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Development of Snakes and Ladders Learning Media on Vector Material: Analysis Using the Rasch Model

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ABSTRACT

This study aims to develop snakes and ladders learning media for vector materials in physics and to assess its feasibility using the Rasch Model. The research uses a research and development approach with the ADDIE model, emphasizing limited feasibility testing. The study involved 35 high school students (12 male and 23 female) at the implementation stage. Research data were obtained through expert validation sheets and student response questionnaires. Media validation consisted of three subject matter experts, three learning media experts, and three physics education experts. The collected data were analyzed using the Many Facet Rasch Model to evaluate item fit, rater consistency, and the reliability of the assessment instruments. The results showed that the validation data met the fit statistics and acceptable reliability criteria, indicating uniformity of assessment among the validators across various evaluated aspects. Analysis of student responses revealed that the snakes and ladders learning media developed met the practicality criteria from a student perspective after being implemented in vector learning activities. Students assessed this media as easy to use and suitable for supporting physics learning. These findings indicate that the developed learning media is feasible in terms of content, design, and learning aspects. The application of the Rasch Model strengthens the objectivity of the feasibility analysis by controlling the level of assessor rigor and item characteristics.

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INTRODUCTION

Physics learning at the high school level requires strong abstract, representational, and mathematical thinking skills. One topic that often causes conceptual difficulties for students is vectors. The concept of vectors demands an understanding of direction, magnitude, and interrelated mathematical operations, so students often experience misconceptions and low learning engagement if instruction is solely centered on verbal explanations and conventional exercises (Ahzari, 2025; Basri, 2025; Byrne et al., 2023; Jones, 2024). This situation indicates the need for learning media that can facilitate active student engagement while also helping to meaningfully visualize concepts.

Learning media play a strategic role in improving the quality of the learning process because they can bridge abstract concepts into more concrete and easily understood forms. Properly designed media can enhance motivation, clarify the meaning of the material, and encourage more varied and participative learning activities (Aprilianita & Yudiana, 2024; Harahap et al., 2022; Hidayat & Suryadi, 2023). In the context of physics learning, game-based media have great potential because they simultaneously integrate cognitive, affective, and social elements.

One relevant game-based medium to develop is the educational snakes and ladders game. This medium allows students to learn through interaction, discussion, and collaborative problem-solving. Several studies have shown that the snakes and ladders medium can increase students' motivation and learning outcomes due to its simple rules, attractive visuals, and flexibility in integrating conceptual questions into gameplay activities (Adelina & Iswendi, 2021; Janah & Mitarlis, 2024; Maulyda et al., 2021; Tiarawati & Sukartono, 2024). The snakes and ladders game has been widely adapted as a learning medium because it is flexible in incorporating subject content and easy to use across various educational levels. This medium enables the gradual presentation of questions or learning stimuli through players' movement on the game board (Fauzi et al., 2021). The linear and turn-based structure of the game supports even student engagement (Fauzi et al., 2021; Lestari et al., 2023; Saskiah, 2023).

Various studies have shown that the snakes and ladders game can be applied in various learning areas, including mathematics, religious education, health, and other context-based learning, thus reflecting its flexibility as a learning medium. For example, Fauzi et al. demonstrated the use of snakes and ladders for addition and subtraction materials by designing a Realistic Mathematics Education (RME)-based learning design for elementary school students (Fauzi et al., 2021), while Permatasari & Marzuki extended this approach to the same material (Permatasari & Marzuki, 2022). Lestari et al. also confirmed the application of snakes and ladders media in second-grade elementary school mathematics learning with very positive material validation (Lestari et al., 2023). Furthermore, cross-disciplinary research has also emerged in non-mathematics contexts: Saskiah explored game-based learning to strengthen Islamic Religious Education learning through snakes and ladders (Saskiah, 2023), and Saci et al.'s research has examined the application of snakes and ladders games to improve healthy lifestyle behaviors in adolescents (PHBS) (Saci et al., 2024). Similar research has also been found in the context of health and disease prevention through technology-based snakes and ladders (Syarifah & Rochadi, 2023). In general, this literature indicates that snakes and ladders is a medium that is easily adapted for various learning purposes and across educational levels (Fauzi et al., 2021; Lestari et al., 2023; Permatasari & Marzuki, 2022; Saskiah, 2023; Syarifah & Rochadi, 2023).

However, most research on developing snakes and ladders media still focuses on elementary school learning and non-physics subjects. Studies on developing snakes and ladders media in high school physics, particularly on vectors, are still limited. This suggests an opportunity to develop Snakes and Ladders media specifically designed to support understanding of the abstract and mathematical concept of vectors.

