



Development of a Team Games Tournament (TGT)-Based Snakes and Ladders Learning Media to Enhance Problem-Solving Skills on the Respiratory System Topic for Grade XI Students

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Abstract: This study aimed to develop a snakes and ladders instructional media based on the *Team Games Tournament* (TGT) cooperative learning model for the respiratory system topic in Grade XI and to evaluate its validity, practicality, and effectiveness in improving students' problem-solving abilities. The study employed a Research and Development (R&D) method using the ADDIE model, consisting of five stages: *analysis, design, development, implementation, and evaluation*. The research involved 30 students from Grade XI Science Class 1. Data were collected through needs analysis, expert validation sheets, teacher and student response questionnaires, and pretest–posttest assessments. The collected data were analyzed using percentage scores and N-gain analysis. The validation results showed that the instructional media obtained scores of 88% from the media expert and 87% from the subject matter expert, indicating a highly valid category. The practicality assessment revealed scores of 93% from teachers and 94% from students, categorized as highly practical. Furthermore, the effectiveness analysis showed an N-gain value of 0.70 with an improvement percentage of 70.40%, indicating a high level of effectiveness. These findings demonstrate that the TGT-based snakes and ladders instructional media is a valid, practical, and effective learning tool for supporting biology instruction. The developed media provides an interactive and collaborative learning experience and has the potential to enhance students' problem-solving abilities in the respiratory system topic.

Keywords: Snakes and ladders instructional media; team games tournament; problem solving; respiratory system

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INTRODUCTION

Biology learning should not only emphasize conceptual mastery but also facilitate the development of higher-order thinking skills that enable students to apply knowledge in solving complex problems. One of the essential skills that should be developed through biology education is problem-solving ability. This ability enables students to identify problems, analyze relevant information, establish relationships among concepts, develop appropriate solution strategies, and draw conclusions based on evidence rather than merely memorizing biological facts. Problem-solving activities encourage students to observe, analyze, and critically evaluate problems (Majid, 2013). Furthermore, problem-solving ability contributes to improved academic achievement, skill development, and students' confidence in addressing challenging situations (Gok, 2014). It also promotes positive attitudes when students encounter problems during the learning process (Chao et al., 2017). In addition, the ability to transfer problem-solving strategies from specific problems to broader contexts represents an important competency that should be developed through education (Greiff et al., 2013).

The development of problem-solving ability is particularly important in biology learning because many biological concepts involve complex, interconnected

processes that require students to apply conceptual knowledge in specific situations. One topic that requires such ability is the human respiratory system. In this topic, students are expected not only to understand the structure and function of respiratory organs but also to analyze relationships among respiratory structures, breathing mechanisms, O₂ and CO₂ exchange processes, and lung capacity in explaining respiratory-related phenomena. Therefore, students need to develop problem-solving skills to analyze respiratory system problems logically and formulate appropriate solutions based on scientific understanding.

However, learning the respiratory system remains challenging for many students because of its abstract and complex characteristics. Students often experience difficulties in identifying problems, analyzing physiological processes, and drawing conclusions, indicating that their problem-solving abilities have not been optimally developed (Sari et al., 2021). These difficulties are partly related to physiological processes that cannot be directly observed, such as gas exchange between O₂ and CO₂, as well as students' misconceptions regarding respiratory mechanisms and lung capacity calculations (Husni, 2023). Furthermore, learning activities that are still dominated by teacher-centered lectures provide limited opportunities for students to actively participate in analytical thinking and problem-solving activities (Sari et al., 2021).

Therefore, innovative learning approaches are needed to facilitate conceptual understanding while providing students with opportunities to actively analyze and solve problems through meaningful learning experiences. One potential approach is the integration of game-based learning media into biology instruction. Previous studies have shown that snakes and ladders game media can increase students' learning interest, learning activities, and social interaction (Alex et al., 2024). However, the use of game-based media alone may not sufficiently stimulate higher-order thinking skills unless it is supported by an appropriate instructional model. Thus, snakes and ladders media should be integrated with a learning strategy that encourages collaboration, discussion, positive competition, and problem-solving activities.

