

Game-Based Learning Media to Improve Understanding of Whole Numbers and Length Measurement for Grade II Elementary School Students

Sri Febrina Dewi^{1*}, Yamanto Isa², Leni Pebriantika³,

^{1,2,3} Universitas Baturaja, Indonesia

Corresponding e-mail : srifebrinadewi@gmail.com

ARTICLE INFO	ABSTRACT
<p>Keywords:</p> <p>Canva; Game-based learning; Heyzine; Mathematics education; Wordwall.</p> <hr/> <p>Article History</p> <p>Received: March 03, 2026 Revised: April 26, 2026 Accepted: May 07, 2026</p>	<p>This research is driven by the low level of student activity and understanding in Mathematics at SD Negeri 14 OKU, where abstract concepts and conventional teaching methods often lead to boredom and confusion. The study aims to develop game-based learning media specifically for whole numbers and length measurement materials for Grade 2 students. The development follows the Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) integrated with Tessmer's formative evaluation. The media was developed using Wordwall as the primary platform, supported by Canva for visual design and Heyzine for interactive flipbooks. Validation results from experts indicated high feasibility: material experts (89.75%), instructional design experts (87.8%), and media experts (91.4%), all categorized as "Very Good". Furthermore, evaluation phases showed excellent results, with one-to-one evaluation reaching 90.07%, small group evaluation at 88.32%, and a field test involving 20 students yielding 89.26%. The final product, Prototype III, effectively creates a joyful learning environment that enhances student motivation and simplifies complex mathematical concepts. In conclusion, this game-based learning media is highly feasible and effective for use in elementary mathematics education to improve student engagement and learning outcomes.</p>

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license



To cite this article : Dewi, S. F., Isa, Y., Pebriantika, L. (2026). Game-Based Learning Media to Improve Understanding of Whole Numbers and Length Measurement for Grade II Elementary School Students. *Information Technology Education Journal*, 4(1), 89-101. Doi. 10.61255/itej.v4i1.1044

INTRODUCTION

Education is a process of learning and individual development aimed at enhancing knowledge, skills, and attitudes in a comprehensive manner. This is in line with the mandate of Law Number 20 of 2003 on the National Education System (Undang-Undang RI No 20, 2003), which defines education as a conscious and planned effort to create a conducive learning environment and learning process in which students actively develop their potential. This potential development includes spiritual strength, self-control, personality, intelligence, noble character, as well as the skills needed for themselves, society, the nation, and the state. Therefore, education serves as a fundamental foundation in human and societal development, playing a crucial role in shaping thinking abilities, skills, and character required to face increasingly complex life challenges. In this context, educational technology has become an essential component of this transformation. According to Kusmiyati & Tobing, (2024), educational technology is a complex, integrated, and continuously evolving process that

functions to improve and enhance learning processes and performance through the effective use of appropriate technology.

The rapid pace of global development has brought significant changes to education systems worldwide. Entering the 21st century, education is no longer expected to produce individuals who are only academically competent, but also those who possess Higher Order Thinking Skills (HOTS). This transformation is further marked by the emergence of the Society 5.0 era, a paradigm that positions technology not merely as a tool, but as a partner in human life (Huda, 2023). In this context, artificial intelligence (AI) and digital technologies are expected to actively support students in the learning process. This new paradigm calls for a fundamental shift from conventional, teacher-centered approaches toward learning that emphasizes creativity, innovation, and collaborative engagement. Furthermore, Isa et al., (2024) explain that learning is a reciprocal process between teachers and students, aimed at fostering changes in attitudes, enhancing skills, and increasing knowledge.

Education in the digital era is no longer limited to the transmission of information from teachers to students. Instead, learners are expected to develop critical thinking skills, communicate effectively, and possess a deep understanding of technology. The education sector must adapt by integrating technology into the learning process from an early age to better prepare students for global challenges (Ristiani et al., 2025). This implies that both teachers and students need to have adequate technological literacy in order to create learning experiences that are meaningful, interactive, and relevant to contemporary developments. In this regard, educational technology has become an integral part of this transformation, functioning as a complex, integrated, and continuously evolving process aimed at improving and enhancing learning processes as well as human performance.

One of the innovations that continues to develop in educational technology is the use of game-based learning media. Hasanah, (2023) states that game-based media integrate elements of entertainment and instruction, thereby reducing students' boredom and enhancing their understanding, particularly in mathematics learning. This approach encourages students to actively engage through challenges, reward systems, and interactive elements embedded within the game (Nisa & Mawardah, 2023). Therefore, games function not only as a form of entertainment but also as effective tools for facilitating learning.

Mathematics, as one of the core pillars of the elementary education curriculum, plays a crucial role in developing logical, analytical, and systematic thinking skills from an early age (Setiyani et al., 2025). It is not merely a subject concerned with computation, but a language of logic that underpins modern technological advancements and is essential in various aspects of human life. According to the guidelines issued by the Pusat Kurikulum dan Pembelajaran, mathematics learning outcomes (Capaian Pembelajaran/CP) are structured progressively from Phase A to Phase F. For students in Phase A (lower grades of elementary school), the primary focus is on the development of number sense. At this stage, students are expected to gain a solid understanding of whole numbers up to 100, including the ability to read, write, identify place value, compare, and sequence numbers.