The ADDIE model is a development model widely used in educational research because it has systematic and flexible stages. The ADDIE stages include Analysis, Design, Development, Implementation, and Evaluation, which allow researchers to develop learning products in a gradual and controlled manner (Branch, 2009; Molenda, 2003; Sugiyono, 2019). This model is suitable for use in learning media development research with limited feasibility testing. In development research, the development and evaluation stages are the main focus when the research objective is to assess the feasibility of the product. Expert validation and user responses are used as the main indicators to determine whether the developed media is suitable for use in learning (Branch, 2009; Retnawati, 2016).

In addition to media development, the validity and quality of assessment instruments are also important issues in educational research. Conventional analyses based on average scores often fail to capture the complex interactions between assessors, instrument items, and the objects being assessed. The Facet Rasch Model offers a more robust measurement approach because it

can analyze multiple facets simultaneously, such as differences in validator stringency and consistency of assessments across experts (Bond, 2015; Boone et al., 2014; Linacre, 2023). This model provides more objective and accurate measurement information in assessing the quality of learning media.

In addition to its use for learning outcome analysis, the Rasch Model approach has been widely utilized in research to more objectively reveal instrument quality, response patterns, and assessor and student characteristics. Numerous studies have shown that the Rasch Model is capable of providing more accurate measurement information than classical analysis, especially in the context of measuring attitudes, perceptions, and validating learning products (Bond, 2015; Boone et al., 2014; Linacre, 2014). In the development of learning media, the Rasch Model is used to identify the suitability of instrument items and the consistency of assessments between validators so that decisions about media suitability can be empirically justified.

The Many-Facet Rasch Model approach specifically allows for analyses involving more than one source of variance, such as differences in validator strictness levels and assessment item characteristics. This model has been widely used in educational instrument validation and evaluation research because it can control rater bias and produce measurements on a logit scale that is interval in nature (Boone et al., 2014; Kurniawan et al., 2024; Linacre, 2014; Sukarelawan et al., 2024). One important output of Rasch analysis is the Wright Map, which presents a mapping of the relationships between raters, items, and the objects being measured on the same logit scale (Bond, 2015; Jimam et al., 2021; Shahat et al., 2022).

In the context of this study, the Rasch Model is not used to measure students' cognitive abilities but rather to analyze the feasibility of learning media based on expert validation and student responses. The use of this approach is expected to provide a more detailed picture of the quality of the developed snakes and ladders media, including the suitability of vector material content, media appearance, and pedagogical aspects of physics learning.

In summary, this study aims to develop snakes and ladders learning media on vector material using the ADDIE model and analyze the feasibility of the media based on expert validation and student responses using the Rasch Model approach. The results of this study are expected to provide an empirical contribution to the development of physics learning media that are methodologically tested and relevant to learning needs in high schools.

To make the research more focused, the research questions are formulated as follows.

1. How is the development process of a Snakes and Ladders-based physics learning media using the ADDIE model on vector material?
2. What is the level of validity of the snakes and ladders learning media on vector material based on assessments from content experts, media experts, and learning experts analyzed using the Facet Rasch Model?
3. How do students respond to the snakes and ladders learning media on vector material in terms of practicality based on Rasch Model analysis?

RESEARCH METHOD

Research Design

This study used a Research and Development (R&D) approach to develop snakes and ladders learning media for vectors and analyze its feasibility in physics learning. The development model used was ADDIE, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009; Molenda, 2003). The study focused on testing the media's feasibility through expert validation and student responses, without measuring the effectiveness of learning outcomes. The research flow of the ADDIE model is presented in Figure 1.

Research Subjects

The study was conducted on 35 high school students taking a physics course on vectors. Media validation involved nine validators: three physics subject matter experts, three instructional

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media experts, and three physics learning experts. Validators were selected based on their relevant professional expertise and experience.

