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Enhancing student achievement: Developing a Differentiated Instruction Formative Assessment Model (DIFAM)

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ABSTRACT

An ideal assessment should offer constructive feedback and insights into students' strengths and weaknesses in learning. This study aims to develop an assessment model integrating formative assessment with Differentiated Instruction (DIFAM) to assess learning achievements proportionally. The DIFAM model was developed using the ADDIE development framework. The research sample consisted of 99 students from four high schools in Bandung Regency. Student learning profiles were analyzed using N-Gain and paired sample t-test. Data analysis was conducted with R Studio and JASP software. Data analysis using the N-Gain formula revealed an average improvement in student learning achievements of 25% with the implementation of DIFAM. The formative tests conducted over eight sessions showed that students grasped the material more effectively compared to conventional teaching methods. Feedback from students and teachers indicated that DIFAM facilitated more structured learning and provided constructive feedback, contributing significantly to enhanced student performance. The DIFAM model demonstrates its ability to cater to diverse student needs, achieve significant learning improvements, and has the potential for broader application to ensure more inclusive and equitable learning outcomes.

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INTRODUCTION

Assessment is an important component in the education system, which aims to measure students' abilities, knowledge and skills objectively (Black & Wiliam, 2018). An ideal assessment must meet several criteria, such as validity, reliability, inclusivity, fairness, and provide useful feedback to students (Alhameedyeen, 2023; Gregory, 2015; Khajuria & Khan, 2021). However, the implementation of assessments in schools, especially in Indonesia, often does not reach the expected standards. Several fundamental problems have been identified. First, the teacher's lack of understanding of the potential and individual needs of each student (Retnawati et al., 2017). This condition results in difficulties presenting learning materials that suit students' specific needs and interests (Morris et al., 2021). Second, there is a lack of accurate mapping of individual students' ability levels (Means & Neisler, 2021; Palieraki & Koutrouba, 2021). As a result, learning is often only tailored to the needs of the average class, without considering the specific needs of individual students. Third, there is no assessment model specifically designed to assist teachers in systematically mapping the abilities and needs of each student. This causes an inability to provide appropriate and targeted feedback to students (Black & Wiliam, 2018; Saleh et al., 2017). Therefore, a more targeted and structured approach is needed to overcome these challenges and improve the overall quality of learning.

One solution to overcome the problems mentioned above is to implement formative assessment and differentiated learning. Teachers can use forms of assessment instruments that suit students' needs and abilities (Marks et al., 2021). Teachers will continue to monitor individual student progress, identify difficulties they face, and provide specific and constructive feedback to help them improve their understanding and skills (Atasoy & Kaya, 2022). By implementing formative assessment in differentiated learning, teachers can pay deeper attention to the learning development of each student (Mngomezulu et al., 2022). Teachers can also identify specific difficulties faced by students, provide necessary assistance, and ensure that students receive useful feedback appropriate to their ability level. However, empirical findings in various schools show a gap between these ideal practices and actual classroom implementation (Joseph & Winberg, 2024; Xuan et al., 2022). Teachers often still rely on summative assessments that focus only on the final outcomes, without integrating formative strategies that address students' ongoing learning needs. Differentiated instruction also remains underutilized, with most learning still delivered uniformly, regardless of students' readiness levels or learning profiles. This highlights the need to develop a model that bridges this gap by combining formative assessment with differentiated instruction, based on students' real-time progress and learning responses.

To respond to this condition, this study proposes the development of a Differentiated Instruction Formative Assessment Model (DIFAM). This model emphasizes assessment as an ongoing process, not just a final judgment tool (Röck et al., 2020). Teachers use formative assessment instruments to continuously monitor student learning and to identify specific needs based on their mastery levels (Box, 2019; Sagi et al., 2021). Feedback is delivered in a timely, constructive, and individualized manner to highlight students' strengths and areas for improvement (Joseph & Winberg, 2024; Koksalan & Ogan-Bekiroglu, 2024), thereby supporting inclusive and equitable learning practices.