In addition to number recognition, Phase A also emphasizes basic operations such as addition and subtraction using concrete objects, as well as the introduction of fundamental concepts of fractions and length measurement. Mastery of whole numbers and measurement concepts is a fundamental prerequisite for understanding more advanced mathematical content at higher levels. However, in practice, there remains a significant gap between curriculum targets and students' actual achievements. Although these topics are often considered basic, many elementary school students perceive mathematics as difficult, intimidating, and confusing. This condition is frequently attributed to the abstract and less contextual nature of instructional

delivery, which makes it challenging for students to relate mathematical concepts to real-life situations.

This condition is further exacerbated by the continued dominance of conventional teaching approaches. Based on preliminary observations and interviews conducted at SD Negeri 14 OKU, particularly in Grade II, it was found that students' level of participation in mathematics learning remains relatively low. During the teaching and learning process, students tend to be passive and act merely as recipients of information delivered by the teacher. Learning activities are generally limited to listening to lectures and completing individual exercises in their workbooks. This one-way interaction restricts opportunities for students to explore mathematical concepts independently or collaboratively, which ultimately contributes to low motivation and suboptimal learning outcomes.

The low level of active student engagement at SD Negeri 14 OKU is evident in the difficulties they experience when performing basic arithmetic operations and understanding measurement procedures. Some students appear to rely on memorizing steps without grasping the underlying conceptual meaning of the numbers involved. This condition highlights an urgent need for instructional innovations that can both attract students' interest and enhance their conceptual understanding. Considering that elementary school students are developmentally inclined toward play, exploration, and visual learning, these characteristics should serve as key considerations in the design of instructional media.

One innovative solution to address these challenges is the implementation of game-based learning. Game-based learning media combine elements of entertainment with educational content, thereby reducing students' boredom and creating a joyful learning environment. Through games, students are encouraged to engage actively by facing challenges, receiving rewards, and participating in dynamic interactions within the learning process. Educational games are not merely a form of entertainment, but also serve as effective tools to help students maintain focus and naturally develop logical thinking skills. Previous studies have demonstrated that the use of games can significantly improve mathematics learning outcomes, enabling students to achieve the expected Minimum Mastery Criteria (KKTP) (Pazira et al., 2025). In addition, Pebriantika et al., (2024) state that learning occurs as a result of the interaction between stimulus and response.

Various relevant studies have demonstrated that technology-based media can significantly enhance student understanding. The implementation of game-based learning has proven effective in reducing student boredom and creating a joyful learning environment. Previous research by Pazira et al., (2025) indicates that games can effectively assist students in achieving high scores in the Minimum Mastery Criteria (KKTP). Nevertheless, there are notable limitations in the existing literature. Most current studies on digital learning media tend to focus on advanced mathematical concepts or are designed for upper-grade students, resulting in a specific literature gap regarding the development of interactive media for whole numbers and measurement materials at the second-grade elementary level. Furthermore, there is a lack of research that synergistically integrates the Wordwall, Canva, and Heyzine platforms into a single learning media ecosystem tailored to the local infrastructure and socio-cultural characteristics of regional elementary schools.

Various studies indicate that the use of technology-based learning media can enhance students' understanding. Almuslim et al., (2021) state that educational game media can sustain students' learning motivation, which in turn contributes to improved learning mastery. However, most of these studies primarily focus on advanced mathematics topics, making their application less suitable for students in the lower grades of elementary school.

This study aims to fill this gap by developing a game-based learning media prototype that integrates the visual ease of Canva, the interactivity of Heyzine flipbooks, and the engaging quiz

challenges of Wordwall. This innovation focuses not only on academic content but also on technological adaptation suited to the digital operational capabilities of lower-grade students. The primary objective of this research is to develop and evaluate the feasibility of a valid and practical game-based learning medium to improve the understanding of whole numbers and length measurement concepts for Grade II students at SD Negeri 14 OKU.

METHOD

This research employs the Research and Development (R&D) method. A research method used to develop a specific product and to test the effectiveness of the product (Sugiyono, 2024). The development model used is ADDIE (Analysis, Design, Development, Implementation, and Evaluation), developed by Robert Maribe Brach, which provides a systematic and integrated framework for designing, developing, and evaluating educational products. The use of the ADDIE model in this study facilitates the process, as its stages are systematically structured and aligned with the needs and characteristics of the learning process (Pratama et al., 2025).

Procedures and Product Development

The study was conducted at SD Negeri 14 OKU, targeting Grade II students. The technical execution of the ADDIE stages is detailed as follows:

1) Analysis

This foundational stage involved identifying curriculum requirements under Kurikulum Merdeka, specifically focusing on whole numbers and length measurement (Rustamana, 2024). Observations and unstructured interviews were conducted with teachers to assess existing infrastructure, such as the availability of laptops and stable internet access, and to profile the learning characteristics of the students (Shabrina et al., 2025).