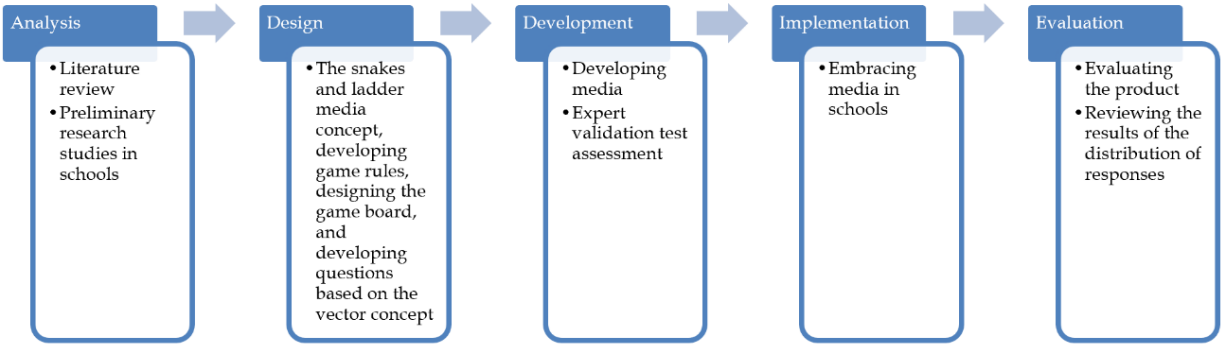

Figure 1. Research flow using the ADDIE model

Media Development Procedures

The analysis stage was conducted through an analysis of the curriculum, student characteristics, and learning difficulties in the vector material. The design stage included developing the snakes and ladders media concept, developing game rules, designing the game board, and developing questions based on the vector concept. This stage also developed expert validation instruments and a student response questionnaire. The development stage produced a learning media product, which was then validated by experts. The validators' suggestions and input were used as the basis for media improvements. The implementation stage involved applying the media to a physics lesson with 35 students. After the lesson, students were asked to complete a response questionnaire. The evaluation stage analyzed expert validation data and student responses to determine the media's suitability.

Research Instruments

The research instruments consisted of an expert validation sheet and a student response questionnaire. The validation sheet was used to assess the suitability of the material, media presentation, and learning appropriateness. The student response questionnaire was used to measure the practicality and ease of use of the media in learning. All instruments used a graded rating scale.

Data Analysis Techniques

Expert validation data and student responses were analyzed using the Many-Facet Rasch Model. The analysis involved several facets: assessors, instrument items, and the objects being assessed. Rasch analysis was used to evaluate item suitability, assessor consistency, and instrument reliability. The suitability of the instrument was determined based on the statistical fit, reliability, and logit mapping values generated from the Rasch analysis.

RESULTS AND DISCUSSION

The research results contain (1) Results of the Development of Learning Media Based on the ADDIE Model, (2) Media Feasibility Based on Expert Validation, and (3) Student Responses to Learning Media.

Results of the Development of Learning Media Based on the ADDIE Model

The development of snakes and ladders learning media for vector material followed the ADDIE model, covering analysis, design, development, implementation, and evaluation phases. The results of these stages provided essential evidence for the media's conceptual and practical feasibility.

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In the analysis stage, a learning needs analysis was conducted through observation and study of vector material. The analysis results showed that students had difficulty understanding the abstract concept of vectors and tended to be less engaged when learning using conventional media. This finding aligns with previous research that suggests that vector concepts require a visual and contextual approach to support student understanding (Bollen et al., 2017; Latifa et al., 2021; Taqwa & Rahim, 2022).

The design phase resulted in a snakes and ladders media design containing a vector concept map, learning indicators, question cards, and game rules tailored to the characteristics of high school students. The media design was designed to encourage interaction, discussion, and repetition of concepts throughout the game. This design approach supports the principle of active learning, which emphasizes student involvement in building conceptual understanding (Annetta et al., 2009; Elfiana et al., 2015; Nyirahabimana et al., 2022; Annetta et al., 2009; Elfiana et al., 2015). The following is the design result for the snakes and ladders physics vector material:

