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Developing An Educational Board Game with Digital Question Cards : A TGT Model Approach to Enhance Natural and Social Sciences Learning Outcomes

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Abstract: This study aims to develop and test the feasibility and effectiveness of an educational board game assisted by digital question cards with the Teams Games Tournament (TGT) model. This research and development used Sugiyono's model with stages of potential and problems, data collection, product design, design validation, design revision, product trial, product revision, usage trial, and product revision. Data collection techniques included interviews, questionnaires, tests, and documentation. The subjects of this study were fifth-grade elementary school students. Data analysis techniques included the normality test as a prerequisite test, paired sample t-test or Wilcoxon signed-rank test, and N-Gain test. The board game that has been developed consists of concrete and digital components. The assessment from media and material experts was 94% and 96.6%, so it was categorized as very feasible. The board game was considered effective with an Asymp. Sig (2-tailed) in the usage trial of 0.000 so that H_a is accepted and H_0 is rejected. The N-Gain score was 0.7058, with high criteria. The board game media was also considered very practical, with the results of the teacher and student response questionnaires amounting to 98.75% and 94.32%. So, the educational board game media assisted by digital question cards with the TGT model that researchers have developed is very feasible and effective in enhancing Natural and Social Sciences *(IPAS)* learning outcomes.

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Introduction

Education is a series of processes that aim to develop every potential possessed by each individual so that the individual can lead to maturity (Zuhdi et al., 2021). One of the main parts of education is the curriculum, where the two cannot be separated (Prihantini et al., 2024). Curriculum components such as goals, content or learning materials, learning approaches, learning methods, and evaluation (Hasbullah et al., 2023) become a reference in the learning process. The current curriculum in Indonesia is called the Merdeka Curriculum, in which there are new subjects, namely *IPAS* (Natural and Social Sciences), which is a combination of *IPA* (Natural Sciences) and *IPS* (Social Sciences). *IPAS* starts to be taught from grade III to grade VI. The merging of these two subjects is intended because students see things in a simple, whole, and integrated way (Kemendikbudristek, 2024).

It is important for teachers to adapt in implementing *IPAS* learning, both from media, models, methods, and learning evaluation. Based on pre-research data from an elementary school in Semarang City that was used as a research location, the *IPAS* learning outcomes of VA class students in chapter 6 are less than optimal, as evidenced by 60.87% of students are not complete. Students experience learning difficulties in chapter 6, especially in topic A Map

material, namely in understanding the components of the map. This is due to the introduction of many new terms and symbols that are unfamiliar to students. From interviews with the teacher and the results of distributing student questionnaires, information was obtained that students like games in the learning process, but due to several obstacles, the use of learning media by the teacher on Map material is still limited, such as PowerPoint and YouTube videos. Therefore, media innovations that are integrated with games are needed.

Pre-research data also revealed that the teacher had implemented several learning models, including Problem-Based Learning (PBL) and Project Based Learning (PjBL), but in its application, it often only follows the guidelines in the student book or teacher book. If there is a project in the book, it is considered an application of PjBL. This shows that the learning models used by the teacher have not been varied. The teacher observed that students like learning that contains elements of games. Therefore, it is also important to implement a learning model according to the characteristics that students have by integrating games into it. Games can be applied in learning as an effective learning method to learn complex material topics in an interactive and fun way (Kantorski et al., 2025). Therefore, the implementation of games in learning, also known as game-based learning, can be one of the approaches to fostering students' interest in learning (Priyaadharshini et al., 2020 in Videnovik et al., 2023).

In accordance with the problems described above, it is necessary to find a solution in the form of innovative media development. Researchers analyze that games also need to be applied so that games that are suitable for application in learning are educational games. An educational game is media in the form of a game that can educate its users, such as stimulating creative thinking; besides that, it also has a role in supporting the achievement of learning objectives (Syaliman et al., 2022). So, researchers developed a media that combines an educational game and integrates it with the appropriate learning model. After analyzing the potential and problems in learning *IPAS* in class VA, the appropriate learning media is a board game. Board game media aligns with the characteristics of elementary school children who like to play (Zainil et al., 2022). Board games can be an effective learning medium in improving the quality of the learning process (Nguyen et al., 2024). In a study that has been conducted by Barekat (2023), it was shown that the implementation of the board game was able to increase students' interest in learning and positively impacted their learning outcomes.

