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Digital Snakes and Ladders for Developing Disaster Mitigation Literacy

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Abstract

This article based on the still low disaster mitigation literacy in Indonesia, especially at the elementary school level, so that the development of learning media is needed to facilitate students in obtaining knowledge related to disasters. Therefore, this article aims to develop a disaster mitigation snake and ladder digital game to develop disaster mitigation literacy. The game incorporates multiple learning mechanisms to enhance disaster mitigation literacy, including scenario-based challenges, interactive quiz elements, and visual representations of disaster preparedness protocols. Players advance through the game by correctly responding to disaster-related situations, identifying safety measures, and demonstrating understanding of evacuation procedures. This article uses Research and Development (R&D) method with Design and Development (D&D) model consisting of analysis phase, design phase, development phase, implementation phase and evaluation phase. Data collection was carried out by distributing online questionnaires and analyzed using descriptive-quantitative methods. The results showed that the disaster mitigation snake and ladder digital game developed based on media and material expert validators received scores of 96.19% and 92.05% respectively, which fall into the highly feasible criteria. Student feedback through response questionnaires achieved 89.03%, demonstrating that the game was eminently practicable and teachers were 87.11% with highly appropriate. The findings contribute to the field of disaster education by providing an evidence-based, gamified approach that can be readily implemented in elementary schools to strengthen disaster preparedness among young learners.

Keywords: *Educational Game Development, Snakes and Ladders Digital Game, Disaster Mitigation, Disaster Mitigation Literacy.*

INTRODUCTION

Indonesia is a flood-prone country. As has been recorded, there were 1,794 flood disaster events in 2021(Disaster Management National Body, 2021). This high frequency of disasters highlights the critical importance of disaster mitigation literacy among the population. Disaster mitigation literacy consist of the knowledge, skills, and understanding needed to effectively respond to and minimize the impact of natural disasters. Research has shown that individuals with strong disaster mitigation literacy

demonstrate better survival capabilities during disaster situations (Caliskan, C. & Üner, S., 2021). Based on research (Juhadi et al., 2021) Disaster mitigation literacy in Indonesia is still low, such as the West Coast District (WCR) community in Lampung Province. The need for disaster mitigation education is particularly crucial in early childhood. For students in the 5-6 year age range, disaster mitigation knowledge is still not optimal. This aligns with research conducted by (Rosyida, F. & Adi, 2017) on students at SDN Pilanggede in Balen District, Bojonegoro Regency, which shows that knowledge related to disasters remains low. Disaster mitigation literacy education in Indonesia has become fundamental and essential as it is expected to enhance skills and creative capabilities based on scientific knowledge as an effort to address the impacts arising from disasters (Basam, F., 2022). Through disaster mitigation literacy education, communities can sort, verify, and filter disaster information they receive (Prakoso et al., 2021). This can provide understanding to Indonesian communities, particularly elementary school students, enabling them to minimize disaster risks.

Disaster mitigation literacy at the elementary school level still needs further development. This is because students lack information about disasters due to limited media, learning materials and appropriate evaluation instruments (Zakwandi et al., 2018). Moreover, the lack of engaging teaching materials hinders students from gaining comprehensive understanding of disaster-related knowledge integrated into their lessons (Romadhon & Prasetya, 2019). Therefore, learning media that are able to provide disaster mitigation education with fun and effective delivery, such as through digital games, are needed. Digital games have the potential to boost learners' motivation as they inspire and immerse players, facilitating learning in an almost unconscious manner (Sabirli & Coklar, 2020). Digital games can also provide feedback, help check learners' understanding and give educators the opportunity to engage directly with learners (Rajabpour, 2021). In addition, digital games, especially snakes and ladders, are able to improve students' proficiency in cognitive and motor aspects (Juniantoro et al., 2021). Disaster mitigation snake and ladder digital game equipped with a disaster mitigation educational video, dice, pictures, and questions relevant to flood disaster mitigation able to attract students' attention. In addition, the concept of going up the ladder after going down through the tail of the snake reflects the ability to deal with tough situations during disasters and recovery in disaster management. The game board containing questions and challenges to be solved encourages learners to simulate disaster mitigation through collaboration between roleplay and group discussion (Widodo & Hariyani, 2022).