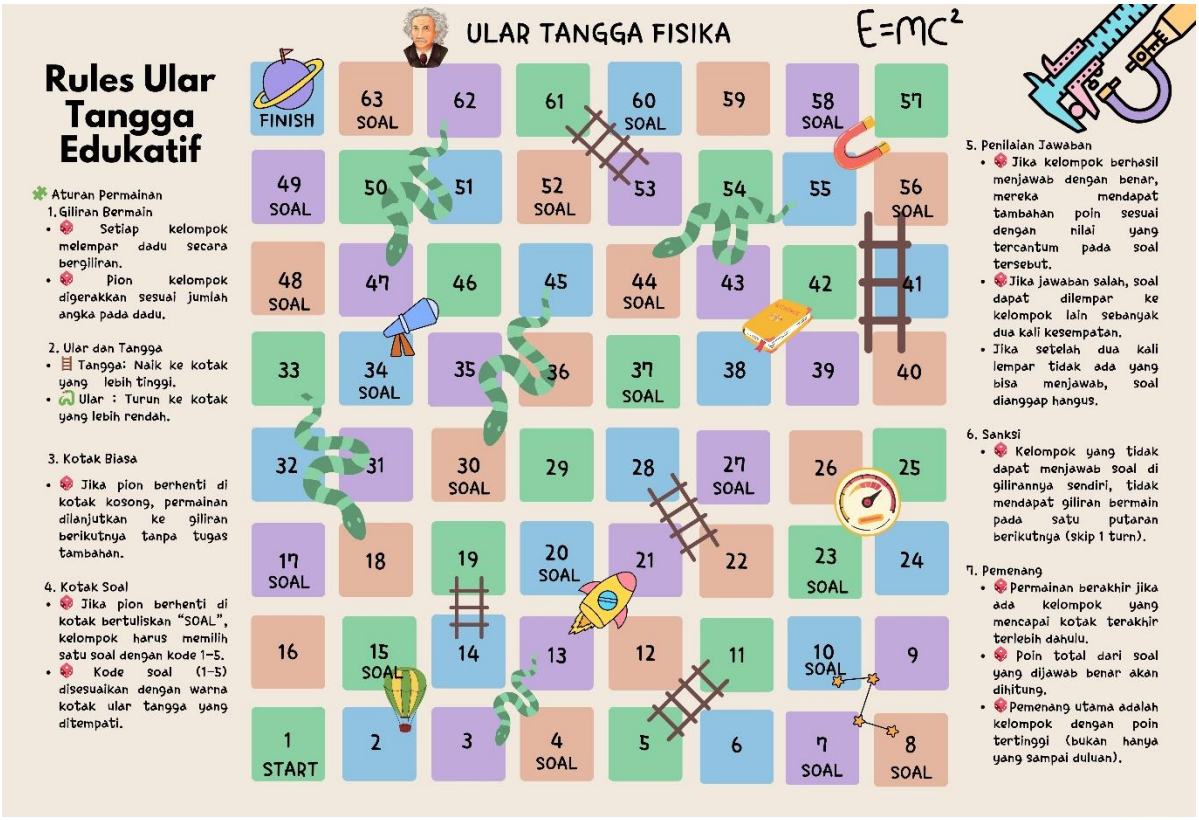

Figure 2. Design of the developed learning media

In the development stage, the designed media is developed into a complete product and then validated by subject matter experts, media experts, and learning experts. Expert input is used to make revisions, particularly regarding question clarity, indicator suitability, and the media's visual appearance. This validation process ensures that the media meets the requirements of content, construction, and usability before being implemented on a limited scale (Boone et al., 2014; Retnawati, 2016; Widoyoko, 2012).

The implementation phase involved 35 high school students, consisting of 12 males and 23 females, aged 14–16 years. The developed media was implemented during vector learning activities, and students' responses were collected through a questionnaire. The media was used in vector learning activities, followed by a student response questionnaire. The implementation results showed that students were able to follow the game flow well and were actively engaged during the learning process. This demonstrates the media's practical application in classrooms with diverse student characteristics (Herdianti et al., 2024; Norlaila et al., 2024; Oktavia et al.,

2024; Purba et al., 2025; Galante, 2014; Caetano & Zaro, 2018; Maulyda et al., 2021). The following are the stages of implementation of the snakes and ladders physics media for vector material to students of SMAN 1 Kota Mojokerto.

Figure 3. Implementation of media to students

The evaluation phase was conducted through analysis of expert validation results and student responses using the Many-Facet Rasch Model approach. This analysis provides comprehensive information regarding the media's feasibility from various assessor and user perspectives. This approach allows for a more objective and consistent evaluation of the quality of the developed learning media (Abdul et al., 2023; Bond, 2015; Linacre, 2023).

Media Feasibility Based on Expert Validation

The validation of the Snakes and Ladders learning media was carried out by three material experts, three media experts, and three learning experts. Each validator provided an assessment of a number of items on the validation sheet using a rating scale. The validation data were then compiled before being analyzed using the Facet Rasch Model.

Table 1. Expert Validation Score Recapitulation

No	Rated aspect	Assessment Indicators	Score		
			V1	V2	V3
		MATERIAL EXPERT VALIDATION			
A. Suitability of Learning Materials					
1	Suitability of KD & objectives	Vector material in questions according to basic competencies	4	4	4
2	Accuracy of the concept	The concept of vectors used is correct and does not cause any misconceptions.	4	4	4

No	Rated aspect	Assessment Indicators	Score		
			V1	V2	V3
3	Scope of material	Questions represent the scope of vector material proportionally	4	4	3
B. Quality of Questions					
4	Cognitive level	The questions have a gradual difficulty level (low-medium-high order)	3	4	4
5	Clarity of questions	The language of the questions is clear, not ambiguous	4	4	4
6	Accuracy of images and illustrations	Illustrations support understanding of vector concepts	3	3	4
C. Alignment with Learning					
7	Relevance	Materials according to student needs	4	4	4
8	Meaningfulness	Questions help students understand the concept of vectors conceptually.	3	4	4
9	Usability	Questions can be used in classroom learning activities	4	4	4
		MEDIA EXPERT VALIDATION			
A. Visual Design					
1	Color Consistency	Harmonious and unobtrusive colors	4	4	4
2	Readability	Clear text, appropriate font size	4	4	4
3	Design Neatness	Neat, proportional layout	4	4	4
B. Game Structure					
4	Gameplay	The flow of boxes 1–64 is clear, not confusing.	4	4	4
5	Snakes & Ladders Clarity	The position of the snake and ladder is proportional and easy to understand.	4	3	3
6	Consistency of elements	Consistent symbols, icons, and colors	3	4	4
C. Technical Aspects					
7	Media durability	Media suitable for printing and repeated use	4	4	4
8	Image quality	Good image resolution, no breaking	3	4	4
9	Practicality	Media is easy to use by teachers and students	4	4	4
		LEARNING EXPERT VALIDATION			
A. Learning Alignment					
1	Suitability of purpose	Media supports the achievement of learning objectives	4	4	4
2	Suitability to student characteristics	The media is suitable for use at the high school level according to the research targets.	4	3	4
3	Integration with learning	Media is easily combined with the teacher's teaching methods	3	4	4
B. The Benefits of Learning					
4	Increase motivation	Media makes students more enthusiastic about learning physics	4	4	4
5	Support student activities	Media provides space for group interaction and activities	4	4	4
6	Support student activities	Media helps students understand the concept of vectors	3	4	4
C. Ease of Use					
7	Convenience for teachers	Teachers can easily use and manage the game.	4	4	4
8	Convenience for students	Students have no difficulty following the game	4	4	4
9	Implementation time	Game duration according to learning time	4	4	3

