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Enhancing Seventh-Grade Numeracy Skills in Data Presentation Through Interactive Gaming

Hans Juwiantho[1], Alycia Jane Sidarta[2]
[1,2]Informatics, Petra Christian University, Indonesia
hans.juwiantho@petra.ac.id[1], ragdollcats39@gmail.com[2]

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ABSTRACT

Integrating educational content into a game format aims to make learning more enjoyable and accessible to students. The game's design focuses on gradually increasing the difficulty level to challenge students' abilities and encourage problem-solving. The benefit of this numeracy game for learning is its ability to create a lively and interactive learning environment. By immersing students in a captivating storyline and providing opportunities for exploration and discovery, the game fosters engagement and enthusiasm for learning. The game offers immediate feedback to players, allowing them to learn from their mistakes and improve their skills over time. Moreover, the game is a supplementary tool for educators to reinforce classroom learning and provide additional practice opportunities for students. It encourages independent learning and critical thinking while reinforcing mathematical concepts in a fun and interactive way. Survey results consist of 21 seventh-grade students from various schools, indicating high engagement, with 95.2% finding the game stimulating. The pre-test and post-test have 5 questions covering various mathematical concepts relevant to numeracy skills; the questions addressed topics such as pie charts, graphs, tables, logical reasoning, and drawing conclusions from given data. The result scores show improvement, rising from 2/5 to 3.43/5, suggesting a learning process during gameplay.

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A. INTRODUCTION

Numeracy skills are crucial in education and everyday life as the foundation for understanding and effectively using mathematical concepts (Kusmaharti et al., 2022; Rohendi, 2019). These skills enable students to comprehend numerical information, solve problems, analyze data, and make informed decisions. Moreover, numeracy skills are vital for success in the workforce, as many jobs require working with numbers accurately and efficiently. Therefore, encouraging numeracy skills in education is paramount for equipping students with the necessary tools to navigate an increasingly quantitative world and to thrive academically and professionally (Kemendikbud, 2017). Exploring the numeracy of seventh-grade students in data presentation skills is fundamental. It provides insights into their foundational mathematical competencies at a critical stage of their educational journey (Situmorang et al., 2023).

Creating a lively learning environment enhances the effectiveness of educational activities by encouraging engagement, motivation, and active participation among students. Students are more likely to be attentive and enthusiastic about learning when the learning environment is dynamic

and stimulating. Elements that can improve engagement include narrative (story), feedback, and replayability (Kapp, 2012). This heightened engagement promotes deeper understanding and retention of concepts, as students are actively involved in the learning process. By creating a lively learning environment, educators can enhance the effectiveness of educational activities by promoting engagement, collaboration, and positive emotional experiences among students. This, in turn, leads to improved learning outcomes and academic success (Bado, 2022; Bilgin et al., 2015).

Educational games are an effective method to infuse enjoyment into the learning process. These games offer a dynamic and interactive approach to learning, engaging students in a way that traditional methods often struggle to achieve (Tokac et al., 2019). By integrating games into educational activities, students can experience learning as an enjoyable and stimulating endeavor rather than a mundane task. Educational games provide immediate feedback, allowing students to learn from their mistakes and track their progress in real time. Employing games in studying can transform the learning experience, making it both engaging and effective for students (Subhash & Cudney, 2018).

Researchers have explored various interactive gaming aspects, including its impact on student engagement, motivation, learning outcomes, and cognitive development. Interactive gaming in education provides valuable insights into the potential benefits and challenges of integrating gaming into educational activities. The results suggest that gaming positively influences educational objectives (Vlachopoulos & Makri, 2017). Other studies have found that interactive games can captivate students' interest and enthusiasm, increasing enjoyment in learning. Gaming can promote active learning by providing opportunities for exploration, experimentation, and problem-solving (Boyle et al., 2016). Exploring interactive gaming in education underscores its potential to positively impact student engagement, motivation, and learning outcomes while offering valuable insights into the challenges and opportunities associated with its integration into educational activities.

The case study employs a mixed-methods approach to assess the effectiveness of a numeracy game in enhancing seventh-grade students' mathematical skills and problem-solving abilities. Quantitative analysis involves pre-test and post-test assessments to measure changes in students' proficiency, while qualitative insights are gathered through participant surveys and interviews to understand students' perceptions and experiences with the game. This combined methodology aims to provide a comprehensive understanding of the game's impact on learning outcomes, engagement, and overall effectiveness.