This research is urgently needed to ensure the availability of valid, inclusive, and fair assessment tools that provide meaningful feedback for each student. By identifying practical obstacles in current classroom assessment practices and offering an evidence-based alternative, this research addresses an important gap in the field. The development and implementation of DIFAM contribute significantly to advancing educational theory and practice by offering a scalable model that supports personalized learning. As a scientific contribution, DIFAM provides a framework that future researchers and practitioners can adopt, adapt, and further develop to enhance learning assessment systems. Therefore, this study aims to describe the design of the Differentiated Instruction Formative Assessment Model (DIFAM) and analyze the profile of students' learning achievement after its implementation in the classroom setting.

METHOD

Research Design

This research was a Research and Development (R&D) study that adopted the ADDIE model, including five stages: Analysis, Design, Development, Implementation, and Evaluation (Kelly, 2013; Plomp, 2013). The ADDIE model was chosen because it offers a systematic and measurable framework for developing comprehensive and structured formative assessments. The advantage of this model lies in its ability to be adapted to research contexts and specific needs, allowing researchers to adapt steps and processes according to the characteristics of differentiated learning under study. In this research, the focus was placed on the DIFAM design stage, the results of DIFAM implementation, and the evaluation of learning after DIFAM implementation.

Research Participants and Procedure

The research sample was determined by using a purposive sampling technique because this technique is relatively inexpensive, does not take much time, and is simple (Creswell, 2022). The subjects of this development research were students of class XI of senior high school (*Sekolah Menengah Atas/Madrasah Aliyah Negeri*) in Bandung City, West Java. The selected schools were those that had implemented the independent learning curriculum. The schools were School A, School B, School C, and School D. During the implementation stage, the model involved 99 students from four schools, comprising two public schools and two private schools. The implementation of the DIFAM model is carried out in two main stages, as illustrated in Figure 1.

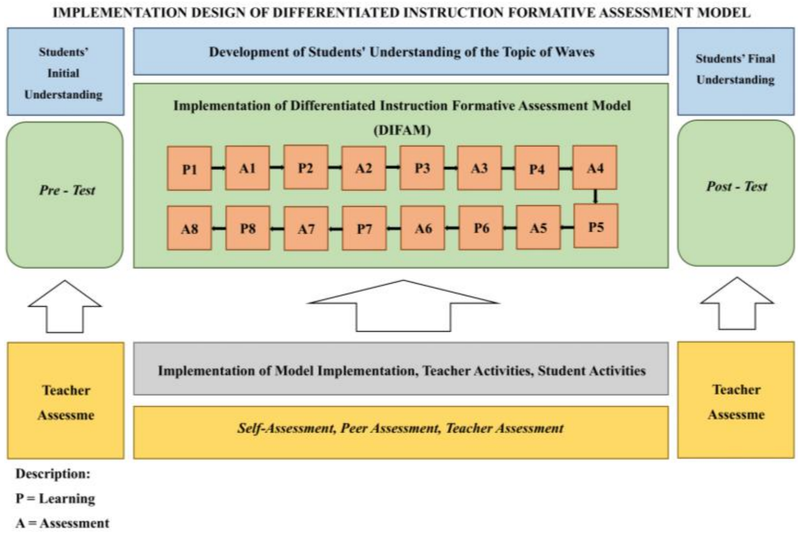

Figure 1. Research Procedure

The first stage involved a diagnostic assessment at the beginning of the learning process to identify students' initial abilities, crucial for understanding their level of comprehension before starting the DIFAM-based instruction. The second stage entailed the administration of formative tests throughout the learning process. After each topic was covered, students were given formative tests to assess their understanding. This model was applied in an alternating sequence: students received the material in the first session and took the formative test in the second. This cycle was repeated over eight sessions, allowing students to gradually deepen their understanding through continuous evaluation. At the end of the learning period, a final diagnostic test was conducted to evaluate students' abilities after applying the DIFAM model. This final assessment aimed to measure the extent of improvement in student performance, providing insights into the effectiveness of the DIFAM approach in enhancing learning outcomes.