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Descriptively, based on Table 1, the expert validation results show that the majority of validators gave a score of 4 for most assessment items. This indicates that the developed learning media meets the required criteria in terms of content accuracy, media design, and instructional suitability, as perceived by the experts. Furthermore, the expert validation data were analyzed using the Many-Facet Rasch Model in Figure 4 below.

Based on the expert assessment of the Snakes and Ladders media in Figure 4, validation was conducted by 3 experts (A, B, and C), consisting of 3 physics teachers (far right) in each category, namely material validation, media, and learning, while the middle section shows the aspects being assessed, covering 27 aspects presented in Figure 3. The interpretation of the Facet Rasch Model analysis results through the Wright map indicates that Validator A tends to give higher ratings (positioned at the top) compared to the other validators. This suggests that this validator is relatively more lenient or agrees more with the quality of the media, whereas Validators B and C are in the same position, meaning these two validators are stricter or more critical in giving assessments compared to the other experts.

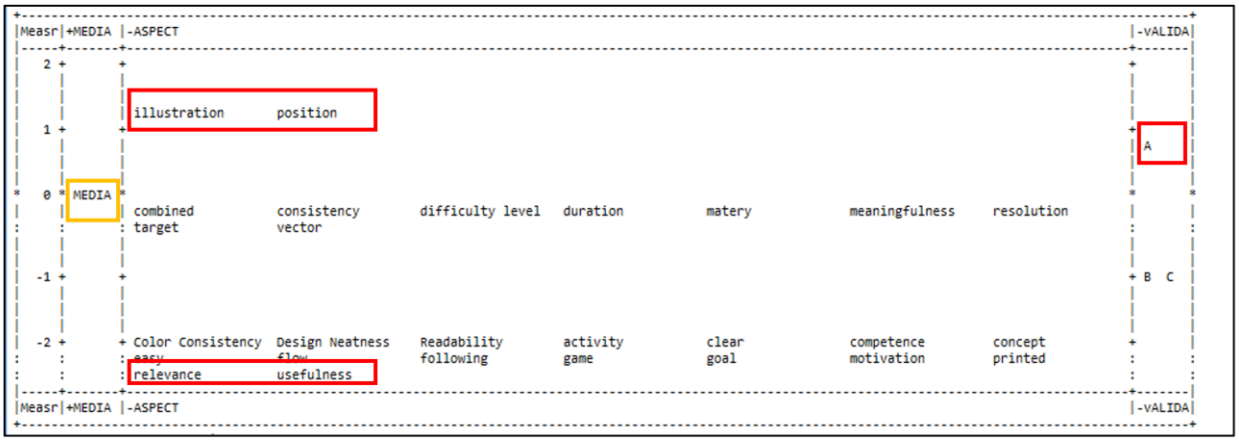

Figure 4. Expert validation analysis with the facet Rasch model

According to all experts, the illustrations support understanding of vector concepts (coded as "illustration"), and the position of the snake and ladder is proportional and easy to understand (coded as "position"). These aspects were at the top level, indicating that these aspects were considered the strongest or most valid by the experts. This indicates that this media is able to cover the understanding of vector concept content and easy-to-understand displays. Meanwhile, the materials according to student needs (coded as "relevance") and questions help students understand the concept of vectors conceptually (coded as "usefulness"). These aspects were at the bottom level, indicating that these aspects were still considered less than optimal by all validators. This reveals that this media needs revision/improvement in these aspects. This is in line with the results of student responses, where several students stated that there were questions that were difficult to understand. However, the positive thing is that the questions in it were able to differentiate aspects of students' levels of understanding. As a follow-up step, we improved the quality of the questions and tested their validity and reliability.

Overall, the analysis results show that validation using the Facets Rasch Model shows that this snakes and ladders media is suitable for use based on the assessment of 3 experts from each aspect, especially the media display aspect. Through these advantages, students can be motivated and collaborate in learning. However, improvements are still needed in the appropriateness of the material content, conceptual accuracy, and the quality of questions in the media that support learning evaluation. Differences in the position of validators confirm the variation in the level of strictness of the assessment, but in general the media received adequate validation because the aspects of the suitability of the material content to the cognitive level of students, easy usability, display, and readability remained at a fairly good level.