The board game developed by the researchers is a combination of concrete and digital, which is realized in a Snakes and Ladders game. The digital component in this board game is question cards made in digital form. Question cards are defined as cards with questions (Rohmah et al., 2019 in Mulyono & Fatika, 2024) according to the material. In Piaget's cognitive development theory, there are stages; where elementary school students aged 7 to 11 years are categorized in the third stage, namely the concrete operational stage (Hetherington et al., 1999 in Hayat et al., 2024) so that the board game media developed by researchers is a combination of concrete and digital. Meanwhile, teachers are expected to be creative in utilizing technology. Combining digital and concrete media is expected to create effective and interactive learning while keeping up with technological developments.

This board game is integrated with the Teams Games Tournament learning model, abbreviated as TGT. In the TGT model, students compete in groups in a game that can create fun learning (Bayhon & Orongan, 2025). Research by Matitaputty et al. (2023) proved that by applying the TGT model, there is a significant increase in the social studies learning outcomes of grade V students, where the N-Gain result in the experimental class that applied the TGT model of 0.71 higher than the control class that did not apply the TGT model with N-Gain of 0.30. In addition, applying question cards and the TGT model can train students'

cooperation skills and accuracy in answering questions because students must discuss with their groups (Mahardika & Putra, 2020).

This study describes the stages of the development process, testing to determine how feasible and effective the educational board game assisted by digital question cards with the TGT model to enhance Natural and Social Sciences *(IPAS)* learning outcomes. The novelty of this study is in the use of digital question cards on the board game and integrated with the TGT model. This board game contains digital components, namely question cards that are developed in digital form, which are called digital question cards. Digital question cards contain questions according to the Map material. Digital question cards are designed in an interactive form where there are buttons that, when pressed, will go to a particular page and can immediately show whether the answer is true or false. This board game is expected to be a learning media innovation in *IPAS* learning that is in accordance with student characteristics and technological developments so that it can facilitate students in learning Map material in an interactive and fun way through a game and improve student IPAS learning outcomes.

Research Method

This research method is research and development using the development process described by Sugiyono and includes 10 stages. This study only reached the ninth stage because the researchers developed concrete media. The stages are (1) analyzing potential and problems; (2) collecting the necessary data; (3) designing the developed product; (4) validating the product design to experts; (5) revising the design according to suggestions from experts; (6) conducting product trial on six students; (7) revising the product according to the application of product trial; (8) conducting a usage trial on 18 students (9) revising the product according to the application of the usage trial (modified from Sugiyono, 2019). The research location was at SD Negeri Purwoyoso 04 Semarang City, with the implementation time from September 2024 to February 2025. The sample collection technique used was purposive sampling, considering students' cognitive abilities. The research sample included VA class students, with six students for product trials and 18 students for usage trials.

Researchers collected data through interviews, questionnaires, documentation, and tests. Meanwhile, the research instruments include interview guidelines, student and teacher needs questionnaires, media assessment questionnaires, trial questions, pretest and posttest questions, and student and teacher response questionnaires to find student and teacher feedback. The trial questions were tested on class VB students. Of the 50 questions developed by researchers, 26 questions were valid with high question reliability and differentiation index (sufficient, good, and very good), and they had a level of difficulty in the scope of easy, medium, and difficult proportionally. Twenty-five questions were used as pretest and posttest questions. Data analysis techniques include the normality test as a prerequisite test, paired sample t-test or Wilcoxon signed-rank test, and N-Gain using SPSS application version 25. The hypotheses set include null and alternative hypotheses.