The *Team Games Tournament* (TGT) cooperative learning model is considered relevant for this purpose because it combines teamwork, academic games, and tournaments to create an active and collaborative learning environment. TGT encourages students to construct and communicate knowledge through group discussions and team-based activities to achieve shared goals (Hendra & Theresia, 2020). According to Susanna (2017), TGT can improve students' learning focus, acceptance of individual differences, conceptual understanding, learning motivation, social skills, and learning outcomes while fostering positive attitudes such as tolerance. Moreover, TGT has been reported to improve problem-solving ability through collaborative work, healthy competition, and active student participation (Sofyan, 2022). Nevertheless, the integration of TGT with snakes and ladders learning media, particularly for respiratory system learning, remains relatively limited.

Learning media function as instructional tools that assist students in understanding concepts that are difficult to explain through verbal explanations alone (Rahim, 2023). Effective learning media should enhance motivation, facilitate conceptual understanding, provide interactive learning experiences, and be practical for classroom implementation (Sugiyono, 2020). Snakes and ladders learning media provides several educational advantages, including encouraging cooperation, increasing motivation, facilitating learning review, and creating enjoyable learning experiences. However, successful implementation requires careful preparation to

ensure that game activities are aligned with learning objectives and instructional needs (Harwini & Khaerudin, 2020).

The use of snakes and ladders media integrated with TGT has the potential to provide more meaningful learning experiences because students engage in answering questions, discussing problems, and collaborating during gameplay. These activities allow students to understand biological concepts while practicing analytical thinking and problem-solving skills (Bahari & Yuliani, 2021). Furthermore, the combination of snakes and ladders media and TGT can promote student interaction, teamwork, and positive competition (Marhaeni et al., 2022). Therefore, integrating these approaches may provide an alternative solution to overcome lecture-dominated learning environments and support students in understanding abstract respiratory system concepts through collaborative problem-solving activities.

Previous studies have demonstrated the potential of snakes and ladders media and TGT-based learning in improving students' learning outcomes. Andriani and Wahyudi (2023) reported that snakes and ladders game media improved students' problem-solving abilities, as indicated by an increase in average scores from 60.4 to 66.8. Marhaeni et al. (2022) developed snakes and ladders learning media for the classification of living organisms and obtained a feasibility score of 93%, indicating that the media was valid and suitable for classroom implementation. Furthermore, Mufidah (2023) found that the implementation of TGT assisted by snakes and ladders media improved students' learning outcomes, with average scores increasing from 75.79 to 84.32 and learning mastery increasing from 67.86% to 92.86%. These findings indicate that snakes and ladders media can increase student engagement and support learning activities. However, previous studies have mainly focused on improving learning outcomes or conceptual understanding and have not specifically examined the development of TGT-based snakes and ladders media designed to enhance problem-solving abilities in respiratory system learning.

Therefore, this study aims to develop a snakes and ladders instructional medium based on the *Team Games Tournament* (TGT) cooperative learning model, equipped with *question*, *problem*, and *punishment* cards, for Grade XI respiratory system learning. This study also evaluates the validity, practicality, and effectiveness of the developed media in improving students' problem-solving abilities. The findings of this study are expected to contribute to the development of innovative and interactive biology learning media that promote active, collaborative, and meaningful learning experiences.

METHOD

Research Design and Development Procedure

This study employed a Research and Development (R&D) method aimed at developing and evaluating a snakes and ladders learning medium based on the *Team Games Tournament* (TGT) cooperative learning model. The developed medium was assessed in terms of validity, practicality, feasibility, and effectiveness in improving students' problem-solving abilities. The development process adopted the ADDIE instructional design model, which is a systematic learning design model consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation (Slamet, 2022).

The developed product was a TGT-based snakes and ladders learning medium designed for the respiratory system topic. The ADDIE development procedure consisted of the following stages:

1. Analysis stage

The analysis stage involved identifying students' learning needs, including difficulties in understanding the respiratory system and students' limited problem-solving abilities. In addition, an analysis was conducted regarding the characteristics of Grade XI students, the applicable curriculum (*Kurikulum Merdeka*), and existing learning media related to biology instruction.