Research Instruments

This study employed two main research instruments: diagnostic tests and formative tests. These instruments were used to evaluate the effectiveness of DIFAM in enhancing students' conceptual understanding and learning achievement.

Diagnostic Tests

The diagnostic test adopted a two-tier multiple-choice format to assess students' conceptual understanding and reasoning skills before and after the implementation of DIFAM. The first tier of each item measured factual or conceptual knowledge, while the second tier measured the reasoning behind the selected answer, allowing the identification of students' misconceptions. The initial diagnostic test helped to establish a baseline of students' prior knowledge and misconceptions. The final diagnostic test was used to assess students' conceptual changes and improvements in understanding after the intervention. The blueprint for the diagnostic test items is outlined in Table 1.

Table 1. Test Blueprint for Diagnostic Instrument (Two-Tier Multiple Choice)

Cognitive Level	Vibrations & Waves	Sound Waves 1	Sound Waves 2	Light Waves
	Item No.	No. of Items	Item No.	No. of Items
C2 (Understanding)	3A, 3B	2	8A, 8B	2
C3 (Applying)	2A, 2B	2	5A, 5B	2
C4 (Analyzing)	1A, 1B; 4A, 4B	4	6A, 6B; 7A, 7B	4
Total Items	8		8	

Formative Tests

Formative tests were given periodically after each major topic's completion. The essay-based items were aligned with Bloom's cognitive taxonomy levels, ranging from understanding (C2) to analyzing (C4). These tests were designed to track students' progress during instruction and provide timely feedback for differentiated support. The blueprint for the formative test items is presented in Table 2.

Table 2. Test Blueprint for Formative Essay Instrument

Cognitive Level	Vibrations & Waves	Sound Waves 1	Sound Waves 2	Light Waves
	Item No.	No. of Items	Item No.	No. of Items
C2 (Understanding)	–	–	1	1
C3 (Applying)	1, 2	2	2, 3	2
C4 (Analyzing)	3	1	–	–
Total Items	3		3	

Data Analysis Technique

To understand students' ability profiles, it is important to analyze formative test results systematically. This process involved a careful assessment of the scores obtained by students and the determination of ability categories based on these scores. The scoring formula is presented in Formula (1). After calculating the values obtained, the criteria were determined based on Table 3.

$$Final\ Score = \frac{Total\ Score}{Maximum\ Score} \times 100 \quad \text{...} \quad (1)$$

Table 3. Student Ability Profile Criteria

Score Range	Formative Test Criteria	Ability Criteria
86 - 100	Very Good	Tall
81 - 85	Very well	
76 - 80	More Than Good	Currently
71 - 75	Good	
66 - 70	Kinda Good	
61 - 65	More than enough	Low
56 - 60	Enough	
41 - 55	Not enough	
≤ 40	Very less	Very Low

After determining the student's ability category based on Table 3, the next step was to conduct an in-depth analysis of the results from this formative test. This analysis provided more detailed insights into students' areas of strength and weakness, and assisted in designing more effective learning interventions to improve students' overall understanding and achievement. By understanding this ability profile, teachers can implement teaching strategies that are more appropriate to individual student needs, making the learning process more optimal and focused.

FINDINGS AND DISCUSSION

Analysis

During the analysis phase, the research identified a critical gap in how traditional assessments fail to address the diverse learning needs of students in physics education. A preliminary diagnostic test using two-tier multiple-choice questions was administered to determine students' baseline understanding. This diagnostic served not only to identify misconceptions but also to classify students into four ability levels: very high, high, medium, and low, based on the Criteria-Referenced Assessment framework by Cynthia et al. (2023). This mapping highlighted the heterogeneity in student understanding, justifying the need for a differentiated formative assessment model to address these disparities.

Design

The DIFAM design is the result of a synthesis of several formative assessment models integrated with differentiated learning design. The formative assessment models that are synthesized include the formative assessment model proposed by Heritage (2010), elements of assessment as learning by Swaffield and Rawi (2023), the formative assessment system by Frey and Fisher (2011), and the model of Dochy et al. (1996) for the integration of assessment and learning, as well as the differentiated learning design formulated by Tomlinson (2017). In general, DIFAM in learning in this research is presented in Figure 2.