This paper examines how interactive gaming can improve numeracy skills among seventh-grade students, with a particular emphasis on data presentation. By reviewing relevant literature and analyzing a case study, this study aims to uncover the advantages and obstacles associated with integrating interactive gaming into educational environments. The primary objective is to enlighten educators about the utility of interactive gaming as a tool to improve learning methods in numeracy education. Understanding the impact of interactive gaming on learning outcomes is vital for addressing the changing landscape of education and promoting innovative teaching approaches. Additionally, this research also provides suggestions for future research and implementation approaches.

B. METHODS

This research, which incorporates a level-based system into educational games, offers several advantages for learning. Firstly, it provides a structured progression of difficulty, allowing players to start with more manageable levels and gradually advance to more challenging ones (Korchi et al., 2021). This gradual increase in difficulty ensures learners are not overwhelmed by complex concepts early on, promoting a smoother learning curve. Additionally, advancing through levels gives players a sense of accomplishment and motivation, as each completed level signifies progress. This sense of achievement can enhance engagement and sustain interest in the educational content. Furthermore, the level-based system accommodates learners of different skill levels by allowing them to progress at their own pace. Players who grasp concepts quickly can move on to higher levels, while those who need more practice can spend more time on earlier levels. This adaptability allows for personalized learning experiences tailored to individual needs. The level-based system provides a structured framework for learning, offering a balance between challenge and support that promotes engagement, motivation, and effective skill development.

In addition to the level-based structure, the game includes several other features to enhance the gaming experience. One such feature is a captivating storyline that immerses players in a rich narrative world, providing context and motivation for their actions (Cameron, 2017; Rowe & Lester, 2015). Players may also be able to move their characters, adding a personal touch to the gameplay. Interactivity is another crucial aspect of the game, with players engaging in various activities such as problem-solving, decision-making, and exploration (Adipat et al., 2021). The game also incorporates feedback mechanisms to provide players with direct information on their answers. Positive reinforcement for correct actions and constructive guidance for mistakes help players learn from their experiences and improve their skills (van der Kleij et al., 2012). Combining the level-based system and these additional features creates an immersive and rewarding gaming experience that promotes skill development, critical thinking, and enjoyment.

The pre-tests were conducted before the students engaged with the gaming intervention, while the post-tests were administered afterward to measure any changes in their numeracy skills. Additionally, surveys and interviews may have been utilized to gather qualitative data about the student's experiences with the gaming intervention and their perceptions of its impact on their learning. These data collection methods provided comprehensive insights into the effectiveness of interactive gaming in enhancing numeracy skills among seventh-grade students.

The participants consist of seventh-grade students from various schools or educational institutions. A total of 21 students participated in the research. The age range of the participants would typically be around 12 to 13 years old. The selection process involved obtaining consent from the students and their school teachers. Data collection procedures included administering pre-tests and post-tests to assess the effectiveness of the interactive gaming intervention in improving numeracy skills. Before engaging with the game, participants completed a pre-test to establish a baseline of their numeracy abilities.

The pre-test and post-test consisted of 5 questions covering various mathematical concepts relevant to numeracy skills, including data presentation, interpretation, and problem-solving. Specifically, the questions addressed topics such as pie charts, graphs, tables, logical reasoning, and drawing conclusions from given data. Each test contained a set of questions with varying 5 levels of difficulty corresponding to the five levels of the numeracy game. The questions were designed to assess students' understanding and proficiency in these areas, with the aim of gauging their progress and skill development for the study. Additionally, both tests included questions

tailored to the specific educational objectives of the game, ensuring alignment between the assessment instruments and the learning goals of the game.

After completing the game, participants did a post-test to evaluate any changes or improvements in their numeracy skills. Firstly, descriptive statistics will be used to summarize the overall performance of participants in both the pre-test and post-test. This includes calculating measures such as mean scores and frequency distributions to provide an overview of students' numerical proficiency levels before and after playing the game. This statistical analysis will help determine whether any changes in students' numeracy skills from the pre-test to the post-test are statistically significant. By comparing the results of the pre and post-tests, the study aimed to determine the effectiveness of the numeracy game in promoting skill development and learning outcomes among seventh-grade students. This method approach allowed for a comprehensive evaluation of the impact of the numeracy game on students' learning experiences and outcomes, contributing to a more robust understanding of the effectiveness of interactive gaming in educational settings.