2. Design stage

The design stage focused on developing the framework of the snakes and ladders learning medium by integrating learning questions and TGT learning principles. The researchers designed various components of the game, including the game board, *question cards*, *problem cards*, *punishment cards*, scoring system, and game procedures. The learning activities were structured according to the TGT learning syntax to encourage teamwork, active participation, and problem-solving activities among students.

3. Development stage

During the development stage, the snakes and ladders learning medium was developed using the Canva application. The developed product was subsequently validated by media experts and subject matter experts to evaluate its quality and feasibility. Revisions were conducted based on suggestions and feedback from the validators. After revision, the developed medium was tested during biology learning activities on the respiratory system topic. Teacher and student response questionnaires were then administered to evaluate the practicality of the developed medium.

4. Implementation stage

The implementation stage involved testing the developed snakes and ladders learning medium with 30 students from Grade XI Science Class 1 at MAS Al-Washliyah 36 Serbelawan. The medium was implemented in respiratory system learning activities using the TGT cooperative learning model. During the learning process, the teacher acted as a facilitator, while the researcher observed learning implementation, student activities, and the use of the medium according to the TGT learning stages. After the learning activity was completed, teacher and student response questionnaires were distributed, and a posttest was administered to evaluate the practicality and effectiveness of the developed medium.

5. Evaluation stage

The evaluation stage aimed to determine the effectiveness of the developed medium in improving students' problem-solving abilities. The evaluation was conducted through HOTS-based tests, observations of student engagement, and questionnaires regarding students' perceptions of the learning medium. Feedback from teachers and students was also collected to identify the strengths and limitations of the developed medium. The evaluation results were used as a basis for improving the product and preparing the final research report.

Research Site and Participants

The research was conducted at MAS Al-Washliyah 36 Serbelawan. The research participants consisted of 30 students from Grade XI Science Class 1. The participants were selected using a purposive sampling technique, in which samples were chosen based on specific considerations, including students' involvement in biology learning activities and their ability to provide responses regarding the effectiveness of the TGT-based snakes and ladders learning medium. The research object was the TGT-based snakes and ladders learning medium developed to improve students' problem-solving abilities on the respiratory system topic.

Data Collection and Research Instruments

This study collected both qualitative and quantitative data. Qualitative data were obtained from expert validation results, observations, and teacher and student response questionnaires. Quantitative data were obtained from expert validation scores and students' pretest and posttest results.

The research instruments included: observation sheets, expert validation sheets, teacher and student response questionnaires, and problem-solving ability tests in the form of pretest and posttest assessments. Observation sheets were used during the implementation stage to evaluate the learning process and students' activities while using the TGT-based snakes and ladders medium. Expert validation sheets were used during the development stage by media experts and subject matter experts to assess the feasibility of the developed medium in terms of content, appearance, language, and presentation before implementation.

Teacher and student response questionnaires were administered after the implementation stage to evaluate the practicality and attractiveness of the learning medium. Meanwhile, pretest and posttest instruments were administered before and after implementation to measure improvements in students' problem-solving abilities through N-gain analysis.

Data Analysis

The collected data were analyzed using qualitative and quantitative approaches. Qualitative data obtained from expert comments, observations, and teacher and student responses were analyzed descriptively to identify suggestions, feedback, and supporting information for improving the developed learning medium. Quantitative data obtained from expert validation scores, teacher and student response questionnaires, and pretest–posttest results were analyzed using descriptive statistical analysis.

1. Validity and practicality analysis

The validity and practicality of the learning medium were calculated using the following formula:

$$Percentage = \frac{\text{Obtained Score}}{\text{Maximum Score}} \times 100\%$$

The calculated percentage scores were categorized based on the criteria presented in Table 1.

Table 1. Criteria for validity and practicality of learning media

No.	Score Range (%)	Category
1	81–100	Highly Valid / Highly Practical
2	61–80	Valid / Practical
3	41–60	Moderately Valid / Moderately Practical
4	21–40	Less Valid / Less Practical
5	≤20	Invalid / Impractical

(Pattimura et al., 2020)

2. Effectiveness analysis using N-gain

To determine improvements in students' abilities before and after using the TGT-based snakes and ladders learning medium, students' performance was assessed through pretest and posttest scores. The obtained data were analyzed using the N-gain formula to determine the level of improvement after implementation. The N-gain formula was calculated as follows:

$$\langle g \rangle = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}}$$

The N-gain values were interpreted according to the criteria presented in Table 2 to determine the level of improvement.

