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Developing an Innovative Game-Based Learning Model in Physical Education to Improve Literacy and Numeracy Skills of 1st Grade Students

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Abstract. Literacy and numeracy have been regarded as a fundamental skill for students' further learning. Many challenges are still faced by elementary teachers related to the limited sources in improving students' literacy and numeracy. The current study aimed at developing an innovative game-based learning model in Physical Education (PE) classrooms to improve students' literacy and numeracy skills. Research and Development (R&) approach was employed by adapting ADDIE model. There were five stages of development; analysis, design, development, implementation, and evaluation. There were 30 of 1st grade students and two PE teachers at Bukit Sunrise School Jimbaran, Bali, selected as research subjects by using total sampling technique. The data were obtained through observation, interview, and test. The observation sheet, interview guide, and test were the research instruments in which the obtained data were analysed quantitatively and qualitatively. The results indicated that; 1) the innovative-game learning model had a very high quality with 92,6% for the validity and practicality, and 2) the implementation of developed learning model effectively improved students' literacy and numeracy, as evidenced with a significant value .001 < .05 and a very large effect size of 5.495. These results imply that game-based learning model within PE is an effective alternative to increase students' fundamental skills.

Keywords: Game, Literacy, Numeracy, Physical Education

INTRODUCTION

Literacy and numeracy are regarded as fundamental skills that are essentially emphasized to support 21st century learning. It is argued that literacy and numeracy are a foundation to achieve a successful 21st century learning that develops students' critical thinking skills (Anggun et al., 2025; Indriani, 2024). 21st century learning frames students to be able to think critically and creatively to solve a contextual problem in which students are supposed to possess numeracy and literacy skills as the base to achieve this goal (Sujatha & Vinayakan, 2022). Numerous attempts have confirmed that literacy and numeracy are vital for students' continuous process influencing their progress in many different learning subjects (Díez-Palomar et al., 2023). Considering that literacy and numeracy fundamentally support students for further learning, these abilities are strongly emphasized as students enter primary or elementary schools (Ifrida et al., 2023; Nadya & Harfiani, 2023; Nityasanti et al., 2025).

Despite its essence in developing students, there is a considerable gaps related to students' numeracy and literacy in developing countries as what has been found in Indonesia. It is relevant to the result of PISA in which Indonesian students achieve low level of literacy and numeracy since 2022 until today (Bilad et al., 2024; Solihin et al., 2024). This issue demands teachers to implement innovative teaching strategies to bridge the gap but they are limited to lack of resourcing access, inadequate teachers' training, and less of comprehension in adopting technological means in the classrooms to increase students' literacy and numeracy (Fathurahman et al., 2023; Nityasanti et al., 2025). A preliminary observation shows that a relevant problem occurs at Bukit Sunrise School Jimbaran, Bali. It is found that first-grade students still have low literacy and numeracy skills. The teachers have unlimited resources since they are able to integrate technology into classrooms but they mention that innovating technology with the learning activities is still challenging. It is proved through how they only adopt a certain video or game from the internet with no innovation. Consequently, the learning environment is less interactive and engaging limiting students to develop their literacy and numeracy skills. As mentioned in the previous study, less interactive and innovative can be an obstacle for students to improve their literacy and numeracy skills (Kartikasari et al., 2025). It indicates that limited innovation and interactivity contributing factors to students' low literacy and numeracy skills.

To foster students' literacy and numeracy skills, an innovative learning model is urgently needed which promises an interactive learning for students' engagement and holistic development. In this sense, game-based learning can be an alternative for an innovative learning engaging students and improving their literacy and numeracy (N. M. Sari et al., 2025). Game-based learning is often defined as a learning model which engages students with an artificial conflict and a set of rules (Cahyana et al., 2023). A study highlights that game-based learning stimulates students' emotion, intelligence, and psychomotor which directly shows that students' learning outcomes are improved due to its implementation (Ifrida et al., 2023). Nirwana (2021) reveals that game-based learning promotes students' literacy and numeracy by engaging them in reading as well as solving numeric problem. An investigation discovers that students who are taught with game-based learning model tend to achieve higher numeracy than the students who are taught conventionally (N. M. Sari et al., 2025). These results provide an overview about game-based learning that innovatively creates interactive learning environment to foster students' literacy and numeracy.