C. RESULT AND DISCUSSION

The storyline of this numeracy game revolves around the Kingdom of Reacynum, a fantasy realm where numbers are used to solve various everyday problems. To protect the kingdom, they conduct regular training sessions for their knights to enhance their numerical abilities and safeguard the realm. One day, a kingdom knight seeks permission to meet with the King. This knight (the protagonist) requests additional training from the King. The picture of the game can be observed in Figure 1, where the knight meets the king. Impressed by the knight's eagerness to learn, the King sends him to meet one of his assistants. The King's assistant is a farmer who typically provides additional training for the knights. The knight sets out to meet the farmer. Upon successfully finding the farmer, the farmer will introduce the knight to the lowest difficulty level to play. After completing the first level, the knight will be instructed to proceed to the next, more difficult level, from level 1 to level 5.

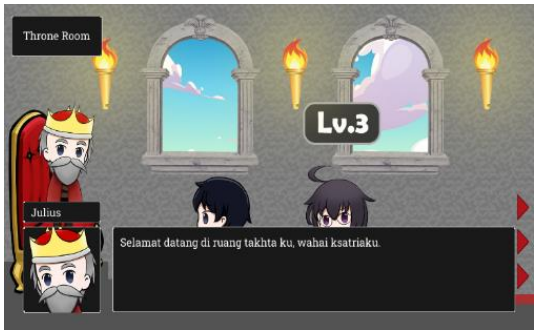

Figure 1. Knight meets The King

The game introduces a variety of characters crucial to its storyline. The protagonist, a knight under the king's command, embarks on a quest to enhance numerical abilities within the fantasy realm of Reacynum. Accompanied by the wise and benevolent King, known for his love for felines, the knight encounters the cheerful and helpful Farmer, distinguished by her unique rabbit-like ears and agricultural expertise. Additionally, the game features characters such as the altruistic Fisherman, the conscientious Treasurer, the hesitant Doctor, and the serene Royal Commander. Each character contributes uniquely to the knight's training, offering diverse perspectives and

challenges reflective of their roles within the kingdom's dynamic landscape. The corresponding characters and levels can be found in Figure 2.

Figure 2. List of 5 Different Levels in The Game with different Characters

Players can interact with the non-playable characters (NPC) present in the game. This allows players to converse with these characters, who can provide clues and information or even trigger certain events in the game. This interaction adds a dimension of interactivity to the game and provides a deeper playing experience for the players. Figure 3 shows the interaction between the player and the NPC. Players can engage in dialogue with NPC or proceed directly to the questions that must be solved.

Figure 3. Interactive Dialog with Non-Playable Characters

The numeracy questions in the game are tailored to varying difficulty levels. Each of the five levels comprises ten numeracy questions, totaling 50 questions in the game's numeracy bank. If players fail to answer a question correctly at a certain level, a new question of the same difficulty level will be presented. The pre-test and post-test consist of five questions, each adjusted to match

the difficulty level of the corresponding game level. The numeracy questions in the game pertain to data presentation or data processing topics. The different difficulty levels across the five levels are as follows: Level 1 involves straightforward interpretation of pie charts; Level 2 introduces varied data presentation formats such as pie charts, graphs, and tables; Level 3 requires basic general knowledge for interpretation; Level 4 incorporates logical thinking alongside data presentation, and Level 5 challenges critical thinking skills for drawing conclusions based on given data. The example question can be seen in Figure 4.