The combination of all previous theories is an important basis for understanding forms of assessment in differentiated learning. The DIFAM design not only carries the principles of differentiated learning but also places formative assessment as a key element in continuously measuring student progress and understanding. In further exploration, it will highlight the concrete steps taken in implementing DIFAM, ensuring adaptability to individual student needs, as well as maximizing the benefits of each learning element.

DIFAM begins with the process of grouping and evaluating students' initial abilities (pretest) through a diagnostic test in the form of two-tier multiple choice. This test aims to identify students' level of understanding in the classroom. After the diagnostic test, students' initial abilities are mapped into four ability groups: very high, high, medium, and low. This mapping follows the Criteria Reference Assessment rules formulated by Cynthia et al. (2023). After capability mapping, the teaching and learning process continues using a differentiated learning design. At each meeting, students undergo learning tailored to their learning needs based on initial ability mapping. During the learning process, students' progress and understanding are evaluated through formative tests in the form of essay tests (Kusairi, 2013). This test aims to evaluate the progress of their learning achievements after participating in the lesson.

During the differentiated learning phase, apart from adapted material, self-assessment and peer assessment are also integrated as part of the student's learning experience. Self-assessment provides students with the opportunity to reflect on their understanding of the material being taught, using an evaluation tool or rubric for guidance. This process helps students identify areas where they require additional support or guidance. Meanwhile, peer assessment allows students to give and receive feedback from one another. This process not only helps in understanding complex concepts but also builds critical skills in providing constructive and empathetic feedback. These two processes add important dimensions to differentiated learning. Additionally, it can enrich students' learning experiences by providing opportunities for them to reflect on their personal understanding and participate in collective learning through feedback from classmates. This approach also enables teachers to more effectively monitor individual student development and adjust learning strategies according to each student's specific needs.

As a closing step, a final diagnostic test (posttest) is carried out as an assessment of the entire learning series. This test aims to evaluate the results of learning and map students' final abilities after the learning process, and ensure whether there are improvements and changes in students' abilities for the better. Thus, the steps in the assessment process are carried out in detail and comprehensively to understand and assess the development of each student's learning achievement from the beginning to the end of learning, according to their learning needs.