H_0: There is no significant difference in the average *IPAS* learning outcomes before and after the implementation of the board game.

H_a: There is a significant difference in the average *IPAS* learning outcomes before and after the implementation of the board game.

Hypothesis determination is known through the significance value. The significance values of the paired sample t-test and the Wilcoxon signed-rank test are found in sig. (2-tailed) and Asymp. Sig (2-tailed). Reject h_a when the significance value exceeds 0.05 and accept h_a when the significance value is less than 0.05 (Sukarelawan et al., 2024).

Results and Discussion

First Stage: Potential and Problems

The process carried out at this stage is to analyze the potential and problems related to *IPAS* learning in class VA. From the documentation of the *IPAS* summative results in Chapter 6, as many as 60.87% of students have not yet reached completeness. According to information from the teacher, students have learning difficulties in chapter 6, topic A, Map material. The learning media the teacher uses on this material topic is still limited, such as PowerPoint (PPT) and learning videos from YouTube. The variety of learning models the teacher uses is also quite limited because it only adapts from teacher and student books. Students like games, so a model based on games also needs to be implemented. The potential found is that there is already a projector in class VA that can support the implementation of digital media. From this analysis, researchers developed an educational board game assisted by digital question cards with the Teams Games Tournament (TGT) model.

Second Stage: Data Collection

Researchers collected data through teacher and student needs questionnaires. Based on the data obtained, the VA class teacher has used learning media on Map material, such as videos from YouTube as learning videos, but through this media, students have not understood *IPAS* material properly, especially Map material. The teacher agrees if there is a learning media innovation on Map material combining concrete and digital. Based on the student needs questionnaire that has been filled out by students of class VA, 95.65% of students stated that they like learning activities while playing, and 91.3% of students like if there is an application of games in *IPAS* learning where specifically 56.52% stated very like and 34.78% stated like. This shows that students like the application of games in learning.

Third Stage: Product Design

At this stage, researchers determine all components of the board game media. The product developed is an educational board game assisted by digital question cards with the TGT model. The board game developed adapts the Snakes and Ladders game but with adjustments. The content of the material on this board game is the *IPAS* class V Chapter 6 Topic A, Map material. The development of this board game pays attention to several things, including suitability for learning objectives, ease of use by teachers and students, student characteristics, and aesthetic or visual aspects (Kristanto, 2016; Jafarkhani et al., 2024).

This board game is a combination of concrete and digital design with the help of Canva and Microsoft PowerPoint applications. The concrete components of the board game include: (1) a game board with a size of 80 cm x 80 cm. (2) Teacher's guidebook, which is a guidebook for teachers in implementing board game media in the classroom. (3) Student guidebook, which is a guidebook for students in playing the board game. (4) Material book containing map materials used by students before and during the game. (5) Pawns as a marker for each group. (6) Dice. (7) Media storage box. These components are printed in concrete form. The digital component is digital question cards containing questions in digital form, which are applied by showing them through a projector.

The board game is played in groups of 3-5 students. One group is represented by one pawn. Playing time is 25 minutes (or according to conditions). The way to play is: (1) The order of play is carried out by means of group representatives doing *hompimpa*; (2) The game is carried out in turns by group representatives. Those who become group representatives also take turns rotating among their respective group members; (3) The player rolls the dice and moves the pawns according to how many spheres are on the dice. If the pawn reaches the snake's mouth, it goes down, and if it reaches the ladder, it goes up. If the pawn stops on the orange circle, the playing player must choose and answer a question card on the digital