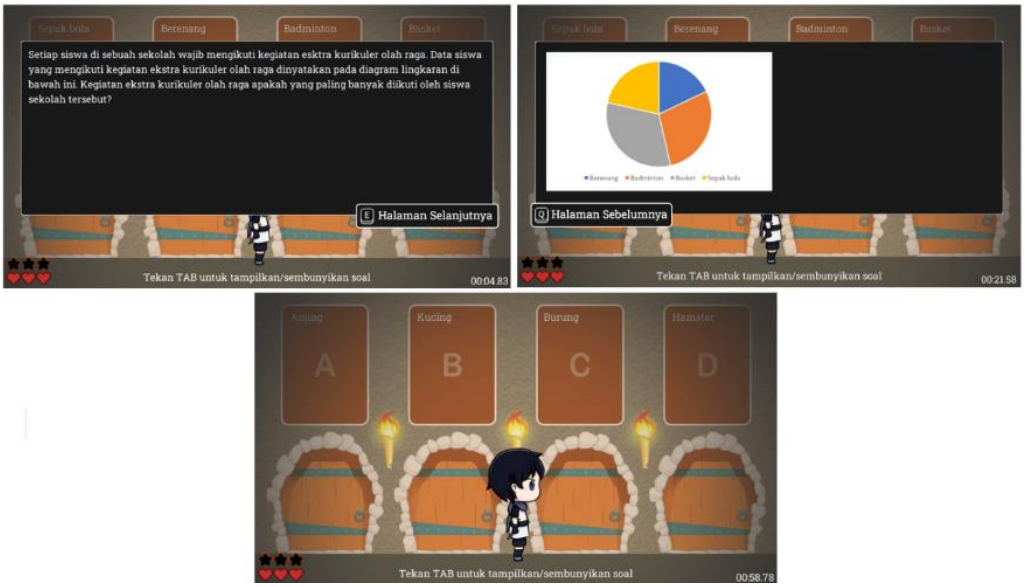

Figure 4. Example Question and List Answer of Level 1

At the start of the game, players have three hearts, which can be lost when they answer a question incorrectly. Each heart indicates the number of lives the player has. If they have already answered incorrectly, the player can view the correct answer explanation to increase their understanding, as illustrated in Figure 5, or move on to choose another answer. When answering a question correctly, the player will receive one star as a reward. If the player has successfully obtained three stars, the "Stage Cleared" message will appear, as shown in Figure 6, and the player can choose to replay the same stage to get another question from the question bank or exit the stage. When exiting the stage, the player will return to the previous location in front of the NPC they talk to.

Figure 5. Question Explanation after Choosing Wrong Answer

Figure 6. Stage Cleared Screen

Table 1. List the School and Number of Respondents

No	School	Total
1	IPH	2
2	SMPN 35	2
3	SMPK Santo Yusuf Tropodo	6
4	PKBM Anak Panah	9
5	SMPN 30	1
6	SMP Dr. Soetomo	1
	Total	21

Testing with respondents aimed to determine the benefits of using this numeracy game in enhancing respondents' understanding of the data presentation topic used in the game. Respondents were asked to answer three questions correctly for each level when playing the numeracy game. There are five levels, starting from level 1 with the lowest difficulty and moving to level 5 with the highest difficulty. If respondents answered incorrectly, they could review the explanation of the correct answer. By reading the explanation of the correct answer, respondents could learn from their mistakes to answer the following question correctly. The number of respondents was 21 seventh-grade students from various schools, with the following breakdown, which can be seen in Table 1.

To determine whether students undergo a learning process when playing numeracy games, the average pre-test scores are compared with the average post-test scores of all twenty-one respondents. The pre-test and post-test consist of 5 questions each, tailored to the corresponding levels in the game. The comparison of average pre-test and post-test scores reveals 2/5 for the pre-test and 3.43/5 for the post-test. From the bar chart pre-test depicting the distribution of total scores, it can be observed that one respondent scored zero (indicating all answers were incorrect). In contrast, no respondent achieved a perfect score of 5 (indicating all answers were correct). Figure 7 shows the pre-test distribution point.

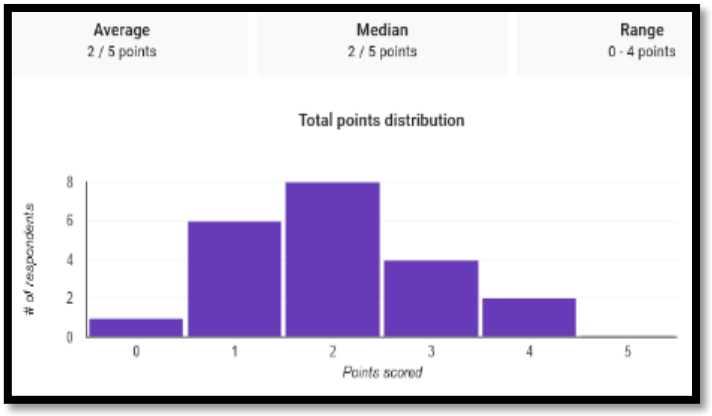

Figure 7. Pre-test Total Distribution Point

The distribution chart of total post-test scores in Figure 8 shows that no respondent obtained a score of zero, and several respondents achieved a score of 5. Examining the data in the table above, the post-test results are superior to the pre-test results. From this, it can be concluded that a learning process occurred during gameplay, increasing the average post-test score among all twenty-one respondents with no one scoring zero or one like pre-test.