2) Design

During this phase, the researcher formulated the Garis Besar Program Media (GBPM) or Media Program Outline. This stage included the creation of a flowchart to map user navigation and a detailed storyboard to visualize the layout of each digital screen (Pazira et al., 2025).

3) Development

The conceptual designs were realized into a functional digital prototype (Prototype I). This involved utilizing Canva for UI/UX design, Heyzine for converting static PDFs into interactive flipbooks, and Wordwall for creating the gamified evaluation components. Ixfina et al., (2023) state that Canva is a platform that can be utilized to create various types of instructional content, such as infographics, posters, banners, and presentations, thereby supporting the effectiveness of the learning process. Furthermore, Fiqri & Sangkala, (2025) explain that Canva is an online design application that provides a wide range of templates, including presentations, resumes, posters, brochures, graphics, and infographics. In addition, it offers diverse presentation themes, such as creative, educational, business, and technological formats, allowing users to tailor content according to their needs. Based on these perspectives, it can be concluded that Canva is an online graphic design platform that enables users to produce a variety of visual content, including infographics, posters, banners, and presentations.

One of the platforms widely utilized in the field of education is Heyzine. Wulan et al., (2024) explain that Heyzine Flipbook is a web-based service that enables users to convert PDF files into flipbooks for free, complete with digital book effects that can be shared with students through an HTML link. In line with this, Mahira, (2023) states that Heyzine is a web-based software used to develop teaching materials in the form of e-books with a two-dimensional page-flipping effect, similar to a physical book. Users simply upload a PDF file to generate a flipbook display, which can be used not only for e-books but also for creating e-modules, e-papers, and similar materials. Additionally, the platform provides various supporting features, including the

integration of audio, images, videos, text, and hyperlinks, and allows the final product to be easily shared via accessible links.

According to Khoiriyatin et al., (2025) Wordwall is an interactive and engaging learning medium that incorporates game-based learning concepts, thereby increasing students' interest and motivation. In addition, it is user-friendly, as teachers can easily create various activities such as quizzes and puzzles simply by modifying text or images without requiring advanced technological skills. Wordwall is also highly flexible, as it can be accessed on multiple devices, including computers, tablets, and smartphones, and can be used both online and offline through printable formats.

4) Implementation

The media was deployed in a controlled environment to undergo expert validation and user testing (Ilahy et al., 2025).

5) Evaluation

Following Tessmer's model, the product underwent Self-Evaluation, Expert Review, One-to-One Evaluation (3 students), Small Group Evaluation (9 students), and a Field Test (20 students).

The overall workflow of the development and evaluation process is illustrated in the flowchart below.

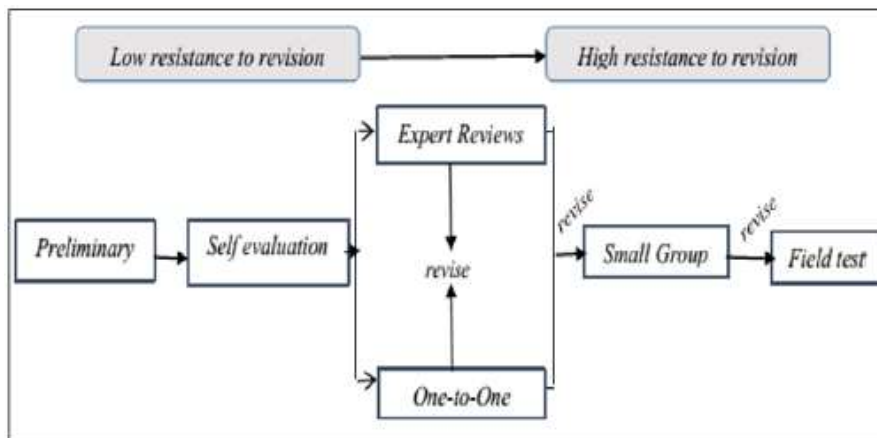


Figure 1. The flowchart illustrating the systematic integration of ADDIE stages with Tessmer's formative evaluation cycles for product refinement.

The product evaluation followed Tessmer's (1993) formative evaluation model, consisting of five stages: 1) Self Evaluation: The researcher independently reviews the prototype against learning theory, curriculum objectives, and student characteristics. 2) Expert Review (Pandangan Ahli): Validation by a content expert, instructional design expert, and media expert using structured questionnaires. 3) One-to-One Evaluation: Testing with 3 students of varying ability levels. 4) Small Group Evaluation: Testing with 9 students to assess practicality and appeal. 5) Field Test: Implementation with all 20 Grade II students to measure feasibility in real classroom settings (Miranti et al., 2024).