Analysis using the Many-Facet Rasch Model showed that most expert assessments had positive logit values and met the model's fit criteria. The Infit and Outfit mean square values were within acceptable ranges, demonstrating consistency of assessments across validators. These results indicate that the media has stable quality when assessed from various expert perspectives. This finding aligns with research emphasizing the superiority of the Rasch Model in objectively and multidimensionally evaluating the quality of educational products (Bond, 2015; Boone et al., 2014; Linacre, 2023). This approach supports the view that the Rasch Model is effective in development research to comprehensively evaluate the feasibility of educational products (Ibrahim, 2025; Khotimah et al., 2024). Thus, the results of this study can be a reference for physics learning media developers in conducting product evaluations more accurately and responsibly (Fitria et al., 2024; Nasralla et al., 2021; Y. Wang, 2024).

Qualitative input from the validators reinforces the results of the quantitative analysis of media feasibility. The validators assessed that the content presented is in accordance with the basic competencies of intermediate-level physics, particularly on the fundamental concept of vectors, both in terms of definition and the representation of vector quantities. This suitability indicates that the media has met the aspects of content validity and curricular relevance, which are key prerequisites in the development of physics learning media (Mukti et al., 2021; Ningrum et al., 2023; Rizal et al., 2021).

In terms of question presentation, the validator assessed that the variety of questions with different difficulty codes encompassed various cognitive levels. The question wording was deemed clear and easy for students to understand and supported the visualization of direction and vector concepts. These findings indicate that the media serves not only as an evaluation tool but also as a tool for reinforcing concepts through the application of questions. This aligns with the principles of physics learning, which emphasize the relationship between visual representation and conceptual understanding (Mahardika et al., 2022; Novitasari et al., 2022).

The media design aspect also received positive assessments. The combination of pastel colors, readable typography, and a layout that is not too dense was considered to support students' visual comfort. The zig-zag-shaped game board flow was considered easy to follow, although there were minor notes regarding some visual elements covering numbers. Overall, the media design was considered modern, thematic, and ready to be used in learning, both in terms of aesthetics and functionality. This assessment indicates that the media meets the aspects of display validity and usability (Plass et al., 2015; Wulandari & Amir, 2021).

The validators also emphasized that this media is effective as a means of reinforcing and reviewing material. The systematic game rules, clear assessment instructions, and familiar gameplay facilitate teachers' and students' implementation of the media in the classroom. The competitive element and question-posing mechanism are considered effective in encouraging intergroup discussion and increasing students' intrinsic motivation, while also helping reduce student anxiety in physics learning. These findings support the use of game-based media as an applicable game-based learning approach that is appropriate for the characteristics of high school students (Camacho-Sánchez et al., 2023; Sotos-Martínez et al., 2023).

However, the validator noted the importance of time management during the game to ensure it doesn't exceed the allocated class hours. This note is a crucial consideration in the evaluation and further development of the media, particularly in adjusting the number of questions and game duration to ensure its effectiveness when implemented in the classroom.

Student Responses to Learning Media

Student responses to the learning media were collected through a questionnaire completed by 35 high school students after the media was used in a physics lesson on vectors. This questionnaire aimed to measure the practicality of the media from the students' perspective. The following are the results of student responses to the developed media implemented in the learning process, as shown in Table 2.

Table 2. Percentage of student response results

No	Statement	Percentage of Student Answers			
		SS (%)	S (%)	KS (%)	TS (%)
Aspect of Ease					
1	Physics Snakes and Ladders Media is easy to play.	42.9	54.3	2.9	0
2	The rules of the game are easy to understand without the need for repeated explanations.	31.4	65.7	2.9	0
3	I can follow the flow of the game well.	51.4	45.7	2.9	0
4	The game steps are clear and not confusing.	37.1	62.9	0	0
5	The questions that appear are according to my abilities.	5.7	68.6	25.7	0
6	This media can be used without requiring additional difficult tools.	28.6	65.7	5.7	0
7	Pawn movement, snakes and ladders are easy to understand how they work.	48.6	51.4	0	0
Aspects of Attractiveness					
No	**Statement**	**SS (%)**	**S (%)**	**KS (%)**	**TS (%)**
8	The media display is interesting to look at.	71.4	28.6	0	0
9	The colors on the game board make me more interested in playing.	60	37.1	2.9	0
10	Illustrations and pictures support my understanding.	42.9	51.4	5.7	0
11	I feel happy when using this media.	45.7	51.4	2.9	0
12	This game makes the learning atmosphere more fun.	65.7	31.4	2.9	0
13	I don't feel bored when playing this game.	57.1	40	2.9	0
14	The game sheet looks neat and easy to read.	51.4	48.6	0	0
Aspect of Utility					
No	**Statement**	**SS (%)**	**S (%)**	**KS (%)**	**TS (%)**
15	This media helps me understand the concept of vectors better.	11.4	71.4	17.1	0
16	The questions in the game increase my knowledge.	31.4	68.6	0	0
17	This media makes me more motivated to study physics.	25.7	71.4	2.9	0
18	I find it easier to remember vector material after playing this game.	20	60	17.1	2.9
19	This game helps me cooperate with my group friends.	28.6	68.6	2.9	0
20	This media makes learning feel more active and not monotonous.	48.6	51.4	0	0
21	I feel more confident in answering vector questions after using this media.	11.4	65.7	20	2.9