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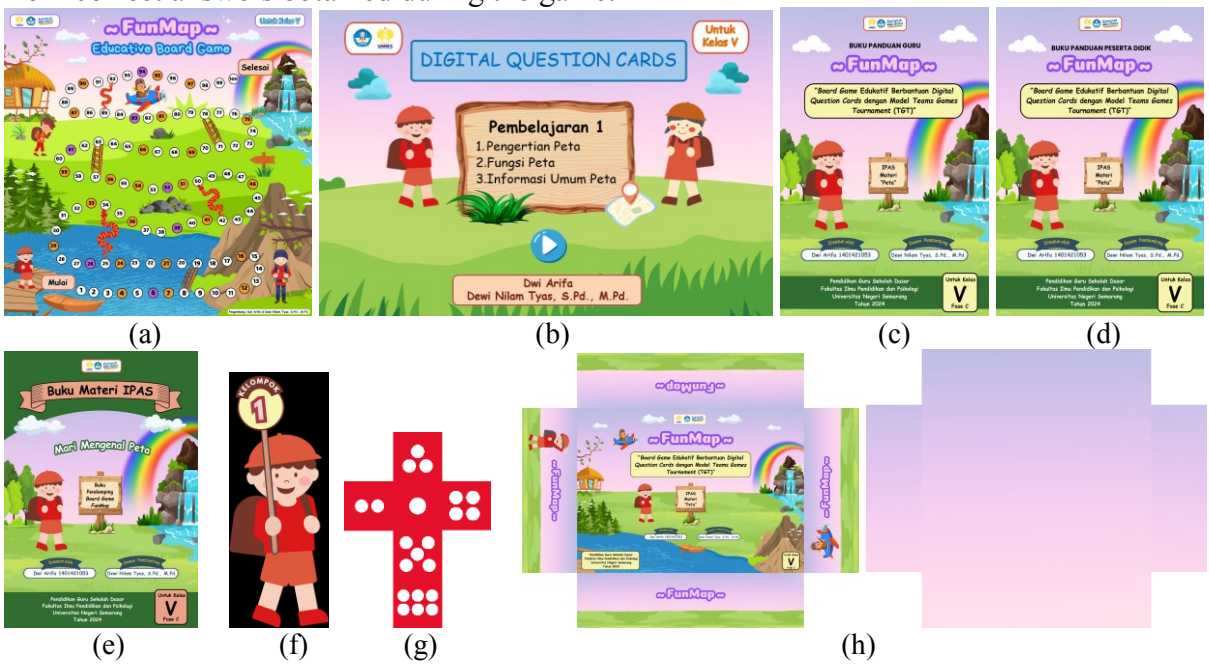
question cards. If the pawn stops on a purple circle, the player must choose a bonus card. The winner is determined based on the number of the last circle reached by the pawn plus points from correct answers obtained during the game.



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 1. Game Board (a); Digital Question Cards (b); Teacher's Guidebook (c); Student's Guidebook (d); Material Book (e); Pawns (f); Dice (g); Storage Box (h)

Fourth Stage: Design Validation

At this stage, the design of the educational board game assisted by digital question cards with the TGT model, was assessed by experienced experts (Sugiyono, 2019). Researchers involved two experts who were expert lecturers in their fields to assess and validate the feasibility of board game media.

Table 1. Results of Media and Material Experts Assessment

No.	Assessment	Total Score	Maximum Score	Percentage	Category
1.	Media Expert	94	100	94%	Very Feasible
2.	Material Expert	116	120	96.6%	Very Feasible

The assessment from the media expert is 94%, with assessment indicators including media efficiency, media size, and aesthetics. Meanwhile, the assessment from the material expert is 96.6%, with assessment indicators including material suitability, language, usefulness in the cognitive domain, assessment of trial questions, and learning tools.

Fifth Stage: Design Revision

Researchers revised the board game design based on suggestions from experts. Suggestions from the media expert are to revise the logo sequence on all media components that are not yet correct, unify the names of the two developers, improve the quality of printed books, and add digital barcode question cards to the storage box. Suggestions from the material expert are to revise the cognitive level of learning objectives, add material descriptions on map function material, and clarify the images presented on the trial questions.

Sixth Stage: Product Trial

At this stage, namely the product trial stage, the board game was tested on six students. This product trial is the basis for assessing the board game before it is tested in a wider class (Rahayu et al., 2025). This board game is considered effective or not based on several test results using SPSS version 25.