Instrument

The primary research instrument used to measure product feasibility was a structured Likert Scale Questionnaire. To ensure methodological integrity, the expert validation instruments underwent a rigorous pre-validation and piloting process before deployment. The initial drafts were developed based on validated indicators from established instructional design literature, encompassing four core dimensions: goal alignment, instructional strategy, supporting media, and content quality. All questionnaires utilized a 4-point Likert scale (4: Very Good/Strongly Agree to 1: Poor/Strongly Disagree), intentionally omitting a neutral middle point to ensure clear evaluative judgment. The instruments for student respondents were

further refined after a pilot trial to ensure the language was developmentally appropriate for second-grade learners (Santika et al., 2023) (Laia et al., 2022).

Table 1. The Blueprint of Research Instruments

No	Dimension	Indicators	Targeted Respondents
1	Goal Alignment	Curricular fitness, CP/KD suitability	Material Experts
2	Instructional Strategy	Gamification principles, active feedback	Design Experts & Students
3	Supporting Media	Visual appeal, navigation, audio quality	Media Experts
4	Content Quality	Accuracy of whole numbers and units	Material Experts & Students

Data Collection

Data collection was carried out through both qualitative and quantitative approaches. Qualitative data were gathered through initial observations and interviews during the Analysis stage to define the research gap and local needs, as well as from qualitative feedback and expert recommendations during the validation phase. Quantitative data were collected through the distribution of structured questionnaires to expert validators and students during the iterative testing cycles.

To ensure inter-rater reliability and consistency across the three distinct expert validators (material, media, and instructional design), the researcher implemented a standardized validation protocol. Each expert received a specific instrument blueprint aligned with their respective domain of expertise, yet all instruments shared a common scoring rubric and standardized feasibility criteria. Consistency was further maintained by conducting a synchronization session where experts were briefed on the product's operational goals before providing independent scores. The final feasibility percentage was calculated by aggregating the individual scores from all experts using a unified descriptive statistical formula to ensure that the cross-categorical evaluation remained balanced and reliable.

Evaluation Sample and Rationale

The evaluation of the game-based learning media followed Tessmer's Formative Evaluation model, which utilizes a tiered sampling approach to identify and rectify product weaknesses across different levels of interaction complexity. The sample sizes for each stage were selected based on the following methodological rationales:

- 1) One-to-One Evaluation (3 students): Three students were selected through purposive sampling to represent diverse academic abilities. According to Tessmer's model, this minimal sample size is optimal for intensive observation to identify fundamental errors in navigation and instruction clarity.
- 2) Small Group Evaluation (9 students): This stage involved nine students to assess the product's practicality and appeal in a semi-collaborative environment. This sample size provides a varied range of feedback while remaining manageable for monitoring interaction patterns.
- 3) Field Test (20 students): The final stage involved all 20 Grade II students at SD Negeri 14 OKU to test the product's effectiveness under real classroom conditions. This sample reflects the actual class size, ensuring that the final feasibility data accounts for standard instructional dynamics.

Data Analysis

The quantitative data from the questionnaires were analyzed using descriptive statistics to determine the percentage of feasibility for each indicator. The percentage was calculated using the following equation :

$$P = \frac{f}{N} \times 100 \%$$

Where P represents the percentage, f is the total score obtained from respondents, and N is the maximum ideal score. The result of equation (1) is then categorized based on the feasibility

criteria. Feasibility levels are defined in Table 2 to ensure a standardized interpretation of the scores.

Table 2. Feasibility Interpretation Scale

Percentage Range (%)	Qualification	Action Required
86.00 – 100.00	Very Good / Very Feasible	No Revision
76.00 – 85.00	Good / Feasible	Minor Revision
56.00 – 75.00	Fair / Sufficiently Feasible	Major Revision
10.00 – 55.00	Poor / Not Feasible	Total Redesign

The final product, categorized as Prototype III, is the result of the cumulative revisions based on these analysis results. This rigorous methodology ensures that the game-based learning media is not only visually engaging but also pedagogically sound for elementary mathematics education.

RESULTS AND DISCUSSION

Results

The development process resulted in a game-based learning media for Grade II Mathematics at SD Negeri 14 OKU. The product, finalized as Prototype III, integrates three major digital platforms: Wordwall for interactive challenges, Canva for user interface design, and Heyzine for digital materials. The product development followed the systematic ADDIE stages, which provided a robust framework for creating effective educational media. This study applied the ADDIE model in a structured manner. In the analysis stage, initial observations revealed that students at SD Negeri 14 OKU tended to be passive during Mathematics lessons, mainly due to the dominance of abstract lecturing methods. Although the school infrastructure already supported digital integration, teachers had not yet utilized interactive tools, especially for topics such as whole numbers and length measurement. In the design stage, the researcher prepared a detailed storyboard and flowchart, outlining the navigation flow from the login page to learning objectives, interactive flipbooks, and four types of game-based evaluations. The development stage involved producing digital learning materials, where Canva was used to design a child-friendly interface resembling a website, while Heyzine was utilized to convert teaching materials into interactive flipbooks that simulate a real page-flipping experience (Puspitaningrum & Witanto, 2024). The implementation and evaluation stages were carried out simultaneously through iterative testing cycles based on Tessmer’s model, with revisions made according to expert feedback, particularly on improving the login interface and clarifying user instructions (Yuni et al., 2025).