Table 2. N-gain criteria

No.	N-gain Value	Category	Criteria
1	$g > 0.70$	High	Effective
2	$0.30 < g \leq 0.70$	Medium	Moderately Effective
3	$g < 0.30$	Low	Ineffective

(Kurniawan & Hidayah, 2021)

RESULTS AND DISCUSSION

This study developed a Snakes and Ladders Instructional Medium based on the *Team Games Tournament* (TGT) cooperative learning model to improve students' problem-solving abilities on the respiratory system topic. The development process followed the ADDIE model, consisting of five stages: *Analysis*, *Design*, *Development*, *Implementation*, and *Evaluation*. The data obtained from each stage were analyzed to determine the validity, practicality, and effectiveness of the developed learning medium.

Analysis Stage

The analysis stage aimed to identify students' learning conditions and needs as the foundation for developing the instructional medium. The results of interviews with a Grade XI biology teacher indicated that respiratory system learning was still predominantly conducted through lecture-based instruction supported by textbooks and videos. This learning approach resulted in limited student engagement and suboptimal development of problem-solving abilities.

The needs analysis showed that 74% of students perceived that textbooks and videos alone were insufficient to support their learning process, 75% stated that snakes and ladders media was suitable for biology learning, 80% expressed the need for visual illustrations, and students' problem-solving ability obtained a percentage score of 62%. These findings indicate the need for learning media that are more interactive, visually engaging, and capable of encouraging active student involvement.

Based on the results of the needs analysis, a snakes and ladders learning medium integrated with the *Team Games Tournament* (TGT) cooperative learning model was developed for the respiratory system topic. The selection of the TGT model was supported by Bustami et al. (2022), who reported that TGT can support students' thinking abilities in science learning, and Alhara et al. (2021), who demonstrated the relationship between TGT implementation and problem-solving abilities. Furthermore, Nugroho and Listyarini (2018) highlighted the relevance of TGT-assisted snakes and ladders media in improving problem-solving abilities.

Therefore, the developed medium combined game elements, visual representations, teamwork activities, and problem-based cards to facilitate students' understanding of the respiratory system while simultaneously developing their problem-solving skills.

Design Stage

The second stage of the ADDIE model was the design stage, which aimed to develop the structure and components of the learning medium according to the

identified learning needs and objectives. In this study, the design focused on developing a snakes and ladders instructional medium based on the *Team Games Tournament* (TGT) cooperative learning model to improve Grade XI students' problem-solving abilities on the respiratory system topic.

Based on the analysis results, the medium was designed as an educational game that integrated interactive activities, competition, and teamwork according to students' characteristics. The snakes and ladders board was designed in the form of a 1.5 m × 1.5 m banner consisting of numbered squares equipped with respiratory system-related illustrations. The title of the medium used the *Gagalin* font with a size of 62, while the numbers on the game board used the *League Spartan* font with a size of 25. The medium incorporated green, blue, yellow, and pink color combinations to attract students' attention.

In addition to the main game board, the medium was equipped with three types of cards: *question cards*, *problem cards*, and *punishment cards*. The *question cards* were designed in green and contained respiratory system questions. The *problem cards* were designed in blue and contained contextual respiratory system problems supported by QR codes that directed students to related videos. Meanwhile, the *punishment cards* were designed in pink and contained educational challenges related to the respiratory system topic.

The three types of cards used the *Gagalin* font size 30 for the title section and the *Cooper Hewitt* font size 11 for the content section. The medium was also equipped with a cube-shaped flannel dice to facilitate students in determining the number of steps obtained during the game. Instead of conventional game pieces, students themselves acted as playing pieces by standing on the squares according to the dice results.

In addition to the main medium, supporting learning materials were developed, including lesson plans integrating the TGT learning steps. Research instruments were also prepared, including media validation sheets to assess the validity and suitability of the developed medium by experts, teacher response questionnaires to evaluate teachers' perceptions regarding the use of the medium, and student response questionnaires to determine students' perceptions after participating in learning activities using the TGT-based snakes and ladders medium.

