn & Hazzard, 2019). Health literacy is an important skill that needs to be introduced from an early age. At this age, children begin to learn about how to wash their hands, brush their teeth, eat nutritious foods, and recognize other healthy lifestyle habits. Early introduction of health literacy helps children form positive habits that are important for their growth and well-being (Gonzalez-Rodríguez et al., 2020). In addition, Nutbeam (2000) also states that health literacy also includes an understanding of how to maintain personal safety and prevent disease. Through health literacy, children learn to be more independent and responsible

in maintaining health, so that children who have a basic understanding of health have more potential to develop healthy living habits that will be carried over to adulthood.

Early childhood's ability to understand health information often depends on the learning media used by educators and parents. Unfortunately, health materials in general are less attractive to children because they are presented in a passive form and tend to be difficult to understand, so children lose interest in learning about the importance of maintaining health (Parisod, 2019). Research shows that passively delivered health materials often fail to attract children's interest, because they lack motivation to understand or internalize the concept (Ouedraogo et al., 2022). Passive health materials, such as presentations without interaction or engaging visuals, tend not to actively engage the child. Children are more motivated and interested when learning is carried out with the approach of playing, interacting, or experimenting directly. When information is presented only through texts or lectures without context relevant to everyday experiences, understanding becomes more difficult and interest decreases.

Other research has found the impact of passive and less engaging material makes children less interested in health learning (Conard, 2019). The material delivered by the lecture method tends to involve children who are less active, so they have difficulty understanding and are less interested in exploring health topics. As a result, children's motivation to learn about health is low. On the contrary, health learning methods that involve games or direct activities have proven to be more effective in attracting children's interest (Pangestu et al., 2024). Research supports that play-based learning methods can increase children's understanding and interest in health materials, because children are actively involved and feel more motivated to practice healthy lifestyle habits (Li et al., 2013). Several research results show that health materials are needed that are packaged into interesting and interactive media to foster children's interest.

In today's digital era, the use of interactive media, such as educational games, is a relevant and effective choice in delivering learning materials to children. Educational *games* are designed to combine learning concepts with interesting game elements, making children learn in a fun way. Various studies have shown that play-based learning can increase children's motivation, engagement, and understanding of the material presented (Kutbay et al., 2024; Pazarcikci & Ağrali, 2024). In line with the meta-analysis in Frontiers in Psychology reveals that digital game-based learning not only helps children become more motivated but also provides a more interactive and enjoyable learning experience (Fitri et al., 2025; Mancone et al., 2024). This has proven to be effective in improving the cognitive, social, and emotional abilities of early childhood so that it becomes a potential tool to be applied in Early Childhood Education (PAUD). Other research has also shown that students tend to be more interested and perform better when learning with digital game methods compared to traditional methods (König & Suhr, 2023). Some students stated that digital game-based learning increases their interest and efficiency in learning, as well as gives them a higher sense of confidence in the material being studied. So that through active interaction in play, children not only listen to information, but also practice it in a more interesting and interactive context.

However, there are still limited educational games that focus on health literacy for early childhood as a challenge in an effort to improve children's understanding of basic health concepts, such as personal hygiene, healthy diet, and the importance of physical

activity. Most educational games for children still focus on cognitive aspects such as number or letter recognition, while aspects of health literacy are often overlooked (Dadaczynski et al., 2021; Siuko et al., 2023). In line with the Multidisciplinary Digital Publishing Institute (MDPI) which states that serious play for children with learning disabilities mostly focuses on developing reading and writing skills, but less covers skills related to health literacy and other aspects of health-related education (Themistokleous et al., 2020). In fact, health literacy from an early age can be the foundation for maintaining children's health and quality of life in the future.

Based on the description above, this study aims to develop a prototype *of an educational* game that is specifically designed to improve early childhood health literacy. This game is expected to not only convey health information, but also encourage children to practice healthy living habits through the activities presented in the *game*. This research will use *the Research and Development* (R&D) method with a focus on the development stage *of games* that are valid and suitable for use as a learning medium. Thus, the results of this research are expected to contribute to providing interesting and educational innovative learning media for early childhood, especially in improving health literacy.