Validation and Testing Data

The feasibility of the media was determined through validation from three types of experts and three phases of student testing. The quantitative data is summarized in Table 3 below.

Table 3. Recapitulation of Validation and Testing Scores

No	Evaluator Category	Average Percentage (%)	Feasibility Category
1	Material Expert	89.75%	Very Good / Very Feasible
2	Media Expert	91.40%	Very Good / Very Feasible
3	Instructional Design Expert	87.80%	Very Good / Very Feasible
4	One-to-One Evaluation (3 Students)	90.07%	Very Good / Very Feasible
5	Small Group Evaluation (9 Students)	88.32%	Very Good / Very Feasible
6	Field Test (20 Students)	89.26%	Very Good / Very Feasible

As shown in Table 3 above, all evaluator categories yielded scores in the “Very Good / Very Feasible” range. The material expert provided a score of 89.75%, the media expert awarded 91.40%, and the instructional design expert gave 87.80%. Student testing results were equally positive: One-to-One evaluation reached 90.07%, Small Group evaluation achieved 88.32%, and the Field Test involving 20 students yielded 89.26%. These results collectively confirm the product’s functional readiness for classroom implementation across all evaluation dimensions.



Figure 2. Home Page Appearance

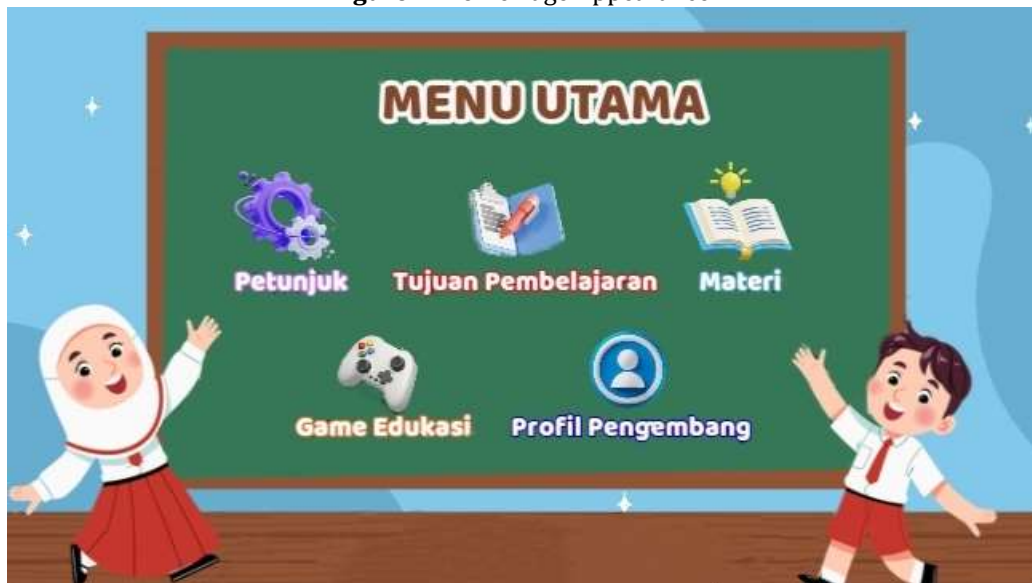


Figure 3. Main Menu Page Display

Final Product Features

The final prototype (Prototype III) features a centralized navigation hub with five core menus: Instructions, Learning Objectives, Material (Flipbook), Educational Games, and Developer Profile. The media utilizes high-contrast colors and large icons to facilitate navigation for Grade II students. The gamification element consists of four Wordwall challenges, including "Airplane" and "Balloon Pop" templates, which provide immediate automated feedback to the user.

Student Task Performance Data

During the One-to-One stage (3 students), all three students completed all Wordwall game activities independently without requesting teacher assistance. During the Small Group stage (9 students), 8 out of 9 students completed the length measurement tasks (cm and m) without requiring additional clarification from the researcher. In the Field Test (20 students), all 20 students successfully completed all four Wordwall game types within the scheduled session. Students who encountered the visual-animated instruction version in Prototype II were

observed re-attempting tasks without external prompting, whereas in Prototype I (text-only instructions) several students paused and requested guidance before proceeding.

Refinement Through Formative Evaluation

Prototype I underwent expert review and was revised into Prototype II based on three categories of expert feedback: (1) the Instructional Design expert recommended adding a dedicated “Tujuan Pembelajaran” (Learning Objectives) button to the home screen; (2) the Media expert recommended redesigning the login interface for visual clarity; and (3) reviewers noted the need for animated instruction tutorials to accompany written task directions. These revisions produced measurable score differences: the One-to-One evaluation yielded 90.07%, and subsequent Small Group testing scored 88.32%. Following further refinements to game navigation and visual layout in Prototype III, the Field Test produced a score of 89.26%, with all 20 participants completing all four Wordwall game activities within the scheduled session.