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Table 2. Normality Test Results (columns 1-4) and Paired Sample T-Test (columns 5-8)

	Statistic	df	Sig.		t	df	Sig. (2-tailed)
Pretest	.960	6	.823	**Pair 1 Pretest - Posttest**	-4.409	5	.007
Posttest	.829	6	.105				

Table 2 shows that both data fulfill the assumption of normality because the sig. value exceeds 0.05 (0.823 for pretest and 0.105 for posttest). With a significance value (2-tailed) of 0.007 (Table 2), which is lower than 0.05, it confirms that H_a is accepted.

Table 3. N-Gain Test Results on Product Trial

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	6	.27	.92	.6547	.26520

From Table 3, the N-Gain score is in the Mean column, where N-Gain = 0.6547, so it is in the medium category. The analysis of questionnaires from the teacher and students conducted after the product trial was used to assess how practical the board game was.

Table 4. Results of Teacher and Student Response Questionnaires on Product Trial

No.	Respondents	Total Score	Maximum Score	Percentage	Category
1.	Teacher	77	80	96.25%	Very Practical
2.	Students	281	288	97.56%	Very Practical

Table 4 shows that the board game was declared very practical, with a percentage of 96.25% from the teacher and 97.56% from students.

Seventh Stage: Product Revision (Based on Product Trial)

At this stage, researchers made revisions to the board game referring to the teacher and student questionnaires at the previous stage, namely the product trial stage, but no suggestions were given. Researchers re-analyzed the application of the media in the product trial. Based on the analysis, a group name board was needed to make it easier to identify group names and organize students.

Figure 2. Group Name Board Design

Eighth Stage: Usage Trial

At this stage, the educational board game assisted by digital question cards with the TGT model that has been revised by researchers based on the product trial is tested again in a wider class of 18 students. As in the product trial, in this usage trial, this board game is considered effective or not based on several test results using SPSS.

Table 5. Normality Test (columns 1-4) and Wilcoxon Signed-rank Test (columns 5-6)

	Statistic	df	Sig.		Posttest-Pretest
Pretest	.916	18	.111	**Z**	-3.727
Posttest	.820	18	.003	**Asymp. Sig. (2-tailed)**	.000

Pretest data meets the assumption of normality (0.111 exceeds 0.05), while the posttest data does not (0.003 less than 0.05) (in Table 5). Then, the following type of test is nonparametric statistics. With an Asymp. Sig. (2-tailed) 0.000, which is below 0.05 in Table 5, confirms that H_a is accepted.

Table 6. N-Gain Test Results on the Usage Trial

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	18	.17	1.00	.7058	.22349

The N-Gain score is in the Mean column (Table 6), where N-Gain = 0.7058, so it is in the high category. Table 7 explains whether the board game is practical or not.

Table 7. Results of Teacher and Student Response Questionnaires on the Usage Trial

No.	Respondents	Total Score	Maximum Score	Percentage	Category
1.	Teacher	79	80	98.75%	Very Practical
2.	Students	815	864	94.32%	Very Practical

Table 7 shows that the board game is rated as very practical, with a percentage of responses from the teacher of 98.75% and students of 94.32%.

Ninth Stage: Product Revision (Based on Usage Trial)

In accordance with the response questionnaires that were filled out by the teacher and students, as well as the results of the evaluation of the usage trial implementation, the researchers concluded that the media was feasible without revision again because there were no suggestions given from the teacher and students.

Discussion

Based on pre-research data in class VA, the media and learning models used by the teacher in *IPAS* learning have not varied. This causes less than optimal learning outcomes in Chapter 6. Students' difficulties are in Topic A, Map material. Whereas students like the integration of games or play activities in learning. Play is an activity that cannot be separated from elementary school children, so teachers should be able to view play as one of the bases for developing learning media or methods (Legowo, 2022; Guan et al., 2022). These play activities can be implemented through educational games, which are games that can create a fun and interesting learning experience (Sari & Rohmani, 2024). Therefore, educational games can be applied to deliver learning materials interactively.