Furthermore, pretest and posttest instruments were developed to measure students' problem-solving abilities before and after implementation of the learning medium. The learning design also included group formation procedures, game mechanisms, tournament rules, scoring systems, and group rewards based on the TGT learning syntax. These arrangements were designed to improve students' learning motivation, peer interaction, teamwork skills, and create a competitive yet collaborative learning environment.

Development Stage

The development stage was conducted after completing the analysis and design stages. At this stage, the planned design of the learning medium was transformed into a tangible product in the form of a snakes and ladders game equipped with *question cards*, *problem cards*, *punishment cards*, and a dice. The developed medium was subsequently evaluated through validation by media experts and subject matter experts. The assessment results are presented in Tables 3 and 4.

Table 3. Media validation results

No.	Assessment Aspect	Obtained Score	Maximum Score	Percentage	Criteria
1	Graphic Design	46	50	92%	Highly Valid
2	Media Quality	29	35	83%	Highly Valid
Total		75	85	88%	Highly Valid

Media expert validation was conducted to evaluate the feasibility of the appearance, design, and presentation aspects of the developed learning medium. Based on the data presented in Table 3, the assessment consisted of graphic design and media quality aspects. The graphic design aspect obtained a score of 46 out of 50 (92%), while the media quality aspect obtained a score of 29 out of 35 (83%). Overall, the developed medium obtained a total score of 75 out of 85, equivalent to 88%, which was categorized as highly valid.

This finding indicates that the developed snakes and ladders medium had an appropriate visual appearance, design structure, and presentation quality for biology learning. This result is consistent with Wulandari et al. (2019), who reported an expert media validation score of 83.51% with a very good qualification in the development of interactive multimedia-based biology learning media.

Table 4. Subject matter validation results

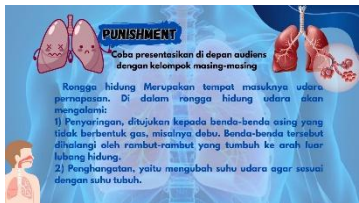
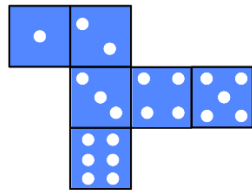
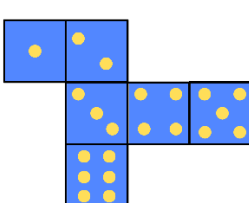
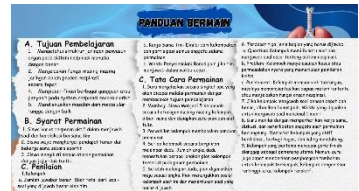
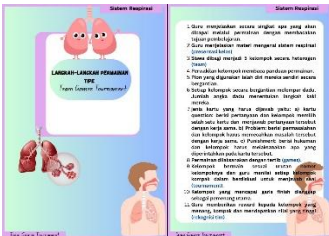
No.	Assessment Aspect	Obtained Score	Maximum Score	Percentage	Criteria
1	Content/Matter Feasibility	81.51	11.45	87%	Highly Valid
2	Presentation Feasibility	72.81	15.45	88%	Highly Valid
Total		105	120	87%	Highly Valid

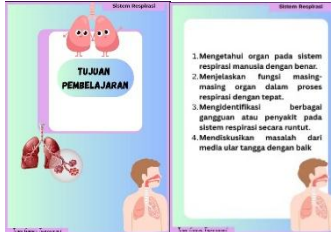
Table 4 shows that the subject matter validation covered content feasibility and presentation feasibility aspects. The assessment by the subject matter expert resulted in an overall percentage score of 87%, which was categorized as highly valid. These results indicate that the content presented in the developed snakes and ladders medium was appropriate, relevant to the respiratory system topic, and aligned with the intended learning objectives.

After undergoing validation by both media experts and subject matter experts, the developed learning medium was considered highly valid and suitable for implementation in biology learning activities. The validation process also provided suggestions for improvement, which were incorporated into the revision process. The comparison between the medium before and after revision is presented in Table 5.