The snakes and ladders game helps combine different ways to reduce disaster risks in one place. This makes understanding disasters more complete (Ariyanto et al., 2020). This fits with constructivist theory, which says that we learn through direct experience (Slavin, 1997). These experiences create knowledge and give meaning. Meaningful learning helps students remember, recognize, and connect facts and ideas about the lesson they are studying (Purwani et al., 2019). In its application, the snakes and ladders digital game only focuses on basic visualization in conventional or physical form. So far, there is no research that combines disaster mitigation snake ladder digital gamewith roleplay and discussion. Some studies only use snakes and ladders games without any integration and interactive multimedia with students. The use of technology-based snakes and ladders games can motivate and attract attention so that it can improve students' understanding (Choirunnisa & Febriani, 2021).

This research focuses on the development of disaster mitigation snake and ladder digital game to improve disaster mitigation literacy. This study not only covers the process of designing and developing an educational game that integrates multimedia such as videos and images, but also assesses the feasibility of the media through comprehensive validation from media validators, material validators, as well as teacher and student responses as users. By adopting an approach that involves roleplay and group discussion, this study aims to develop learning media that measures several indicators of disaster mitigation literacy, including: understanding of basic disaster concepts, recognition of disaster signs, knowledge of evacuation procedures, safe zone identification skills, and ability to take preventive actions according to the type of disaster.

METHODS

This research uses a development research method or known as Research and Development (R&D) using the model Design and Development (D&D), includes analysis that begins with data and fact collection, design, development, implementation, and evaluation (Richey & Klein, 2007). The D&D model was chosen for its ability to produce technology-based products through a systematic and iterative process that is suitable for the development of digital learning media. In the analysis stage, a comprehensive collection of data and facts is carried out including analysis of learning media needs, curriculum analysis, user analysis, material analysis and learning objectives, as well as analysis of tool and material needs. The design stage includes the development of learning tools, collection of objects and features to be used, determination of applications for the development of digital game learning media, making a list of

questions to be included in the digital game, as well as determining the software and hardware used. In the development stage, disaster mitigation snake and ladder digital game for was created based on the outline design of the media program. All materials and elements that have been collected are applied in making disaster mitigation snake and ladder digital game. Then disaster mitigation snake and ladder digital game was developed based on suggestions from media and material validators on the planning results of disaster mitigation snake ladder digital game.

The implementation stage was carried out through trials on 18 students and 2 teachers in two meetings. The first meeting focused on the introduction and orientation of media use, while the second meeting focused on complete use and collection of user response data. This stage was conducted to determine the level of acceptance and ease of use of the disaster mitigation snake and ladder digital game. The evaluation stage was carried out at each stage of the development of disaster mitigation snake and ladder digital game.

Data collection in this study used a mixed-methods approach, combining qualitative data from interviews with three students and observations of school facilities, with quantitative data from expert and stakeholder validation questionnaires. In addition, data collection through analysis of student evaluation documents was carried out to provide contextual understanding.

This study used descriptive-quantitative techniques to analyze numerical data from Likert scales, combined with qualitative analysis through open-ended questions in the questionnaire that allowed respondents to provide in-depth responses, suggestions, and impressions of the media use experience. The use of a questionnaire with a combination of closed-ended (Likert scale) and open-ended questions allowed the researcher to collect comprehensive data regarding the functional aspects, visual design, educational content, and usability of the digital game from the user's perspective, resulting in a more holistic view of the quality of the developed learning media.

The percentage of scores obtained is then confirmed against the assessment criteria according to (Riduwan, 2010) on the quality of the media digital game snakes and ladders for disaster mitigation based on the following table:

Table 1. Quality Interpretation Assessment Criteria

Average score (100%)	Category
81-100	Excellent
61-80	Good
41-60	Adequate
21-40	Inadequate
0-20	Severely Deficient

Based on Table 1 above, disaster mitigation snake and ladder digital game is said to be feasible if the average value is ≥ 80%

RESULTS AND DISCUSSION

The development of a disaster mitigation snake and ladder digital game through the Design and Development (D&D) model has yielded several significant findings across different implementation phases.

1. Analysis (Problem and Needs Analysis)

The analysis of the independent science curriculum for grade 5 revealed a critical gap in disaster mitigation education materials, particularly in connecting theoretical concepts with practical understanding. While existing learning resources primarily focused on basic earth surface changes, they lacked interactive elements that could engage students in understanding disaster preparedness. This finding aligns with (Rajabpour, 2021) assertion about the necessity of interactive feedback in digital learning environments.