Since game-based learning is perceived as an efficient innovative learning model, the educators across various subjects start to implement it. In Physical Education (PE), an integration of game-based learning underexplored yet promising area to increase students' literacy and numeracy skills. Differ from other subjects, Physical Education embeds literacy and numeracy through movement-based game activities that not only engages students physically but also cognitively stimulate them to read and comprehend the instruction or rule, calculate or measure distance or score, as well as interpret data related to their performance (Rejeki et al., 2024). The activities provided in PE game requires students to communicate, strategize, and solve a problem collaboratively encouraging students to practice functional literacy in the forms of verbal or written communication, and numeracy by comparing, estimating, or counting numeral values (Hakim et al., 2023). Those activities clearly nurture students' literacy and numeracy through physical and cognitive activities.

Several studies have been conducted to explore the implementation of game-based learning in Physical Education; however, discussions related to game-based learning model developed to enhance students' literacy and numeracy skills remain scarcely explored. Vetter et al., (2020) have found that games-based learning improve

both students physical engagement and mathematic learning outcomes indirectly shows that students' numeracy is improved through physical activity. It is added that a development of a game-based literacy and numeracy in PE improves students' locomotor movement (Jannah et al., 2024). On another side, a study has discovered that digital game application effectively improves students' literacy and numeracy skills (Azali & Latipah, 2022). Empirically, these studies have revealed the effectiveness of game-based learning model for both students' physic and cognition; however, there is no current study which explicitly develops game-based learning model within PE that directly targets the improvement of these foundational skills. Therefore, as a further action, the current study is conducted to develop an innovative game-based learning model in Physical Education to improve the literacy and numeracy skills of 1st grade students at Bukit Sunrise School Jimbaran, Bali where the students have been identified with low literacy and numeracy skills.

METHOD

The current study adapted Research and Development (R&D) method particularly by employing ADDIE model. It consisted of five stages, such as; analysis, design, development, implementation, and evaluation. The stages were illustrated in figure 1.

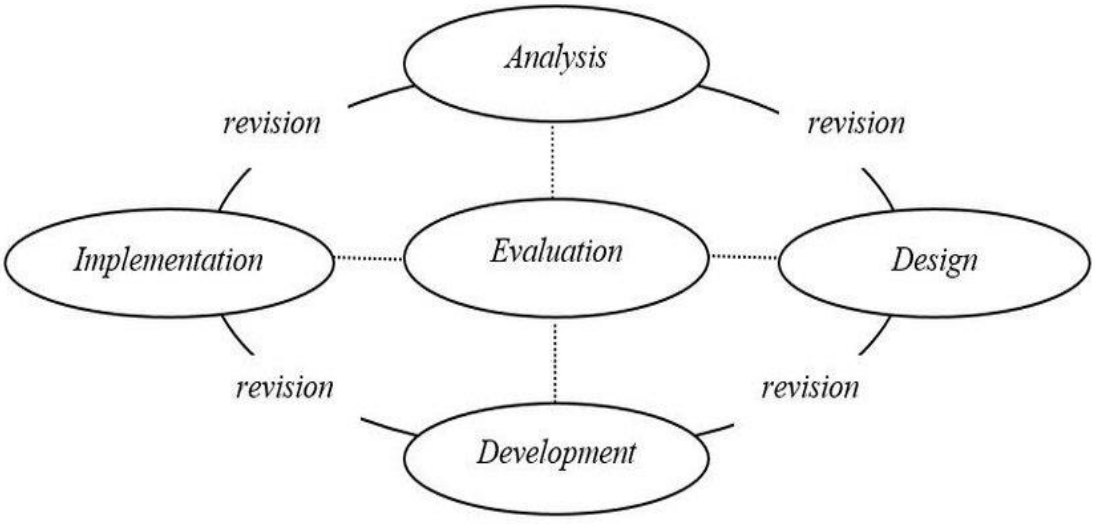


Figure 1. ADDIE Development Model

Based on Figure 1, there were five steps of developing an innovative game-based learning model in Physical Education to improve students' literacy and numeracy skills. Analysis was an initial step for identifying students problems and their needs. The analysis was conducted by observing the learning process and interviewing the teachers. The research subjects were 1st grade students and two PE teachers. The students were observed to find out their basic competence related to literacy and numeracy in PE class. In addition, the observation result was supported with the interview result which showed what students' needs and lacks in the learning process based on the teachers' lens. Design was a step for designing the developed learning model in which it was conducted by using the analysis result as a foundation. A prototype was designed by combining physical movement, literacy, and numeracy to form an educative game. The flow of the game was also designed in this stage.