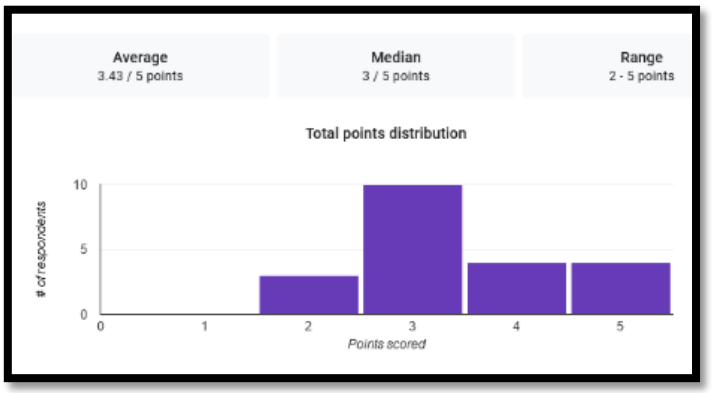

Figure 8. Post-test Total Distribution Point

In addition to testing using pre-test and post-test measures, all twenty-one respondents were asked to provide feedback regarding the numeracy game played. 95.2% of the twenty-one respondents stated that the game is engaging and stimulating for learning. The remaining 4.8% expressed dissent, indicating they found the game unengaging. Using a level-based system with gradually increasing difficulty, 76.2% of participants favored this approach, while 23.8% expressed dissent. Based on the research results, support can be found in previous studies regarding the effectiveness of interactive gaming in enhancing learning outcomes. The findings align with existing literature, indicating that interactive games can engage students and stimulate learning. Specifically, the high percentage of respondents (95.2%) finding the numeracy game engaging and stimulating for learning corroborates previous research highlighting the positive impact of gamified learning approaches on student engagement and motivation (Boyle et al., 2016; Vlachopoulos & Makri, 2017). Therefore, the research results support the existing literature on the benefits of interactive gaming in education, particularly in enhancing student engagement and learning experiences.

D. CONCLUSION AND SUGGESTIONS

In conclusion, the study demonstrated the effectiveness of interactive gaming in enhancing seventh-grade numeracy skills, particularly in data presentation. The findings revealed a significant improvement in post-test scores of 3.43/5 compared to pre-test scores of 2/5, indicating a learning process during gameplay. Additionally, 95.2% of respondents reported enjoying the game and finding it engaging. Moreover, most participants welcomed the introduction of a tiered difficulty system, suggesting that it enhanced the gaming experience by providing a more structured progression. These findings highlight the promising role of integrating interactive gaming into educational practices, which can significantly enhance numeracy skills and promote effective learning strategies. By leveraging game-based learning approaches, educators can create dynamic and engaging learning environments that foster student engagement and enthusiasm for learning. Immediate feedback mechanisms embedded within educational games enable students to learn from their mistakes in real time, facilitating a deeper understanding of mathematical concepts. Furthermore, the immersive and interactive nature of educational games encourages active participation and exploration, promoting a deeper level of student involvement in the learning process. Overall, these findings underscore the potential of interactive gaming to revolutionize educational practices and empower students to develop essential numeracy skills for academic success.

Future research could further explore the lasting impact of interactive gaming on enhancing numeracy skills, particularly by investigating its effects on long-term academic performance, the retention of mathematical concepts, and the factors that may hinder the effective integration of interactive games into formal education settings. Additionally, examining various gaming elements, such as narrative structures and customization options, may offer valuable insights into optimizing the educational benefits of gaming experiences. Barriers to implementing interactive games in formal education contexts may include limited access to technology, concerns about screen time, resistance from traditional teaching methods, and difficulties in aligning games with curriculum standards. On the other hand, opportunities may include increased student engagement, personalized learning experiences, enhanced problem-solving skills, and the ability to cater to diverse learning styles. Exploring these challenges and opportunities is crucial for devising strategies to maximize the benefits of interactive gaming while mitigating potential obstacles in educational settings. Furthermore, studying the role of educators in facilitating gaming activities and integrating them into the curriculum could provide practical insights for classroom implementation. Overall, continued research in this field has the potential to inform educational practices and advance the use of interactive gaming as a tool for strengthening numeracy skills.

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