Table 2. Results of Curriculum Analysis

Learning Outcomes	Flow of Learning Objectives	Learning Objectives
Students reflect on how changes in natural conditions on the earth's surface occur due to natural factors and human actions, identify lifestyles that cause environmental problems and predict their impact	1. Able to elaborate the concept of flood natural disasters due to changes in natural conditions 2. Able to study the cycle of flood natural disaster management	• Students are able to determine the definition and causes of flood natural disasters appropriately • Students are able to determine the right mitigation and pre-paredness actions for

on social, social, and economic conditions.	flood natural disasters • Students are able to make disaster response actions when natural disasters flood occur appropriately • Students are able to design steps of post-disaster management of natural floods in a coherent manner.
	• Students are able to show their participation in the flood natural disaster prevention campaign appropriately
	• Students are able to make route plans to escape to a safer place during natural disasters and floods • Students are able to take steps to save themselves through movement and song

The needs assessment through teacher interviews highlighted that while students at Madrasah Pembangunan were familiar with digital learning platforms like Quizizz and YouTube, they had limited exposure to game-based learning for disaster education. This technological readiness, combined with inadequate disaster mitigation resources in the school library, provided a strong foundation for developing a digital game-based solution. The choice of a snake and ladder format was strategic, building upon (Sabariah, 2021) framework of media selection criteria, particularly considering learning objectives alignment and student characteristics.

2. Design

The analysis of the independent science curriculum for grade 5 revealed a critical gap in disaster mitigation education materials, particularly in connecting theoretical concepts with practical understanding. While existing learning resources

The development phase encompassed critical design decisions and systematic planning processes. The conceptualization of the disaster mitigation snake and ladder digital game was guided by a comprehensive Media Program Outline which served as the foundational framework. This media program outline incorporated multiple essential pedagogical elements: learning objectives, structural components (including interactive features such as the introduction interface, game mechanics, boardgame layout, and assessment questions), multimedia integration (visual, textual, and audio elements), and detailed annotations explaining the pedagogical rationale behind each design element.

The technical implementation leveraged multiple digital platforms to enhance user engagement and learning outcomes. Canva was strategically employed to create visually compelling introductory elements, while Groovepad facilitated the development of appropriate audio elements that complement the learning experience. The game's core architecture, developed through the Genially platform, integrated various interactive elements including the title interface, creator attribution, randomized dice mechanics, educational video content focusing on flood disaster mitigation, player tokens, instructional guidelines, and clearly defined learning objectives. This systematic integration of elements was specifically designed to support the game's educational goals in disaster mitigation awareness.

3. Development

The development of this disaster mitigation snake and ladder digital game incorporates several key elements to enhance the learning experience. Notably, the game cover features an engaging interactive button labeled "Let's Start," which is specifically designed to immediately capture the attention of students and foster a sense of anticipation for the gameplay ahead. Upon entering the game, the interface presents a variety of functional icons that facilitate interaction and learning. These include icons for accessing videos related to the game's theme, a virtual dice for game progression, clear instructions on how to play that symbolized by a book icon, a description of the learning objectives hat can be viewed after clicking on the message icon, and the central game board itself, numbered from 1 to 55. Importantly, strategically placed numbers on this board are embedded with interactive questions and instructions, adding an educational dimension to the gameplay.

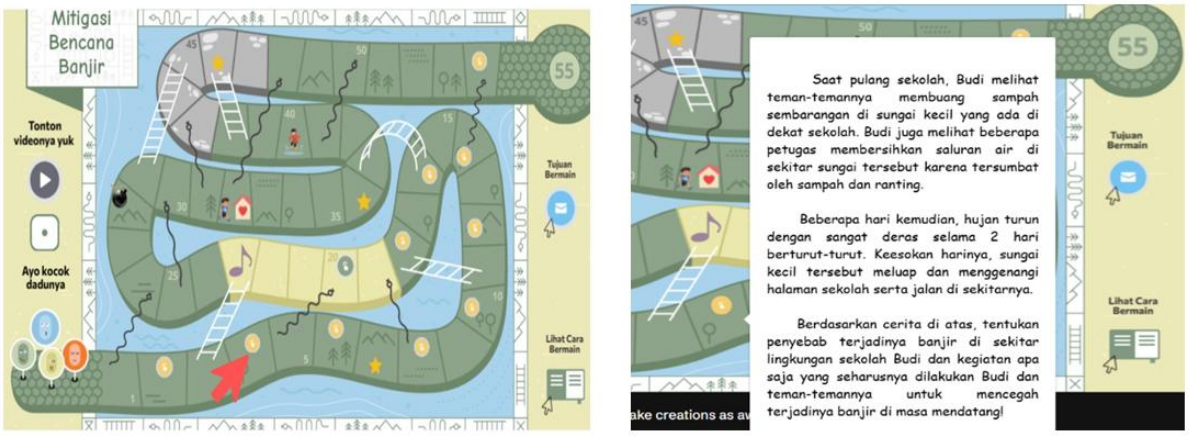


Figure 1. Intro Display Plan and Disaster Mitigation Snake and Ladder Digital Game

Next, throughout the game path, there are small yellow circular icons. When a player lands on one of these yellow circles and clicks on it, a question will appear.