Development was the step of developing prototype in the real product in which its reliability and validity were tested by conducting expert judgements before it was implemented to the students and teachers. Implementation was the step for implementing the developed model to the subjects who were 1st grade students. There were 30 students involved to the implementation. Evaluation was conducted in the form of formative and summative evaluation. Formative evaluation was conducting along the development process where the revision was conducted in each step based on suggested by the supervisor and expert judgement. Summative evaluation was conducted through pre-test, post-test, and user judgement by the teachers. These evaluations were conducted to fully investigate the effectiveness of developed learning model.

Based on the development model employed in the current research, it was found out that 30 of 1st grade students and 2 PE teachers at Bukit Sunrise School, Jimbaran were selected by using total sampling technique. The data were collected through observation, interview, test, and questionnaire distribution. The research instruments were observation sheet, interview guide, questionnaire, and test. The obtained data were analysed quantitatively and qualitatively. Quantitative analysis was conducted with descriptive statistic and inferential statistic in the form of t-test. Qualitative analysis was conducted with Qualitative Data Analysis consisting of three stages; data reduction, data display, and conclusion drawing. The findings were presented in the form of numeric data and elaboration.

RESULT AND DISCUSSION

Result

The findings of this study were presented in accordance with the research questions formulated earlier. Each finding was addressed systematically covering; the process of developing an innovative game-based learning in PE to improve students' literacy and numeracy skills, the quality of developed learning model covering its feasibility and practicality, and the effectiveness of developed learning model in improving students' literacy and numeracy skills. Those results were presented in the each stage of ADDIE model as presented in the following sections.

Students' Needs Analysis Related to An Innovative Game-Based Learning Model to Improve The Literacy and Numeracy Skills of 1st Grade Students at Bukit Sunrise School, Jimbaran, Bali

The needs analyses focused on finding students' basic competence, characteristics, and students' needs. The finding were presented in Table 1.

Table 1. The Result of Students' Needs Analysis

Dimension	Descriptors	Yes	No
Students' Basic Competence	Students are able to identify letters and numbers within a text	90%	10%
	Students are able to read words and rewrite them	63%	37%
	Students are able to identify, understand, and rewrite phonemics found in words	23%	77%
	Students are able to calculate things directly	100%	0%
	Students are able to understand abstract addition and subtraction through English word problems	53%	47%
Students' Characteristics	Students have better comprehension through fun learning activities involving repetition and body movement	70%	30%
	Students are enthusiast with various activities; gaming, singing, moving, and exploring environment	100%	0%

	Students are actively working in collaboration and cooperation	70%	30%
Students' Needs	Students need body movement activity	50%	50%
	Students need visual learning media	100%	100%
	Students need team work activities	63%	37%
	Students need reading, writing, and calculating activities in PE	63%	37%

Based on Table 1, it was found out that students were in variant level for the basic competence of literacy and numeracy skills. It was found that 90% of students were able to identify letters and numbers within a text and 23% who were able to read and rewrite the words. The problem occurred on their ability in identifying, understanding, and rewriting phonemics found in the words considering that only 23% of students who had this ability and the others were still lack of. All of the students were able to calculate numbers directly but 53% students were failed in understanding abstract addition and subtraction through English word problems. Since the first grade students were taught in bilingual environment, the teachers mentioned that it was quiet challenging to improve their literacy and numeracy, however; the findings revealed that their literacy and numeracy were in intermediate level.

Dominantly students preferred to learn in a more engaging learning environment in which they were enthusiast for body movement, singing, and gaming activities. It also indicated that majorly students had auditory, kinaesthetic, and visual learning styles where they were excited for singing, moving, and visual learning. The observation also showed that students tent to be bored when the teachers only explained the learning materials verbally. Therefore, these findings really supported the development of an innovative game-based learning model in PE to improve their literacy and numeracy skills.

The Design of An Innovative Game-Based Learning Model to Improve Literacy and Numeracy Skills for 1st Grade Students at Bukit Sunrise School Jimbaran, Bali

Based on the needs analysis, the game was designed in the digital form named as "Treasure Hunt: Read, Write, and Count". The game was specifically designed to help students in reading, writing, and calculating. The design was presented in Table 2.