Description: SS (Strongly Agree), S (Agree), KS (Less Agree), and TS (Disagree)

Based on Table 2, student responses to the physics snakes and ladders learning media showed a positive trend in all measured aspects, namely ease, interestingness, and usefulness. In general, the percentage of Strongly Agree and Agree responses dominated almost all statements, indicating that the media can be used practically and is well received by students. Next, analysis was conducted using the Facet Rasch Model as follows in Figure 5.

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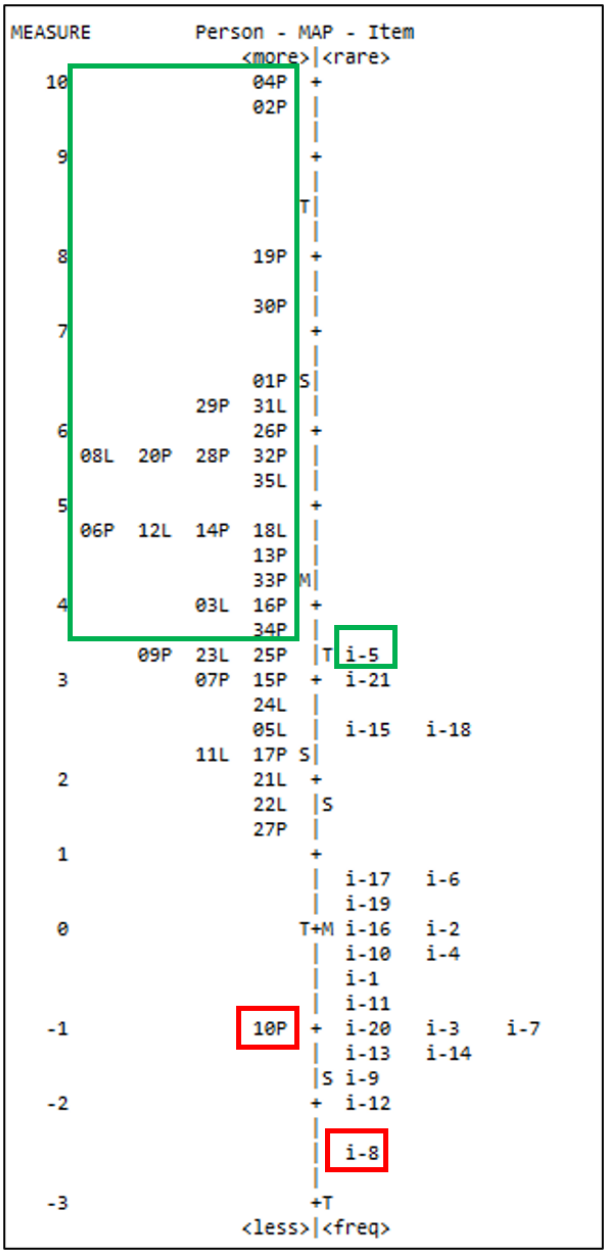

Figure 5. Analysis of student responses with the facet Rasch model

Figure 5 shows the distribution of response items (right side) and student responses (left side). A total of 35 students were coded by number and gender (M/F), while a total of 21 items were coded from i-1 to i-21. The results of the Wright map analysis indicate that item 8 (i-8), with the statement "The media display is interesting to look at," which is located at a logit value of -3, is the easiest item. Almost all students answered positively. This means that the majority of students found the media display interesting to look at. This enthusiasm became a motivation because this media was interesting. Only students with a dominant high positive response (for example, 02 P and 04 P) tended to align with this statement. In addition, statements with a low level of difficulty were dominated by statements related to visual appearance, ease of rules, and enjoyment of playing, including items i-1, i-2, i-3, i-4, i-8, i-9, and i-12. The low level of difficulty of these items shows that almost all students agree that the media is easy to use, visually appealing, and able to create a pleasant learning atmosphere.

Items with a moderate level of difficulty generally relate to aspects of learning motivation, activeness, cooperation, and practicality of media use, such as items i-6, i-16, i-17, i-19, and i-20. Most students agreed with these items, indicating that this media is effective in creating a more

active, collaborative, and enjoyable learning atmosphere. This finding is in line with research stating that game-based learning can increase student participation and learning interest in science learning (Clarice et al., 2023; Kalogiannakis et al., 2021; Plass et al., 2015).