Table 5. Revision of the snakes and ladders learning medium

No.	Media Component	Before Revision	After Revision	Revision Description
1	Main Board			The board shape was changed from a rectangular design to a square design measuring 1.5 m × 1.5 m. The color scheme was also modified using brighter colors to improve visual attractiveness and student interest.

No.	Media Component	Before Revision	After Revision	Revision Description
2	Question Cards			The card design was changed from a landscape rectangular format to a portrait format measuring 7.5 cm × 10 cm. The revised cards included a cover design and a clearer question section.
3	Problem Cards			The card format was changed from landscape rectangular to portrait format measuring 7.5 cm × 10 cm. The revised cards included a cover design and respiratory system-related problem illustrations to support students' understanding of the presented problems.
4	Punishment Cards			The card format was modified into a clearer design measuring 7.5 cm × 10 cm. The revised cards included educational challenges related to the respiratory system topic.
5	Dice			The dice size remained unchanged; however, the color of the dots was modified to yellow to create a more prominent and attractive appearance.
6	Playing Piece	-	-	Students themselves acted as playing pieces by moving according to the number obtained from the dice.
7	Supporting Cards			Game Procedure Cards
				Game Requirement Cards

No.	Media Component	Before Revision	After Revision	Revision Description
				Assessment Cards
				Learning Objective Cards

The revision process was conducted based on suggestions provided by validators, focusing on improving the visual appearance, practicality, and completeness of the learning medium components. The main game board was modified into a square shape measuring 1.5 m × 1.5 m with brighter colors to improve usability and attract students' attention. The *question*, *problem*, and *punishment* cards were redesigned into a 7.5 cm × 10 cm format and equipped with clearer covers and content sections.

Specifically, the *problem cards* were enhanced by adding respiratory system-related illustrations to provide students with visual stimuli before solving the presented problems. These modifications indicate that the revision process was not limited to aesthetic improvements but also considered usability and alignment with learning objectives.

The illustrated *problem cards* provide students with contextual stimuli to identify and analyze respiratory system-related problems, while the *question cards* and *punishment cards* support the implementation of the game mechanism according to the TGT learning model. Furthermore, supporting cards were improved by organizing them into game requirement cards, assessment cards, and learning objective cards, making the game procedures more structured and understandable.

Therefore, the revised learning medium was considered ready for the implementation stage because it had been adjusted to students' characteristics, learning requirements, and the research objective of improving problem-solving abilities.

Implementation Stage

At the implementation stage, the validated snakes and ladders learning medium was tested with 30 students from Grade XI Science Class 1 at MAS Al-Washliyah 36 Serbelawan. This stage involved introducing the learning medium, implementing the learning activities, and collecting teacher and student responses to evaluate the practicality of the developed medium.

The implementation began with an introduction to the TGT-based snakes and ladders medium, followed by its application in biology learning activities on the respiratory system topic. During the learning process, students were divided into five groups. Each group selected one representative student who acted as the playing piece by moving on the snakes and ladders board according to the obtained dice number.

Before the game activities began, the teacher provided a brief explanation of the respiratory system material. Students were also introduced to supporting cards, including learning objective cards, assessment cards, game requirement cards, and game procedure cards. These components were designed to ensure that students understood the rules and learning procedures before participating in the game.

During the tournament activities, each group was required to answer the questions provided on the *question cards* and solve contextual problems presented on the *problem cards*. Students were also expected to complete the educational challenges provided on the *punishment cards*. Throughout the learning process, students actively participated, collaborated with group members, and demonstrated enthusiasm in answering questions, solving problems, and completing assigned challenges.

After the learning activity was completed, teacher and student response questionnaires were distributed to determine the practicality of the developed learning medium. The results of the practicality assessment are presented in Tables 6 and 7.