Table 2. The Design of "Treasure Hunt: Read, Write, and Count"

Features	Descriptions
Game Instruction/Rule	- The game was played by two teams consisting of an equal number of students - 3 posts were gradually finished by each team - Each post consisted of ten instructional cards in which each member only had 1 instructional card to finish - Each students wrote their answer on the whiteboard - The winner was the team with the highest point, in case of a tie, an extra round could be held.
Game Plot	- Reading Station: the first post to practice students' reading by identifying the letters and reading simple instructions. The students were also trained to comprehend the meanings and rules given - Writing Station: students were trained to write or write words or phrases based on the instruction given - Counting Station: the last post to lead students for finishing numeric questions
Tools	- Instructional cards - Response cards - Movement tools

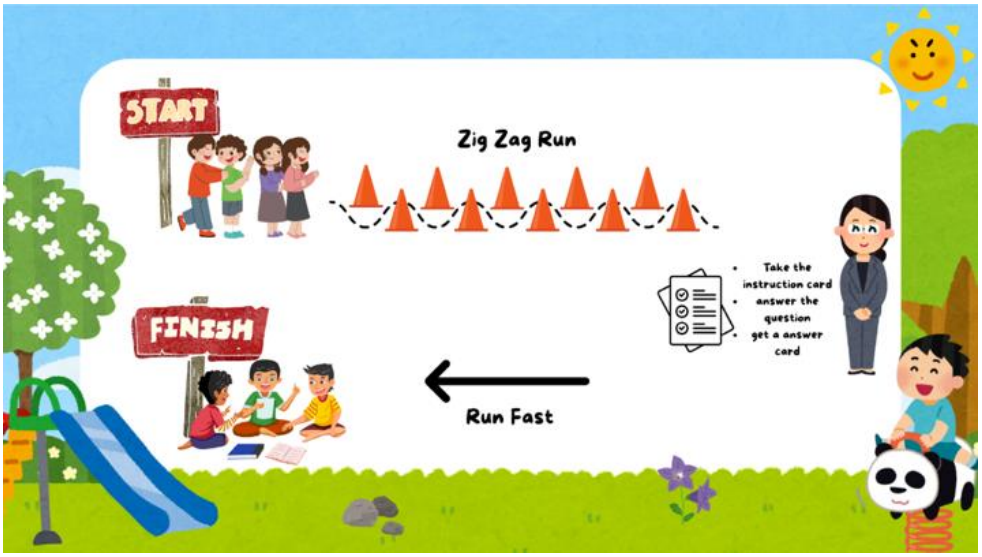
The game was designed in the form of three main stages in which it gradually trained students' literacy and numeracy skills. The game was also completed with instructions or rules with the tools needed.

The Development of An Innovative Game-Based Learning Model to Improve Literacy and Numeracy Skills for 1st Grade Students at Bukit Sunrise Schools, Jimbaran, Bali

The development was started by developing the instructions or rules for conducting the games. It was proposed that the game should be joined by two teams where each team consisting with equal members. Each member was supposed to complete one instruction for each post. There were only ten instructions cards for each team. The students should write their answers on the whiteboard that had been provided by the teacher. The students were not allowed to whisper or tell their friends about the answer. All the students were encouraged to actively participate. The winner was the team with the highest point, in case of a tie, an extra round could be held. The game was plotted gradually from first post to the third post by adapting explorative approach.

Students' Activities in Reading Station

Reading Station aimed at training students' reading skills where they practiced in recognizing letters and reading simple sentences or instructions related to daily life. It assisted students to comprehend the meaning of written commands and respond to them orally. The activities were illustrated in Picture 1.