METHODOLOGY

This study uses a qualitative approach with a *Research and Development* (R&D) design that focuses on the development stage (Branch, 2009) to produce educational *games* that are used to improve early childhood health literacy (Richey & Klein, 2014). A qualitative approach was chosen in this study to better understand the needs of early childhood and the perspective of educators regarding health literacy in the context of learning. While the R&D design in this study was adapted from the steps developed by Borg & Gall (1984), it only reached the development stage without further trials. The R&D stage involves several main steps: needs analysis, product design, and product development. The following is a chart depicting the stages of this research.

Chart 1. Research Procedure

Based on the graph, it illustrates that at the needs analysis stage, interviews with three PAUD teachers in Serang City as participants one, two and three. In addition, the participant in this study is a pediatrician (Sp.A) who has at least five years of experience in clinical practice and is active in health education for early childhood and the elderly. The selection of participants was carried out by *purposive sampling* to ensure that the doctors involved had in-depth insights into early childhood health literacy. This was done to identify health themes that are important for early childhood, namely personal hygiene, healthy diet, and physical activity. The product design stage involves designing visual concepts, characters, and game plots that are in accordance with early childhood preferences, as well as inserting educational elements that encourage understanding of healthy living habits. The development stage is carried out

by making an initial version (prototype) of an educational *game*, which is then validated by an IT expert who has an educational background in information technology, software, or *game* development and has experience in designing *educational games* for early childhood. The validation process aims to ensure that the content and display of *the Game* are in accordance with the child's developmental needs and have high visual appeal. These three stages are the initial part of the R&D process and focus on making products that are relevant, as needed, and worthy of further testing.

RESULTS AND DISCUSSION

This research develops a prototype of an educational game that combines health literacy with interactive design elements for early childhood. The findings show consistency with previous research that emphasizes the effectiveness of digital game-based approaches. Further testing on prospective users is expected to strengthen the validity and positive impact of this game in improving health literacy in early childhood. Here are the results and discussion.

RESULTS

1. Needs Analysis Stage

Participant one gave a statement that teaching children about the importance of washing hands, brushing teeth, bathing, and maintaining body hygiene to prevent diseases is very important to teach in early childhood. Meanwhile, participant two provided information that introducing healthy food, the importance of consuming vegetables and fruits, and avoiding foods that contain a lot of sugar or chemicals as well as teaching the importance of movement and play, as well as how physical activity supports growth and body health also needs to be understood by early childhood. In line with the three participants who provided information that maintaining personal hygiene, a healthy diet and exercising regularly are very important things to know in early childhood.

Then, the statements from the three participants were complemented by four participants who provided information that it is important for children to understand the importance of washing their hands properly, maintaining body hygiene, brushing their teeth, and other healthy habits to help protect themselves from germs and diseases. Then introduce the concept of balanced nutrition, which is to consume a variety of healthy foods for physical and mental development. Children can learn about the benefits of vegetables, fruits, and water for their health. Physical activity should also be taught to early childhood to understand the importance of exercising or moving actively every day to help gross and fine motor development. From the four participant statements, it can be concluded that the health literacy material that will be the theme in the digital game is maintaining personal hygiene, balanced nutritious food, and physical activity.

2. Product Design Stage

This research resulted in the initial design of an educational *game* prototype based on the results of the analysis of early childhood needs and health literacy materials. Here are some specific findings from the design phase:

a. Game Content Structure

Theme: "Clean and Healthy Adventure with Vivi and Vito". This theme was chosen because the Children's characters are considered interesting and can be used to convey health messages visually.
Key Ingredients: Healthy living habits that include washing hands properly, maintaining environmental cleanliness, choosing healthy and nutritious foods and exercising regularly.
Game Stages: This *game* is designed to have four levels, each focusing on a single health literacy topic.

Figure 1. Game Content

b. Visual and Interactive Design Elements
Colors: Bright colors such as red, yellow, green, and blue are used to create a friendly and inviting atmosphere for children.
Characters: The main characters (Vivi and Vito) come with simple animations, such as joyful expressions and simple instructions to keep the child engaged.
Interaction: Children are asked to complete simple tasks such as: performing sequential handwashing steps according to the World Health Organization (WHO), throwing garbage in the trash, choosing healthy and unhealthy foods and following physical activity movements from the videos in the *game*.
c. Narration and Audio
Narration: Each level has a brief instruction that is read out before the game starts, such as: "Look! The playground is so dirty, Can you help me clean it up?"
Audio: Fun sounds like mouse clicks, upbeat background music, and sound effects for certain actions (for example, clapping when your child successfully completes a level).