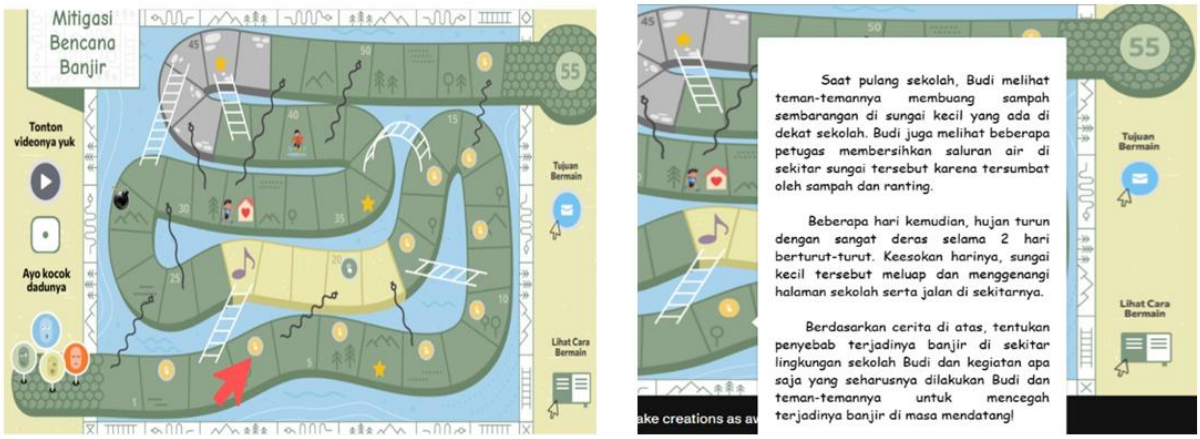


Figure 2. Sample of Questions in Disaster Mitigation Snake and Ladder Digital Game

In this disaster mitigation snake and ladder digital game there is one special square equipped with a music icon located at a specific number along the game path. When players land on or stop at the square featuring this music icon, the system automatically activates an interactive feature that plays an educational song called "Be Careful During Floods." The player whose token stops exactly on the music-icon square becomes the song leader for that session, where the application displays a music interface showing the song lyrics. The player serving as the leader guides all participants to sing the song together in unison, with the song containing educational messages about awareness and safety measures when facing flood disasters.

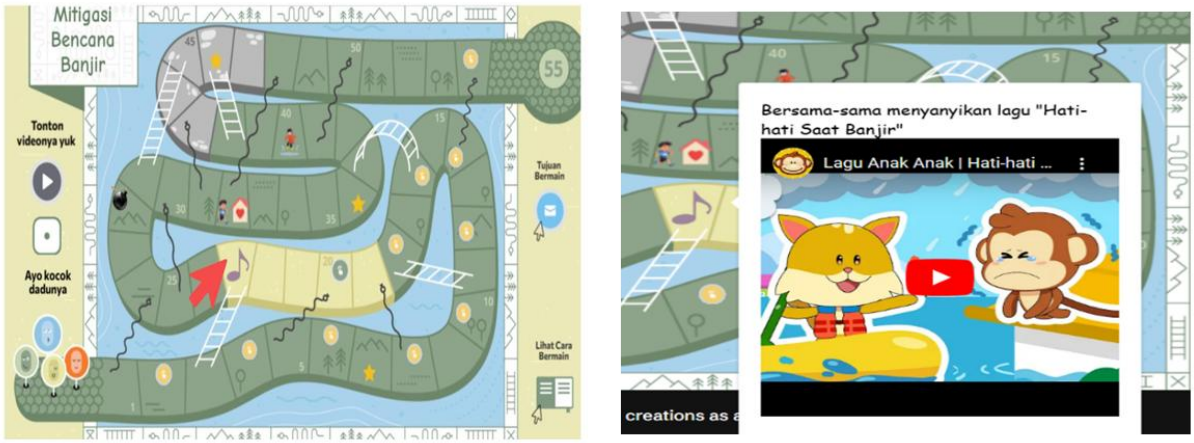


Figure 3. Command to Sing Together

Furthermore, there are star icons on a number of numbers on the game board, which means that when a player lands on a square with such an icon and clicks it, the system displays the message “Congratulations! You are eligible to advance to the next three numbers” which gives the advantage of moving three steps forward quickly.