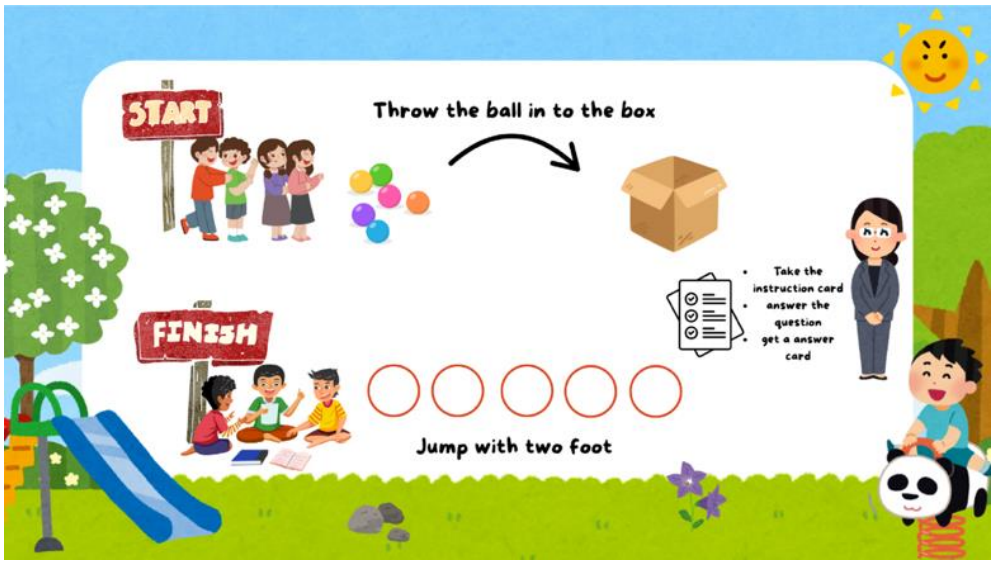
Picture 1. Reading Station

Students were asked to run in a zig-zag pattern with a basket containing reading instructions card. Each student was asked to pick one card and run back to the teacher. The student was asked to read aloud and the teacher was allowed to assist him or her. The student responded to the instruction orally and run to the team table for writing the answer onto the worksheet in the *Reading Post* section. After writing, the student run back to the start and gave the turn to the next member. If the oral answer was incorrect, they were given three chances to respond. The next member had a chance to take the previous student's turn if he or she could not answer it correctly. This activity combining physical movements; zig-zag running, raising hands, making two small jumps with literacy and numeracy practices. It was reflected from the instruction *"Hop and find a word that starts with A"*. It asked students to move and answer.

Students' Activities in Writing Station

This post focused on developing students' writing skills as a part of literacy by copying, rewriting, or writing words or phrases based on their understandings to the instructions given. This activity encouraged students to write short answers with physical

movement by simultaneously training their hand-eye coordination and concentration. The activities were illustrated in Picture 2.

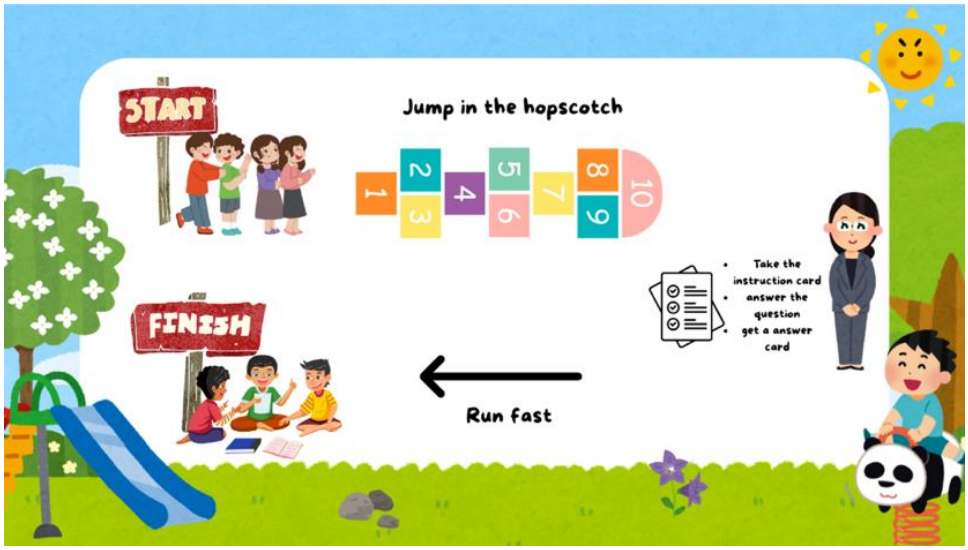


Picture 2. Writing Station

The activities were started by students jogging toward a basket filled with several balls. The students were asked to take and throw one ball to a mini ring, basket, or box. After the ball was successfully into the target, each student was asked to take a card consisting of writing instruction, for example; "*write the word of apple*". The teachers were a facilitator and providing students with a card for witing their correct answers. They sat on the writing areas to write their answers onto the worksheet. After writing, the students went back quickly to the start and gave the turn to their members. The students were also given two chances to correct their answers before submitting them. These activities were a combination between physical movements and visual learning where the teachers used colourful balls and instructional cards.