Discussion

The high feasibility scores reported in the Results section all six evaluator categories ranging from 87.80% to 91.40% indicate that Prototype III successfully met the development objective. This discussion interprets the underlying pedagogical mechanisms that explain why these scores were achieved, drawing on relevant learning theories and connecting them to the specific student behavior data documented during the evaluation stages. Three key interpretive findings are discussed: (1) the role of gamification in creating a joyful learning environment that drove high student engagement, (2) the function of visual scaffolding in helping students bridge abstract mathematical concepts to concrete understanding, and (3) the effectiveness of animated instructions in reducing cognitive load during task navigation.

First, the Field Test score of 89.26% and the 100% task completion rate across all 20 students can be interpreted through the lens of Constructivism (Vygotsky, 1978; Piaget, 1972). Constructivist theory posits that students learn most deeply when they are active participants in constructing their own knowledge through direct experience and interaction, rather than passive recipients of information. The Wordwall game-based evaluation components “Airplane” and “Balloon Pop” operationalized this principle by requiring students to solve mathematical problems through interactive play. This design created a “joyful learning” environment in which the act of playing became inseparable from the act of learning, which is consistent with Constructivist principles that knowledge is internalized most effectively through self-directed, experiential engagement rather than direct instruction. The high student engagement and completion rates observed during the Field Test are thus explained not as a superficial motivational effect, but as a structural outcome of a learning design grounded in active knowledge construction.

Second, the task performance data from the Small Group evaluation—where 8 out of 9 students completed length measurement tasks (cm and m) without requesting clarification—can be explained through Piaget’s theory of cognitive development and the concept of instructional scaffolding. Grade II students are in the concrete operational stage, meaning they can manipulate concrete objects and understand relational concepts, but still struggle with purely abstract symbolic reasoning. Length measurement units such as centimeters and meters are inherently abstract for this age group because they cannot be directly perceived without a reference object. By pairing these abstract units with real-world object images as visual prompts within the Wordwall quizzes, and by presenting measurement concepts through the interactive Heyzine flipbook materials before assessment, the media provided the concrete referents that students in this developmental stage require. This pedagogical approach constitutes an instructional scaffold that bridges the gap between abstract mathematical notation and concrete student experience, which theoretically accounts for the high task completion rates observed when visual prompts were present compared to text-only formats.

Third, the observation that students who used Prototype I (text-only instructions) paused and requested guidance, while students in Prototype II and III (animated instructions) re-attempted tasks independently, is theoretically explained by Mayer's Cognitive Theory of Multimedia Learning (CTML). CTML proposes that humans process information through two separate channels: a verbal/text channel and a visual/pictorial channel. When instructions are delivered in text-only format, all cognitive processing is funneled through a single channel, which creates high extraneous cognitive load and can cause working memory overload particularly in young learners whose working memory capacity is still developing. By contrast, animated instructions engage both channels simultaneously: the visual animation carries the procedural information while verbal elements reinforce it. This dual-channel processing reduces the cognitive effort required to decode instructions, freeing the learner's working memory to focus on the mathematical task itself. The measurable reduction in help-seeking behavior observed between Prototype I and Prototype II is therefore a direct empirical validation of the CTML dual-channel principle as applied to this age group.

Taken together, these three theoretical interpretations converge on a central implication: high feasibility scores in a game-based learning media study are not merely a product of technical quality, but reflect the degree of alignment between the media's design principles and the developmental and cognitive characteristics of its target learners. The fact that scores remained consistently high across all three expert domains (content, design, and media) and across all three student testing stages confirms that Prototype III achieved this alignment. These findings are consistent with previous studies demonstrating that game-based media adapted to local student contexts effectively support the achievement of mastery criteria in primary mathematics education (Pazira et al., 2025). These results are consistent with Pazira et al. (2025), who demonstrated that contextually adapted game-based media effectively support students in achieving mastery criteria in primary mathematics education.

Furthermore, the integration of three platforms Canva, Heyzine, and Wordwall within a unified media ecosystem represents a theoretically grounded and practically scalable instructional design model. Each platform fulfills a distinct pedagogical function aligned with the theories discussed above: Canva provides the visual-perceptual scaffolding consistent with CTML principles; Heyzine structures content delivery in concrete, flipbook format consistent with Piaget's concrete operational stage requirements; and Wordwall operationalizes active, gamified knowledge construction consistent with Constructivist principles. This functional specialization is the theoretical reason why multi-platform integration outperforms single-platform approaches for this age group. The primary implication of this study is therefore that other elementary schools facing student passivity in mathematics could replicate this design framework, provided the platform selection is similarly mapped to the developmental and cognitive characteristics of the target learners. These findings are consistent with previous studies by (Pazira et al., 2025), who demonstrated that games assist students in reaching mastery criteria, confirming the broader applicability of this study's findings beyond the specific context of SD Negeri 14 OKU.