Figure 2. Narration

d. Storyboard and Initial Sketch

Home Screen: Displays menus with simple navigation buttons, such as "Start" and "Exit". Game Screen: Each level has a preliminary sketch that shows the layout of elements such as buttons, interactive objects (e.g., healthy food), and the main character. Animation: The initial sketch explains how the animation works, such as a checkmark when the child chooses the correct answer and a cross when the child chooses the wrong answer.

Figure 3. Animation

e. Feedback and adjustments

Design Validation Results: Input from experts suggests adding a home button.

Revised: The design is improved by adding a home button that will help the child return to the beginning of the menu on each screen.

3. Development Stage

In the development stage, the prototype design that has been created at the design stage is implemented into a starting product that can be technically tested. Here are the results.

a. Game Prototype Development

Bright colors of red, yellow, green, and blue are applied to graphic elements. The main characters, "Vivi and Vito," are created in a simple yet engaging 2D animation. The background of each level is designed according to the theme, such as the backyard for the topic of physical activity and the dining room for the topic of healthy food. *This game* was created using *the Game development software* namely Smart Apps Creator, the game logic is programmed to create interaction between the player and *the game* elements such as when a child chooses a healthy food (e.g. vegetables or fruits) a checkmark will appear, while choosing an unhealthy food (e.g. junk food) will give a cross-warning with audio.

b. Initial Testing of Prototypes by IT experts

Table 1. Quantitative Validation Results

Validated Aspects	Test Methods	Measured Indicators/Parameters	Measurement Scale	Test Results	Categories Assessment
Game Performance	Technical performance testing across devices	- Game loading time (in seconds)	< 5 seconds (ideal)	4 seconds	Excellent
		- CPU/RAM usage during the game	< 60% CPU/RAM usage	55%	Excellent
		- Frame rate (frames per second/FPS)	≥ 30 FPS	45 FPS	Excellent
Usability (Navigation)	Button and navigation functionality testing	- Time it takes to complete a task (e.g., choosing healthy foods)	< 2 minutes/ task	1,5 minute	Excellent
		- Task success rate	≥ 90%	95%	Excellent
		- Number of errors (e.g., click the wrong button)	≤ 2 errors/ session	1 error	Excellent
User Experience (Satisfaction)	Post-use questionnaire	- General satisfaction with the game (scale 1-5)	1 (Very Dissatisfied) - 5 (Very Satisfied)	4,7	Excellent
		- Understanding of educational content (scale 1-5)	1 (Very Ignorant) - 5 (Very Understanding)	4,8	Excellent
		- Ease of navigation in the game (scale 1-5)	1 (Very Hard) - 5 (Very Easy)	4,6	Excellent
System Error Rate	Game stability testing	- Number of crashes or bugs detected	≤ 1 Crash for Sesi	0	Excellent
		- Responsiveness of buttons and game	100% responsif	100%	Excellent

		elements			

Based on the table above, the tested Game prototype showed excellent results in all aspects tested, in terms of technical performance. *The game* manages to meet the set standards, with most indicators achieving optimal and very satisfactory results, such as fast loading times and minimal technical errors. Thus, this *game* is considered ready to proceed to a larger testing stage with more users (teachers, parents, and children).

c. Prototype Improvement Based on Feedback
Narrative Revision: Sentences like "Let's clean this playground" were changed to "Let's clean up!" to make it simpler.
Visual Adjustments: The playground background color is changed to a predominantly light green to reduce the visual intensity.

d. Final Results of the Development Stage
The Game Prototype which includes four levels *of the Game* has been completed. Each level contains animations, interactions, and challenges according to the topic of health literacy. Furthermore, the prototype is ready for further testing to get input from potential users (teachers and parents).

DISCUSSION

1. Needs Analysis Stage

The findings at this stage show the importance of health literacy which includes personal hygiene, nutritious food, and physical activity for early childhood. These findings are in line with the research of Radhakrishnan et al. (2016) and (Rahayu & Setiasih, 2022a) which show that early hygiene education can prevent infectious diseases such as diarrhea and ISPA. In addition, the study of Parisod et al. (2017) emphasized that the introduction of a healthy diet from an early age can help reduce the risk of obesity in the future. Parental participation in conveying healthy habits is also supported by research (Rahayu & Setiasih, 2022b) which confirms that family involvement in health education provides more effective results. This research underscores the importance of activity-based interactive approaches, such as educational digital games, to improve children's understanding.