Figure 4. Game Bonus on Star Icon

In addition, there is a bomb icon, which when a player lands on a square that has the icon, the system will display a warning message “You are passing through a flooded area” accompanied by instructions stating the player affected by the bomb icon must skip their turn and wait until all other players have completed a full round before being able to move again.



Figure 5. Bomb Icon with Its Instruction

In this game there is safe place icon, when the player lands on the number with the icon, then clicks on it, the system will display a message regarding the action that the player must take, namely by moving to a higher place in the flood simulation in this game. After successfully doing so, the player gets a reward, which is the right to advance for the next five steps.



Figure 6. Safe Place Icon Provides Reward

The last icon in this game, which is the person on the flood, the system will display a warning message that there is a puddle ahead accompanied by an instruction to backtrack to the previous 2 numbers to avoid it, simulating a dangerous situation where one has to backtrack to avoid the flooded area and look for a safer alternative route.



Figure 7. Person on The Flood Icon with Its Command

Furthermore, product validation is carried out by media and material validators. Media experts focus on the display and programming aspects. Meanwhile, material experts assess the feasibility of content aspects, learning design, presentation components, language and communication. The results of the validation of media experts can be seen in Table 4.

Table 3. Media Expert Validation Results

No.	Aspects	Score	Maximum Score	Percentage
1.	Display	62	65	95.38%
2.	Programming	39	40	97.05%
Total Score		101	105	96.19%
Criterion			Excellent	

Table 3 shows that the average validation score from media experts is 96.19% with a very feasible category so that it can be continued to the implementation stage.

The display aspect's high rating (95.38%) reflects the successful integration of visual elements and user interface design principles. This achievement is particularly significant given the challenge of balancing educational content with engaging visual presentation. The programming aspect's exceptional score (97.05%) demonstrates the technical robustness of the platform, specifically in terms of user interaction responsiveness, system accessibility and resource efficiency, integration of performance metrics, and alignment with student learning capabilities. These findings align with Daryanto's framework for educational media effectiveness (Rahmat, et al., 2021), while also extending beyond basic functionality to create an immersive learning environment.

The results of the validation of the subject matter experts can be seen in Table 4 as follows.

Table 4. Material Expert Validation Results

No.	Aspects	Score	Maximum Score	Percentage
1.	Content/Materials	46	50	92.00%
2.	Components Coherence	28	30	93.33%
	Total Score	74	80	92.50%
	Criterion		Excellent	

Table 4 shows that the average validation score from material experts is 92.50% with a highly appropriate category so that it can be continued to the implementation stage.

The material evaluation (92.00%) demonstrates the game's success in effectively conveying disaster mitigation concepts. This high score suggests that the educational content successfully balances comprehensiveness of disaster mitigation topics, age-appropriate content delivery, sequential learning progression and integration of practical applications. Meanwhile, the presentation components' score (93.33%) validates the effectiveness of the multi-modal learning approach, incorporating visual, textual, and interactive elements. This comprehensive presentation strategy appears to enhance content accessibility while maintaining pedagogical integrity.

4. Implementation

After making improvements based on suggestions from material and media expert validators, the disaster mitigation snake and ladder digital game product for disaster mitigation was tested on 18 grade V students and 2 teachers of Madrasah Ibtidaiyah Pembangunan. The implementation of the disaster mitigation snake and ladder digital game began by ensuring the availability of all necessary facilities and infrastructure, including tablets for each student. Along with the preparation of the devices, researchers distributed Learner Worksheets (LKPD) that outlined important actions to be taken in three stages: before a flood occurs (preparation and prevention), during a flood (emergency response), and after a flood (recovery). After being given an understanding of how to operate the game, students were given 30 minutes to play and complete the game.

After all students have completed the game, the next stage is the evaluation of understanding through the prepared question sheet. The evaluation contains 10 multiple choice questions covering all aspects of disaster mitigation that have been learned. Students were given 20 minutes. The last stage of implementation is filling out a response questionnaire to the disaster mitigation snake ladder digital gamefor disaster mitigation by students and educators for 15 minutes.