Limitations and Applicability

While the research results demonstrate the high feasibility and effectiveness of the developed media, several limitations must be acknowledged. The most significant constraint relates to the generalizability of the findings. The field test was conducted with a relatively small sample size ($n=20$) from a single institution, SD Negeri 14 OKU. Consequently, the positive outcomes observed in this study may not be immediately generalizable to other elementary schools with different socio-cultural backgrounds, varying levels of student digital literacy, or limited school infrastructure.

Furthermore, the effectiveness of this game-based media is highly dependent on external factors, specifically the availability of digital hardware (laptops or smartphones) and a stable internet connection for accessing the Wordwall and Heyzine platforms. For the findings to be applied to other relevant educational problems such as literacy in rural or under-resourced areas future developers must consider the necessity of offline versions or printed companion materials to ensure that technology does not act as a barrier to access. To broaden the impact of this innovation, subsequent research should involve larger, more diverse participant samples across multiple regions to validate the longitudinal effects of joyful learning on student mathematics mastery.

CONCLUSIONS

The development of game-based learning media for Grade II Mathematics at SD Negeri 14 OKU provides a definitive solution to the need for interactive instructional innovations that overcome student passivity and the abstract nature of foundational mathematical concepts. This research establishes a highly feasible digital learning ecosystem by synergistically integrating Wordwall, Canva, and Heyzine to simplify whole numbers and length measurement materials. The quantitative evidence confirms the superior quality of the product, with validation scores from material experts (89.75%), media experts (91.4%), and instructional design experts (87.8%) all consistently falling into the "Very Good" category.

Furthermore, the field test score of 89.26% demonstrates that this media is an effective tool for practical classroom application, successfully fostering a joyful learning environment that enhances student engagement. The study yields significant implications for elementary education, proving that developmentally appropriate digital tools can bridge the gap between abstract curriculum targets and actual student understanding. This research offers a scalable model for further development, with the prospect of expanding this game-based framework to other mathematical topics or diverse subjects. Future studies should prioritize summative evaluations across broader regions to fully validate the long-term impact of this digital innovation on national literacy and numeracy outcomes.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to Universitas Baturaja for the institutional support provided throughout this research. The authors also extend their appreciation to the principal, teachers, and Grade II students of SD Negeri 14 OKU for their cooperation and participation during the data collection and product evaluation stages. Special thanks are also due to the expert validators the material expert, media expert, and instructional design expert whose constructive feedback greatly contributed to the refinement of the game-based learning media.

AUTHOR CONTRIBUTION STATEMENT

SFD conceived the research idea, conducted the literature review, and led the overall development of the game-based learning media using Wordwall, Canva, and Heyzine. SFD also carried out the data collection, product implementation, and drafted the manuscript. YI supervised the research design and the application of the ADDIE development model, provided critical feedback on the instructional design framework, and reviewed the final manuscript. LP contributed to the formative evaluation process, assisted in data analysis and interpretation of the expert validation and student testing results, and participated in manuscript revision.