Meanwhile, item 5 (i-5) with the statement "The questions that appear are in accordance with my abilities," which is located at +3 logit, is the item that is most difficult for students to agree with. This result can be interpreted as students who have a logit value above +3 consider the questions in this media to be in accordance with their abilities. Some other students feel that they are not in accordance with their abilities, or it can be interpreted that these students have difficulty in solving the questions. In addition, items 8 (i-8) and 21 (i-21) are also at high logit, which indicates that not all students directly feel an increase in conceptual understanding, memory, and self-confidence after using the media. Thus, this media is able to distinguish students who can experience benefits related to conceptual understanding and student confidence levels. Some students only feel benefits in the aspects of pleasure and ease. Based on Figure 4, students coded 10P are the students who least agree with all statements positively. These students stated that the media does not fully cover improvements in conceptual understanding, memory, and self-confidence. This means that there are some parts of this media that need some improvement. These findings are important for teachers to reflect on when adjusting the difficulty level of questions and managing game time to ensure optimal use of the media. Previous research also emphasizes that differences in students' initial abilities need to be considered in the design and implementation of game-based learning media (Plass et al., 2015; M. Wang et al., 2025; Zhao et al., 2021).

Overall, the Wright map analysis results show that the average student response ability is above the average item difficulty level. This condition indicates that this media can be used as an innovation in vector learning, has a very good level of acceptance by students, excels in aspects of appearance, ease of use, and enjoyment of learning, has a positive impact on motivation and learning activity, and shows an influence on high-level cognitive aspects, although these effects have not been felt evenly by all students. Thus, this media is suitable for use as a physics learning medium and has the potential to be further developed to strengthen its impact on conceptual understanding and student confidence in vector material.

In addition to quantitative data from student questionnaire responses analyzed using the Rasch Model, this study also collected qualitative data in the form of open-ended comments from students. This data was used to strengthen the interpretation of the results and provide a contextual overview of students' experiences using the Snakes and Ladders physics learning media.

Based on a thematic analysis of student comments, student responses can be grouped into several main themes: learning engagement, learning atmosphere, understanding of the material, and challenges in answering questions. Most student comments indicated a high level of engagement during learning. Students stated that the use of the snakes and ladders game made learning more active, varied, and less monotonous. This condition indicates that game-based media can create a learning environment that encourages active student participation. This finding aligns with research stating that educational games can increase student engagement and motivation through interactive and collaborative activities (Plass et al., 2015; Prayuda et al., 2024). The high level of student engagement also correlated with the results of the Rasch analysis of the questionnaire responses, where most items fell into the positive logit category and met the fit criteria. This indicates that students' perceptions of the media's practicality were statistically consistent and supported by qualitative data.

Student comments also indicated that the Snakes and Ladders game created a more relaxed yet focused learning environment. Students assessed that the learning process was less boring and encouraged collaboration among group members. The social interactions that emerged during the game contributed to a more meaningful learning experience. These findings support the view that board games can strengthen social interaction and collaboration in science learning (Mamotheti & Daramola, 2022; Zou et al., 2021). In the context of Rasch evaluation, consistently

positive student responses indicate that the questionnaire items reliably represent students' learning experiences (Deeba & Ahmad, 2023). This strengthens the construct validity of the student response instrument.

The integration of quantitative and qualitative data indicates that the snakes and ladders learning media developed meets the feasibility criteria in terms of practicality and user acceptance. Student comments reinforce the results of the Rasch analysis, which demonstrates consistent responses and good instrument reliability. This data triangulation approach provides a strong basis for concluding the media's feasibility empirically and contextually (Bond, 2015; Boone et al., 2014; Linacre, 2023).

CONCLUSION

This research produced snakes and ladders learning media for vector material developed using the ADDIE model and was tested on high school students on a limited basis. The development process showed that each stage of ADDIE contributed to the refinement of the media, both in terms of content suitability, media design, and its integration with the physics learning process.

Validation results by content experts, media experts, and learning experts indicated that the media met the feasibility criteria based on assessments of content, appearance, and pedagogical aspects. Analysis using the Many-Facet Rasch Model reinforced these findings by showing consistency in evaluations among validators and the absence of significant assessment bias. The media falls into the feasible category based on logit values and model fit statistics.

Student responses also showed a positive reception towards the learning media. Students rated the media as easy to use, helpful in understanding the concept of vectors, and capable of creating a more active learning environment. Rasch analysis of the student response questionnaire indicated that the instrument has good reliability and is able to consistently represent students' perceptions.

Based on these results, the snakes and ladders learning media on vector material is declared suitable for use as a supporting medium for learning physics in high schools. This research contributes to the development of game-based learning media that is systematically evaluated using the Rasch Model approach.

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