Table 6. Student response results for practicality assessment

No.	Assessment Aspect	Obtained Score	Maximum Score	Percentage	Criteria
1	Interest	1453	1500	97%	Highly Practical
2	Content	389	450	86%	Highly Practical
3	Language	129	150	86%	Highly Practical
Total		1971	2100	94%	Highly Practical

Table 7. Teacher response results for practicality assessment

No.	Assessment Aspect	Obtained Score	Maximum Score	Percentage	Criteria
1	Media Design and Appearance	10	10	100%	Highly Practical
2	Content	9	9	90%	Highly Practical
3	TGT Learning Implementation	9	10	90%	Highly Practical
4	Problem-Solving Ability Support	14	15	93%	Highly Practical
5	Language	4	5	80%	Highly Practical
6	Effectiveness of Media Use	10	10	100%	Highly Practical
Total		56	60	93%	Highly Practical

The practicality assessment results obtained from student and teacher response questionnaires are presented in Tables 6 and 7. The teacher responses showed that the media design and appearance aspect obtained the highest score (100%), followed by the effectiveness of media use (100%), content aspect (90%), TGT learning implementation (90%), problem-solving ability support (93%), and language aspect (80%). Overall, the teacher response obtained an average score of 93%, indicating that the developed medium was categorized as highly practical.

Similarly, student responses showed that the interest aspect obtained the highest score (97%), while the content and language aspects each obtained 86%. The overall student response score was 94%, indicating that the medium was categorized as highly practical from the students' perspective.

The high practicality scores indicate that the developed snakes and ladders medium was considered attractive, easy to use, and suitable for supporting biology learning activities. The integration of game elements with the TGT cooperative learning model encouraged students to participate actively through teamwork, discussion, and academic competition.

The implementation of the snakes and ladders medium followed the TGT learning syntax, including class presentation, team formation, group learning, biology snakes and ladders games, and group recognition (Hasanah, 2021). These stages provided opportunities for students to interact, collaborate, and engage in problem-solving activities during the learning process.

Evaluation Stage

The evaluation stage was conducted after the implementation stage to determine the effectiveness of the developed snakes and ladders learning medium in improving students' problem-solving abilities. The effectiveness assessment was performed by comparing students' pretest and posttest scores, which were subsequently analyzed using the normalized gain (N-gain) value. The results of the effectiveness analysis are presented in Table 8.

Table 8. Effectiveness analysis based on pretest and posttest results

Indicator	Pretest	Posttest	N-gain	Improvement Percentage	Criteria
Students' Problem-Solving Ability	55.55	86.87	0.70	70.40%	Effective

Based on Table 8, the average pretest score of Grade XI Science Class 1 students at MAS Al-Washliyah 36 Serbelawan was 55.55, while the average posttest score increased to 86.87 after the implementation of the TGT-based snakes and ladders learning medium. The difference between pretest and posttest scores was 44.51. The N-gain analysis resulted in a value of 0.70, which was categorized as high, with an improvement percentage of 70.40%. These results indicate that the developed learning medium demonstrated effectiveness in improving students' problem-solving abilities.

The development of the snakes and ladders learning medium was based on the results of the needs analysis, which indicated that students experienced difficulties in understanding the respiratory system topic, learning activities were still dominated by one-way lectures, and interactive learning media were rarely utilized. These conditions limited students' opportunities to actively engage in learning activities and develop problem-solving abilities. Therefore, students required learning media that were more varied, interactive, and capable of involving them directly in the learning process.

The integration of snakes and ladders media with discussion activities and problem-solving tasks provided students with opportunities to learn through playing, collaborating, and analyzing problems related to the learning material. Consequently, students could develop a better understanding of respiratory system concepts while improving their ability to formulate solutions to problems.

The use of snakes and ladders media supported by *question cards*, *problem cards*, and *punishment cards* facilitated students' understanding of the respiratory system, which involves complex relationships among various organs and physiological processes. These cards were designed not only to assess conceptual understanding but also to stimulate students' thinking processes through questions, contextual problems, and educational challenges.

This finding is consistent with Yuliani et al. (2024), who reported that integrating snakes and ladders media with the TGT (*Team Games Tournament*) cooperative learning model enables students to work collaboratively in small groups to solve problems and achieve shared learning objectives. Cooperative learning in science education encourages students to formulate questions, discover solutions, understand scientific explanations, and develop systematic approaches to interpreting natural

phenomena (Syukurti, 2020). Therefore, the implementation of TGT-based learning activities can support students' active involvement in the learning process.

Snakes and ladders is a board game consisting of numbered squares connected by snakes and ladders, where players use dice to determine the number of steps taken during the game (Salam, Safei, & Jamilah, 2019). In this study, the learning content embedded in the *question*, *problem*, and *punishment cards* was related to respiratory system subtopics, including respiratory organs, types of respiration, respiratory mechanisms, respiratory volume, and respiratory disorders.