AI DISCLOSURE STATEMENT

The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

REFERENCES

- Almuslim, Rahma, R., & Nurhayati, N. (2021). *PENGEMBANGAN MEDIA INTERAKTIF BERBASIS GAME EDUKASI*. 2(1).
- Febriantika, L., Wijaya, J. E., & Arta, D. (2024). *Efektivitas Model Pembelajaran Kartu Arisan terhadap Hasil Belajar Siswa pada Mata Pelajaran Prakarya Kelas VIII di SMP*. 8(1), 503–506. <https://doi.org/10.54895/bajet.v8i1.2675>
- Fiqri, M. A., & Sangkala, I. (2025). *Meningkatkan Keterampilan Desain Media Pembelajaran Melalui Canva Bagi Tenaga Pendidik SMP Muhammadiyah Takkalasi*. 12(1), 62–71.
- Hasanah, N. (2023). *Pengembangan Media Pembelajaran Berbasis Game Tebak STKIP PGRI Situbondo*. 10(1), 171–180.
- Huda, M. (2023). *Implementasi Teori Belajar Behavioristik Dalam Proses Pembelajaran*. 1(4).
- Ilahy, W. Q., Subali, B., & Widiarti, N. (2025). *Kajian Literatur Tren Penelitian Pengembangan Media Pembelajaran Interaktif Berbantuan Canva pada Rentang Tahun 2020-2025*. 10. <https://doi.org/10.23969/jp.v10i01.23780>
- Undang-undang RI No 20, (2003).
- Isa, Y., Rahmi, J., Novita, R., Cc, A. A., & Baturaja, U. (2024). *Pengembangan Multimedia Interaktif dengan Menggunakan Adobe Animate CC pada Mata Pelajaran Ilmu Pengetahuan Alam Kelas VI Semester I di SD Negeri 10 OKU*. 247–259. <https://doi.org/10.47709/educendikia.v4i02.4423>
- Ixfina, F. D., Fitriani, S. L., & Rohma, S. N. (2023). *Penggunaan Aplikasi Canva sebagai upaya Meningkatkan Teknologi Knowledge Guru di Era Digital di Sekolah Dasar YP Nasional Surabaya*. 2. <https://doi.org/10.36781/khidmatuna.v2i2.482>
- Khoiriyatin, V. Z., Muhayarotun, S., & Chasanah, U. (2025). *Pengaruh Media Pembelajaran Gamifikasi Berbasis Wordwall Terhadap Hasil Belajar Peserta Didik Kelas 3 Pada Mata Pelajaran Pendidikan*. 5(5), 518–532.
- Kusmiyati, & Tobing, V. M. L. (2024). *Landasan Teknologi Pendidikan*. Literasi Nusantara Abadi Grup.
- Laia, S. S., Hafizhoh, S., Al, U., Medan, W., Pelajaran, M., & Pembelajaran, M. (2022). *Kemampuan Guru Menyesuaikan Antara Materi Pelajaran Dengan Media Pembelajaran Pada Mata Pelajaran Pendidikan Agama Islam*. 2.
- Mahira. (2023). *Pengembangan Bahan Ajar Berbasis E-Book Interaktif pada Heyzine Flipbook Materi al-Tahiyya Watta'uf Kelas X MAN 1 POLMAN*.
- Miranti, M. Y., Saryantono, B., & Ristika. (2024). *Pengembangan Media Pembelajaran Berbasis Game Edukasi pada Mata Pelajaran Matematika untuk Siswa Kelas IV di SD Kartika II-5 Bandar Lampung*. 141–152.
- Nisa, R., & Mawardah, F. (2023). *Pengembangan Media Pembelajaran Matematika Berbasis Game Edukasi dengan Program Construct 2*. September, 159–169.
- Pazira, D., Istianingsih, S., & Fauzi, A. (2025). *Pengembangan Media Permainan Ular Tangga Berbasis Kearifan Lokal Berorientasi Pada Kemampuan Berhitung Peserta Didik Kelas II SD Negeri 1 Krama Jaya*. 10, 2429–2438. <https://doi.org/10.29303/jipp.v10i3.3921>
- Pratama, R. Y., Syaifurrohman, A., & Sari, D. P. (2025). *AL-AFKAR: Journal for Islamic Studies Pengembangan Media Pembelajaran Pendidikan Agama Islam Berbasis Media Smart Spinner di SDN 34 Negeri Katon Kabupaten Pesawaran*. 8(4), 68–77. <https://doi.org/10.31943/afkarjournal.v8i4.2008.Development>
- Puspitaningrum, P. N., & Witanto, Y. (2024). *E-Module Teaching Materials Based on Heyzine Flipbook on the Meaning of NKRI for Grade IV Elementary School*. 8(3), 423–431.
- Putra, F. M., & Nurlina, L. (2025). *Development of E-Module based on Heyzine Flipbook to*

- Increase Student Motivation and Learning Outcomes in Learning Letters. *Jurnal Inovasi Pembelajaran*, 11(2), 171–181.
<https://doi.org/https://doi.org/10.22219/jinop.v11i2.37066>
- Ristiani, R., Yuliana, C., & Rusli, T. S. (2025). *Analisis Penggunaan Aplikasi Wordwall sebagai Media Pembelajaran Interraktif dalam Pembelajaran IPA*. 10.
- Rustamana, A. (2024). *Penelitian dan Pengembangan dalam Pendidikan*.
- Santika, A. A., Saragih, T. H., Kartini, D., & Ramadhani, R. (2023). *Penerapan Skala Likert Pada Klasifikasi Tingkat Kepuasan Pelanggan Agen BRILink Menggunakan Random Forest Application Of Likert Scale On Classification Of Customer Satisfaction Level Of BRILink Agents Using Random Forest*. 11(3), 405–411. <https://doi.org/10.26418/justin.v11i3>.
- Setiyani, A., Kustiana, Y., Wantini, S., Wibowo, S. A., Sugeng, K. A., & Susanto, D. (2025). *Panduan Mata Pelajaran Matematika*. Badan Standar, Kurikulum, dan Asesmen Pendidikan.
- Shabrina, A., Putri, R., Khairi, A., Pgri, S., Trunojoyo, A. J., Barat, G., Batuan, K., & Sumenep, K. (2025). *Pentingnya Pemilihan Media Pembelajaran Yang Tepat Untuk Meningkatkan Hasil Belajar Siswa*. 1(April), 120–131.
- Sugiyono. (2024). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.
- Wulan, O., Sari, N., & Pratiwi, V. (2024). *Development Of Interactive E-Modules Based On Heyzine In The Subject Of Basic Accounting And Institutional Finance For Class X Accounting*. 8, 12–30. <https://doi.org/10.31851/neraca.v8i1.15371>
- Yuni, R., Sari, P., Silaban, M. J., Thohiri, R., Kemala, P., & Lubis, D. (2025). *Effectiveness of Using Heyzine Flipbook Maker-based E-Modules through Problem-Based Learning Model*. 9(1), 92–98.