Referring to the explanation above, researchers developed media that integrates educational games, namely educational board games. Student characteristics are one of the things considered when developing this board game. Based on Piaget's cognitive development theory, where elementary school students aged 7 to 11 years are categorized in the concrete operational stage (Hetherington et al., 1999 in Hayat et al., 2024). Children can think rationally but must interact with real objects (Pakpahan & Saragih, 2022). Meanwhile, the application of technology can help in improving the quality of education as well as the learning process in it (Gusho et al., 2023; Haleem et al., 2022), so teachers are expected to utilize existing technological advances to create learning media (Cheng & Tsai, 2019 in Istmadelia & Tyas, 2024). Therefore, researchers developed this board game in a concrete form integrated with digital question cards and the TGT model. The TGT model and the board game both emphasize the element of competition so that by applying this model can create interactive learning.

The board game media developed by researchers combines concrete and digital. Based on the analysis of potential and problems as well as the questionnaire given to the teacher and students, the media developed includes eight components, namely the game board, digital question cards, teacher's guidebook, student's guidebook, material book, pawns, dice, and storage box. Then, after the product trial, there was one additional component, namely the group name board. This board game media was designed using Canva and Microsoft PowerPoint applications. Media designs can be made as creative as possible by utilizing the various features provided by Canva (Putri et al., 2024; Mulyati et al., 2022). Microsoft PowerPoint is also used to design interactive learning media because it has various features such as animation, inserting images, sound or video, various types of text, transitions, and hyperlinks that can be used to move between slides (Osman et al., 2022; Baskaran et al., 2023). By combining the utilization of these two applications (Canva and Microsoft PowerPoint), researchers can design board game media components attractively.

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The educational board game media assisted by digital question cards with the TGT model is categorized as very feasible to be applied in *IPAS* learning on Map material. Two experts validated this board game. On the media expert validation form, there are 25 statement items, which are divided into four indicators (media efficiency, media size, and aesthetics). The maximum score for each statement is 4, so the maximum score is 100. The total score obtained from the media expert is 94, so the percentage is 94 divided by 100, then multiplied by 100%, and the result is 94%. On the material expert validation form, there are 30 statement items, which are divided into five indicators (suitability of material, language, usefulness in the cognitive domain, trial questions, and learning tools). So, the maximum score is 120. With a total score of 116, the percentage is 116 divided by 120, then multiplied by 100%, the result is 96.6%.

The board game that has been declared very feasible is then implemented in the classroom with two trials, namely a product trial with a limited number of students and a usage trial with a larger number of students. This board game was tested in learning by applying one type of cooperative model, namely the TGT learning model. The TGT model, initiated by Slavin, is not only about learning in groups but also about competing between groups, which requires each student to actively participate and think critically (Fadly, 2022). The implementation of the TGT model in learning process in elementary schools contributes to improving students' understanding and learning motivation (Mahardika & Putra, 2020; Cahyani & Mustadi, 2021) because there are awards (Damarwan et al., 2018) so that the material taught must be understood by students if they want to win the tournament.

The board game is declared effective or not based on several tests using SPSS, both from the results in the product trial with six students and the usage trial with 18 students. In the product trial, student learning outcomes showed an increase based on the average pretest and posttest scores, from 49.3 to 83.3. The pretest and posttest data were declared normally distributed with a significance value exceeding 0.05 (0.823 for pretest and 0.105 for posttest). The next test is parametric statistics, namely paired sample t-test. SPSS output shows a significance value (2-tailed) of 0.007 (< 0.05) so that H_a is accepted. While the N-Gain is 0.6547, indicating an increase in *IPAS* learning outcomes with medium criteria.