The *problem cards* presented contextual problems related to students' daily lives and environmental conditions associated with the respiratory system. These cards were also equipped with QR codes that directed students to relevant videos, providing additional visual information to support problem analysis. During the tournament activities, each group was required to collaborate in answering questions, analyzing problems, and completing educational challenges provided in the three types of cards.

Among the three card types, the *problem cards* played an important role in stimulating students' problem-solving processes because they encouraged students to identify problems, analyze information, and determine possible solutions. The game-based activities created an active and enjoyable classroom atmosphere while maintaining a structured learning environment. Students demonstrated enthusiasm in responding to questions, solving problems, and competing positively with other groups. Each group attempted to reach the finish line with the highest score, and the group achieving the highest score was recognized as the winner.

Overall Discussion of Validity, Practicality, and Effectiveness

The findings of this study indicate that the TGT-based snakes and ladders instructional medium fulfilled the criteria of validity, practicality, and effectiveness as a biology learning medium. The high validity scores obtained from media experts (88%) and subject matter experts (87%) indicate that the developed medium was appropriate in terms of design, content, and presentation. The well-organized visual components, relevant biological content, and integration of learning activities contributed to the suitability of the medium for respiratory system learning. A well-designed learning medium can attract students' attention and encourage greater engagement during learning activities (Nikmah, 2024).

In terms of practicality, the developed medium received highly positive responses from both teachers and students, with practicality scores of 93% and 94%, respectively. These findings suggest that the medium was considered attractive, easy to use, and capable of facilitating interactive learning activities. The combination of game elements, teamwork, and structured TGT activities provided students with opportunities to actively participate, communicate, and collaborate during the learning process.

The effectiveness analysis showed an increase in students' problem-solving abilities, as indicated by the improvement from the pretest score (55.54) to the posttest score (86.87) and an N-gain value categorized as high. The improvement observed after implementation may be associated with the integration of game-based learning, collaborative activities, and problem-oriented tasks embedded in the *question* and *problem cards*. These activities encouraged students to analyze situations, discuss possible solutions, and apply respiratory system concepts in problem-solving contexts.

Overall, the TGT-based snakes and ladders instructional medium provides an interactive and collaborative learning experience that supports biology learning, particularly in developing students' problem-solving abilities. Therefore, this medium

has potential as an alternative instructional resource for biology teachers in implementing more active and meaningful learning environments.

CONCLUSION

This study successfully developed a Snakes and Ladders Instructional Medium integrated with the *Team Games Tournament* (TGT) cooperative learning model for Grade XI respiratory system learning. The developed medium demonstrated high validity based on assessments by media experts and subject matter experts, indicating that it met the requirements for use as a biology learning medium. The implementation results showed that the TGT-based snakes and ladders medium was highly practical based on positive responses from teachers and students regarding its design, usability, attractiveness, and support for interactive learning activities. Furthermore, the effectiveness analysis based on pretest and posttest comparisons showed an increase in students' problem-solving abilities, with an N-gain value categorized as high. These findings indicate that the integration of game-based learning, cooperative learning through TGT, and problem-oriented activities within the snakes and ladders medium can provide an engaging and collaborative learning environment. Therefore, the developed TGT-based snakes and ladders instructional medium can be considered an alternative innovative learning resource to support active biology learning and facilitate the development of students' problem-solving abilities, particularly in the respiratory system topic.

RECOMMENDATION

This study has several limitations. The research was conducted in only one Grade XI class, focused specifically on the respiratory system topic, required relatively high development costs, and involved a research location with limited accessibility. Therefore, the findings regarding the development of TGT-based snakes and ladders learning media for improving problem-solving abilities should be interpreted within the context of the research setting and cannot yet be widely generalized.

Future studies are recommended to involve larger samples, include a wider range of biology topics, and develop learning media with more interactive and innovative features. Further research may also examine the implementation of the TGT-based snakes and ladders medium in different educational contexts to obtain broader evidence regarding its contribution to improving students' problem-solving abilities in biology learning, particularly in respiratory system instruction.

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