In addition, the integration of health literacy into the early childhood education curriculum can also be a strategic step to support the holistic development of children. In accordance with the findings presented by Rivera et al. (2020), educational programs involving play-based activities can increase children's interest and involvement in understanding health concepts. In addition, this approach provides an opportunity to actively engage children in the practice of healthy habits, so that the learned behaviors can be better internalized. Another study by Horowitz et al. (2017) also shows that collaboration between educational institutions and parents is key to creating an environment that supports healthy habits in a sustainable manner. Thus, the results of this study provide a foundation for the development of holistic and community-based health education programs, which not only focus on children but also involve families and the wider community as agents of change.

2. Product Design Stage

The product design, especially the theme "Clean and Healthy Adventure with Vivi and Vito," reflects the combination of health literacy with interesting game elements. Research by Arzaqi et al. (2024) shows that the use of children's characters in educational games increases engagement and understanding of concepts in early childhood students. Interactive elements such as handwashing tasks according to WHO standards are also relevant to the findings of Haruna et al. (2023) who stated that the hands-on approach in digital learning media is more effective in forming habits than traditional methods. Meanwhile, the use of bright colors and animation is in accordance with the principles of children's educational design according to Palumbo et al. (2022), which shows that attractive visual aesthetics increase information retention in children.

In addition, the theme "Clean and Healthy Adventure with Vivi and Vito" not only serves as a means of learning, but also as a medium to encourage collaboration between children and parents. Research by Themistokleous et al. (2020) shows that digital activities involving parents can strengthen children's understanding through strengthening health values at home. In this context, *Game features* such as daily hygiene challenges that can be accessed together provide opportunities for meaningful interaction between children and parents. In addition, the emphasis on interactive tasks such as choosing healthy foods or engaging in simple physical activities reflects the integration of the principles of learning through play, which according to Dunn & Hazzard (2019) is the most effective approach to early childhood learning. Thus, this design offers an innovative solution to introduce health literacy in a fun, effective, and sustainable way.

3. Development Stage

The use of Smart Apps Creator software to prototype *Games* demonstrates the adoption of technology in education. This is supported by research by Davaris et al. (2021) which found that the use of application-based game technology can increase children's motivation to learn, especially for health topics. Technical testing and initial validation of prototypes reflect the importance of iteration in the development of learning media. These findings are in line with the research of Kutbay et al. (2024), which emphasized that input from education and visual design experts is essential for creating effective and user-friendly educational products.

Furthermore, the development of a prototype using Smart Apps Creator also highlights the flexibility of this software in producing interactive learning media that suits the needs of early childhood. According to research by Bao et al. (2020), software that supports interactive features and gamification can provide a more personalized learning experience, allowing children to learn at their own pace and interests. In addition, the iteration process carried out during the development of the prototype not only improves the technical quality of the product, but also ensures that its educational and visual elements are in harmony with the characteristics of the child's development. The involvement of experts from various fields, such as early childhood education, graphic design, and information technology, reflects the importance of a multidisciplinary approach in creating innovative and effective learning media. Thus, these results reinforce the argument that cross-disciplinary collaboration and cutting-edge technology can provide relevant and impactful educational solutions.

Then when compared to conventional approaches, such as delivering material through books or passive videos, the use of interactive games is superior in attracting the attention of early childhood. Research by Rahayu & Setiasih (2022c) shows that play-based learning can improve children's gross and fine motor skills through physical and cognitive interaction. However, there are challenges in ensuring that content remains simple but still in-depth, as found (Suci et al., 2024). The study shows that narratives in digital media for early childhood are designed with vocabulary and attention limits in mind.

CONCLUSION

This research produced a prototype of digital-based educational games to improve early childhood health literacy, including personal hygiene, healthy diet, and physical activity. The design and development process results in products that are interactive, engaging, and tailored to children's needs, with expert validation that reinforces their effectiveness. This prototype is expected to be an innovation in supporting children's health literacy through digital media, with further trials to measure its impact on children's behavior.

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