Then, in the usage trial, the average pretest and posttest scores also showed a significant increase, from 47.3 to 84.4, so the increase was 37.1. Furthermore, the normality test resulted in the sig. value of the pretest and posttest data being 0.111 (> 0.05) and 0.003 (< 0.05). Posttest data is declared to be not normally distributed, so the next test used is nonparametric statistics, namely the Wilcoxon signed-rank test. SPSS output shows Asymp. Sig (2-tailed) 0.000. In conclusion, H_a is accepted, so there is a significant average difference between the pretest and posttest in the usage trial. The N-Gain score of 0.7058 indicates an increase in *IPAS* learning outcomes on Map material with high criteria.

The practicality of this board game media is known from the response questionnaire that was filled out by the teacher and students. The practicality of the media is based on how easy it is for teachers and students to use the media so that meaningful and enjoyable learning can be created (Milala et al., 2022). The questionnaire results from the product trial showed that the practicality of the media was rated 96.25% by the teacher and 97.56% by students, so the criteria was very practical. In the usage trial, the board game can be concluded to be very practical because it gets a positive response with the percentage of teacher and student response questionnaires of 98.75% and 94.32%, so it is classified as very practical. SPSS and practicality test results prove that the educational board game media assisted by digital question cards with the TGT model is declared effective in enhancing Natural and Social Science (*IPAS)* learning outcomes in the cognitive domain on Map material.

Researchers observed that students were very active when applying the board game, especially when answering questions on digital question cards. The existence of tournaments also encourages students to study Map material seriously in order to win so that learning is not only fun but also increases understanding of the material. However, the class becomes less conducive, so good classroom management skills are needed. Several participants in a study by Baydar (2020) also expressed that the class became crowded with the application of the TGT model. Several studies have found that students' learning outcomes and creative thinking skills in a class that uses a board game are higher than in a class that does not use a board game (Ilmiyah et al., 2024; Fitriyani et al., 2021). In addition, a study conducted by Fussalam et al. (2023) revealed that the completeness of grade VI students in *IPS* subjects increased with the application of the TGT model, where before the study, only 26.3% of students were complete, then increased to 63.2% and 94.7% in the first and second cycles.

This research integrates game-based learning through a board game, the application of digital technology through digital question cards, and innovative learning models through the application of TGT models that have an influence on improving student learning outcomes. The conceptual implication is that it can add knowledge while strengthening the concept of the importance of learning media innovation and learning design in improving student learning outcomes. This research also adds insight related to the integration of game-based learning, technology, and cooperative learning models in learning activities that have an effect on improving student learning outcomes significantly. Practically, this board game development product can be implemented as a learning media innovation for teachers to create innovative and interactive learning, facilitate students in understanding *IPAS* material in a fun way through a game, and encourage student activeness or involvement in learning.

Conclusion

This research has successfully developed an educational board game assisted by digital question cards with the TGT model. The developed board game adapts the Snakes and Ladders game, consisting of 9 components (the game board, digital question cards, teacher and student guidebook, material book, pawns, dice, group name board, and storage box). The percentage of expert assessment on this board game is 94% and 96.6% from media and material experts, so it is classified as very feasible. SPSS output shows Asymp. Sig. (2-tailed) of 0.000 so that H_a is accepted. The N-Gain score is 0.7058, which shows the improvement is in high criteria. The board game was also considered very practical, with the percentage of the teacher response questionnaire results of 98.75% and students of 94.32%. So, this board game is declared very feasible and effective in enhancing *IPAS* learning outcomes.

Recommendation

Based on the results of the study, the following suggestions can be considered. First, the research was limited to the ninth stage of the ten stages of Sugiyono's development model. Researchers did not carry out the tenth stage because the media developed in the form of concrete media, so there were limited costs. Therefore, future researchers are expected to continue and complete all stages of development up to ten stages. Future researchers can look for alternative product development solutions that are more economical or collaborate and cooperate with other parties, so it is hoped that all stages of the development model can be completed up to the tenth stage. Second, the board game media in this study are only specifically for *IPAS* subjects, Map material. Teachers and future researchers are expected to analyze whether this board game can be applied to other subjects or learning materials. Through this, board game media can be produced with a wider range of learning materials.

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