Students' Activities in Counting Station

Counting Station was a post developed for enhancing students' numeracy skills covering addition, subtraction, and number recognition which encouraged students with playful activities for solving math problems. The activities used concrete number media and simple motor movements. Those were illustrated in Picture 3.



Picture 3. Counting Station

Initially, the students were asked to hop over numbers on the floor (on a hopscotch pattern) toward the problem box area. Each student was asked to pick one math problem from the card. The student was calculated the numbers directly on the spot. If the students were not able to solve the problems, the teachers gave them an answer card consisted of the correct answer. The student moved to the team table and wrote the answer. After writing, they had to go back to the start and give the turn to other members. The physical activities were designed by attaching math challenge while moving, for example; "*Jump six times, then subtract two. What's the number?"*.

Furthermore, the development process was continued by conducting expert judgements to find out the quality of developed game-based learning model covering its validity, and practicality. The expert judgements were conducted by involving a material expert judge, an expert judge of elementary education content, and a learning model expert judge. In addition, the practicality was obtained by conducting user judgement in which the PE teachers became the evaluators. The result was presented in Table 3.

Table 3. The Result of Validity and Practicality

No	Judgement	Max Score	Gained-Score	%	Category
1	Material Expert Judgement	50	88	88%	Very High
2	Expert Judgement of Elementary Education Content	50	88	88%	Very High

3	Learning Model Expert Judgement	60	95	95%	Very High
4	User Judgement	50	94	94%	Very High
	Mean			92,6%	Very High

Based on table 3, it was found out that the total percentage was 92.6% indicating that the developed game-based learning model had very high validity and practicality. It was found that the materials contained in the learning model was at the percentage of 88% categorized as a very high validity. The result of expert judgment for its elementary education content was also at the percentage of 88% which meant it also achieved high validity. Meanwhile, the learning model expert judgement indicated that the innovative game-based learning that had been developed were having very high validity with the percentage of 95%. In addition, the user judgment revealed that the developed learning model had a very high practicality indicated by its percentage on 94%. Therefore, the developed learning model was implemented to find out its effectiveness.

The Implementation of An Innovative Game-Based Learning Model Developed to Improve Literacy and Numeracy Skills for 1st Grade Students at Bukit Sunrise School, Jimbaran

The implementation was conducted as a subsequent phase after the development process. It was a further action to examine the effectiveness of developed product. There were 30 of 1st grade students who were divided into two groups; control group and experimental group. Both of the groups were taught with conventional learning model at the beginning before conducting pre-test. The pre-test was conducted by using the test consisting of reading, writing, and calculating activities. After that, the treatment was given to the experimental group where the innovative game the innovative Teaching Games for Understanding (TGFU) model integrated with literacy and numeracy skills was implemented as a learning model. Meanwhile, control group was treated by using conventional learning only. Post-test was conducted as the last action in which the results from both of the tests were collected and analysed for the summative evaluation.

The Effectiveness of An Innovative Game-Based Learning Model Developed to Improve Literacy and Numeracy Skills for 1st Grade Students at Bukit Sunrise School, Jimbaran

To find out the effectiveness of an innovative game-based learning model, pre-test and post-test were conducted to obtain students' literacy and numeracy skills after the implementation of an innovative game-based learning model in PE that had been developed in the current research. The obtained data were analysed by using inferential statistic particularly by employing paired-sample t-test. the result was presented in Table 4.

Table 4. The Result of Paired-Sample T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	pretest	63.97	30	6.510	1.189
	posttest	85.33	30	3.122	.570

Table 4 showed that there was a difference between the mean score of pre-test and the mean score of post-test. The mean score gained by the students during the pre-test was 63.97 with standard deviation of 6.510, meanwhile there was an improvement found during the post-test indicated with the mean score of 85.33 and standard deviation of 3.122. It indicated that there was an improvement on students' literacy and numeracy skills of 1st grade students after the implementation of innovative game-based learning model developed in the current study. Them, it was supported by the result of paired samples correlations test as presented in Table 5.

Table 5. The Result of Paired Samples Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	pretest & posttest	30	.559	.001

Table 5 presented the coefficient correlation value at .559 with a significant value of .001. This result indicated that there was a paired-correlation between pre-test score and post-test score. It could be assumed that the higher students' prior knowledge of literacy and numeracy, then, the greater chance for them to achieve better literacy and numeracy skills when the developed learning model applied into the classrooms. To find

out the significant difference between pre-test and post-test, paired-sample t-test was conducted where the result was presented in Table 6.