Overall, the results of the questionnaire that have been filled out by students can be seen in table 5.

Table 5. Results of Students' Response Questionnaire on Field Tests

No.	Element	Percentage Response to *Digital* Game Snake Ladder Disaster Mitigation (%)	Criterion
1.	Presentation	89.11%	Excellent
2.	Visual Communication	91.23%	Excellent
3.	Linguistics	86.67%	Excellent
Average Percentage (%)		89.03%	Excellent

Based on Table 5 above, the average student response reached 89.03% with very good criteria, consisting of 89.11% for the presentation aspect, 91.23% for the visual communication aspect, and 86.67% for the linguistic aspect. The high percentage in the visual communication aspect shows that the selection of colors, layout, images, type and size of letters is considered very attractive and appropriate by the students. Although the linguistic aspect received the lowest percentage among the three aspects, it still fell into the excellent category, indicating that the language used in the game was appropriate for the level of understanding of grade V students. Furthermore, in the teacher's response, the overall results can be seen in Table 6 as follows.

Table 6. Results of Teacher Response Analysis

No.	Element	Percentage Response to *Digital* Game Snake Ladder Disaster Mitigation (%)	Criterion
1.	Presentation	88.00%	Excellent
2.	Visual Communication	83.33%	Excellent
3.	Linguistics	90.00%	Excellent
Average Percentage (%)		87.11%	Excellent

From the teacher's perspective, the results of the response analysis also showed a very good assessment with the average eligibility reaching 87.11%. Interestingly, the highest assessment from the teacher was in the linguistic aspect which reached 90%, followed by the presentation aspect at 88.00%, and the visual communication aspect at 83.33%. This difference in assessment patterns between students and teachers provides interesting insights into the differences in perceptions between child and adult users of digital learning media. Thus, it can be concluded that this disaster mitigation snake and ladder digital game is feasible to be applied as learning media because it has met the eligibility criteria from various aspects, including suitability for learning objectives, interactivity with students, providing effective feedback, and presenting material that is relevant to daily life as stated by (Miftah & Rokhman, 2022) in their study on the criteria for effective digital learning media.

5. Evaluation

At the analysis stage, evaluation is conducted by the supervising lecturer in the form of information, guidance, and direction. At the design stage, evaluation is carried out by the supervising lecturer in the form of suggestions for product improvement. At the development stage, evaluation is conducted by expert lecturers and peer review in the form of assessments (feasibility tests) and suggestions for improving media products. While at the implementation stage, evaluation is carried out by educators and students in the form of assessing the product's attractiveness using a questionnaire (product trial).

Through these evaluation stages, the effectiveness, usefulness, and quality of the disaster mitigation snake and ladder digital game can be assessed. The evaluation examines the level of user satisfaction, performance of the digital game, ease of use, understanding gained after using it, and identifies strengths and weaknesses when implemented.

CONCLUSION

The results of this research and development demonstrate that the disaster mitigation snake and ladder digital game has been successfully developed using the D&D (Design and Development) model, progressing through five systematic stages: analysis, design, development, implementation, and evaluation. This educational product effectively integrates multimedia elements including videos, texts, and images to enhance student engagement and learning. Media expert validation confirms the high

quality of the digital game, with exceptional feasibility ratings of 95.38% for display aspects and 97.05% for programming functionality, indicating a technically sound and visually appealing educational tool. Similarly, material expert validation verifies the educational value of the game, with strong feasibility percentages of 92% for content accuracy and 94% for presentation components, confirming its pedagogical appropriateness for disaster mitigation education. User reception has been overwhelmingly positive, with students rating the game at 89.03% and teachers at 87.11% (both in the "very good" category), demonstrating its effectiveness in engaging the target audience.

This research successfully achieved its primary objective of creating an engaging digital tool that enhances disaster mitigation education, with student assessment results indicating significant improvements in disaster awareness and preparedness knowledge. However, limitations include the focus on specific disaster types and limited testing demographics. The disaster mitigation snake and ladder digital game shows promising potential for broader educational implementation, suggesting future research should explore curriculum integration strategies, adaptation for various disaster scenarios relevant to different geographical regions, and longitudinal studies to measure long-term retention of disaster preparedness knowledge. Additionally, developing versions for different age groups and investigating mobile platform adaptations would further expand the educational impact of this innovative teaching tool

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