The Result of Paired-Sample T-Test was found that t_value was 21.597 with df = 29. It was also found that the significant p_value was .001. It indicated that there was a significant difference between the score gained by the students during the pre-test and post-test. In addition, the effect size was also obtained to find out how far is the influence of developed learning model affected students' literacy and numeracy skills. The result was displayed in Table 7.

Table 7. The Result of Paired Samples Effect Sizes

Paired Samples Effect Sizes

				Point Estimate	95% Confidence Interval	
			Standardizer[a]		Lower	Upper
Pair 1	pretest - posttest	Cohen's d	5.423	-3.940	-5.005	-2.865
		Hedges' correction	5.495	-3.889	-4.940	-2.828

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

The paired-sample effect sizes indicated that the value of Cohen's d was 5.423 with the correction of Hedges g = 5.495. Based on the criteria proposed by Cohen (1988), the effect size value which was higher than 0.8 was categorized as a very large effect. It could be assumed that the developed game-based learning model contributed a very large effect on students' literacy and numeracy skills.

Discussion

The current finding reveals that the development of innovative game-based learning is initiated through a comprehensive needs analysis as the foundation for designing relevant and effective learning model. It supports the aims of needs analysis in providing comprehensive information related students' learning and characteristics to achieve an effective learning content (Sari et al., 2020). The needs analysis is also essential for deciding the learning activities for training students' literacy. It is mentioned that the primary role of needs analysis is helping educators to achieve students' target needs and learning needs related to the sources or materials in improving their literacy (Padmadewi et al., 2022). The data obtained from observation and interview of the current study present the actual condition addressing students' characteristics, basic competence,

and learning context. These results lead the development into an innovative game-based learning model that are more students-cantered and contextually appropriate. It is supported teachers to fulfil the demand of 21st century learning framing a learning process which engages students to be active participation in the classrooms to develop their critical and creative thinking skills (Hidayani et al., 2025; Widana, 2017).

Another finding shows that the innovative game-based learning model developed for improving students' literacy and numeracy skills has a very high quality obtained from its validity and practicality. This result signifies that the model component including the instructions, the activities, and the content are relevant to the learning outcomes expected for the students as well as fulfil students' characteristics related to auditory, kinaesthetic, and visual learning styles. It also reflects that the developed product is conceptually sound and systematically constructed which supports other development researches mentioning that validity and practicality examination are important to guarantee the quality of educational product (Dewi & Handayani, 2021; Ekarini et al., 2024; Novitasari et al., 2017). The teachers respond to the developed learning model where they perceive the model is procedurally easy to implement, engaging, supportive for students. This response is relevant to the critical criterion of practicality which determines whether a learning product provides an ease and efficiency for the users (Puspita et al., 2017). It is confirmed that the innovative game-based learning model has fulfilled the specification of good learning product.

The last finding demonstrates that the developed learning model is effective in improving students' literacy and numeracy skills, as evidenced by a very large effect size. It indicates that the implementation of developed product has a substantial impact on students' literacy and numeracy skills in Physical Education (PE). This result strengthens many previous researches revealing game is an effective in improving students' learning outcomes in PE classrooms (Amiariasti et al., 2024; Darsana et al., 2021; Raditya et al., 2023). It also supports another finding revealing that game is a promising alternative to foster elementary students' literacy and numeracy skills by providing an active, meaningful, and joyful learning experiences (Nadya & Harfiani, 2023). However, despite of its effectiveness, this study has a limitation related to the technological integration in the developed model. The activities primarily rely on physical activities rather than digital technology-assisted media. As a result, the developed learning model not fully captures

the 21st century learning and digital environment that are widely assumed bringing optimal impact on elementary students' literacy and numeracy.

CONCLUSION

The current study concludes that the development of an innovative game-based learning model is conducted through five stages; analysis, design, development, implementation, and evaluation which the developed product has a very high validity and practicality and effective for improving students' literacy and numeracy skills. This finding implies the existence of a feasible and evidence-based instructional model (game-based learning) can be an alternative approach to integrate literacy and numeracy development in Physical Education (PE) learning. Since this study is limited to an optimal technological integration, it is suggested for other researchers to conduct a study by incorporating digital tools or technology-based platforms into the game-based learning model. Future research may explore how digital game-based environments, interactive simulations, or augmented reality applications can enhance students' engagement and further strengthen the improvement of literacy and numeracy skills in Physical Education contexts.

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