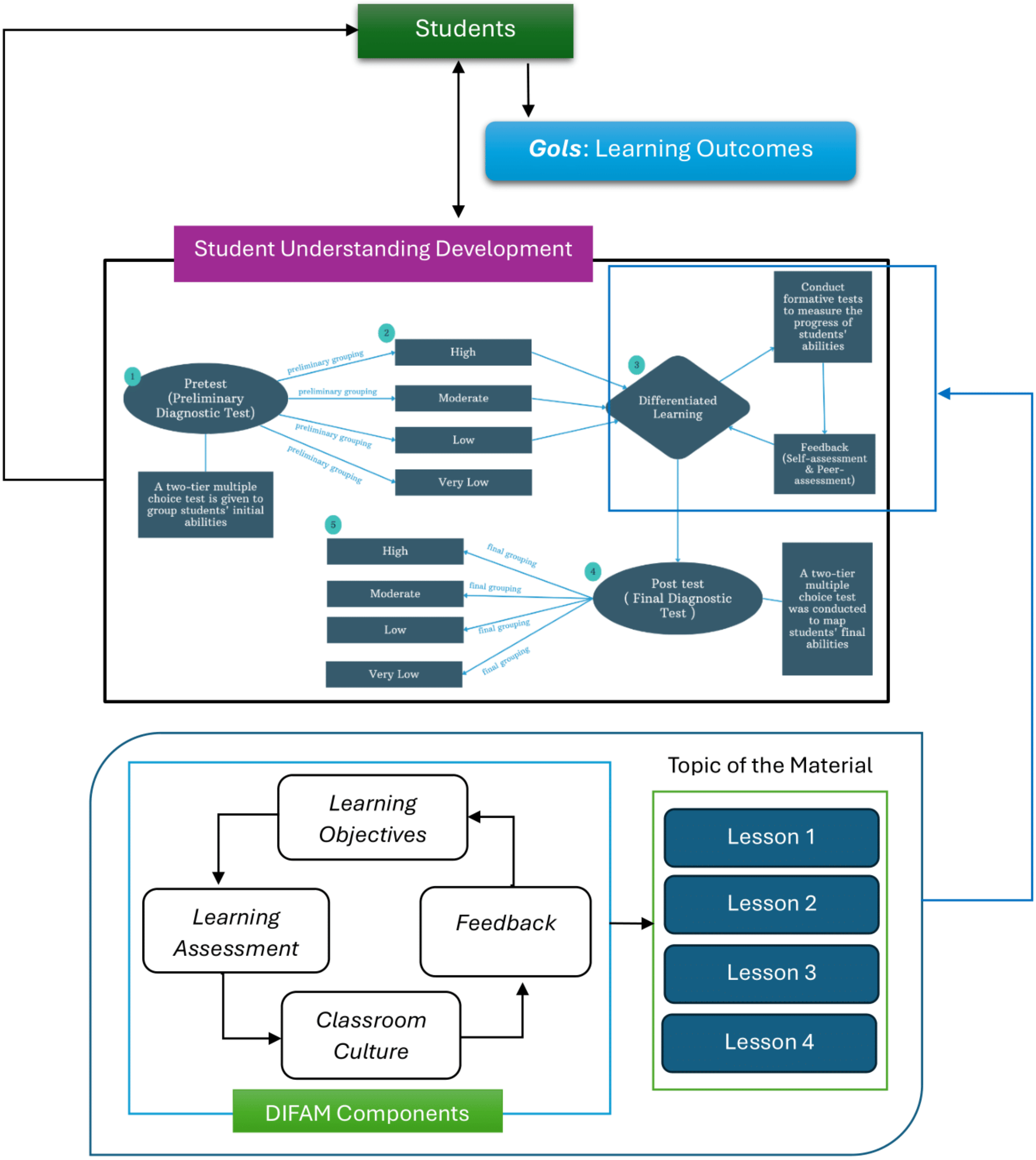

Figure 2. DIFAM Design

Development

The development phase involved constructing the instruments and tools used to support the implementation of the DIFAM. These included a two-tier diagnostic test to assess conceptual understanding, formative essay-based tests to monitor progress after each topic, and rubrics for self- and peer-assessment. The instructional materials were adapted based on the four levels of student ability identified during the diagnostic phase. These learning supports were tailored to ensure that each group received appropriately challenging content and scaffolded support aligned with their cognitive level and conceptual mastery.

Implementation

During implementation, the DIFAM model was applied across four high schools in Bandung, involving a total of 99 students. Instruction was carried out in phases that aligned with the mapped student abilities. Differentiated instruction was integrated with ongoing formative assessment processes. After each topic covering M1 to M4 (e.g., vibrations, sound intensity, and light waves), students took formative essay tests, while also engaging in self-assessment and peer-assessment. These practices promoted metacognition, collaborative learning, and real-time instructional adjustments by teachers.

Evaluation of Student Learning Achievement Profile

The application of the Differentiated Instruction Formative Assessment Model (DIFAM) in the educational context has shown significant potential in improving student achievement results. The material taught in this model includes several important concepts, namely M1: vibrations, waves and superposition; M2: Melde's law, Doppler Effect, and sound transmission; M3: intensity and level of sound intensity; and M4: light waves. Analysis of improving learning achievement using N-Gain highlights the effectiveness of DIFAM in several secondary schools in Bandung. Table 4 shows the learning outcomes of several schools, as measured by the N-Gain value for each subject taught with DIFAM. The results of this analysis provide an overview of the extent to which this model contributes to improving student learning achievement in participating schools.

Table 4. Analysis of Increasing Learning Achievement with N-Gain

School Name	Learning Outcomes	N Gains	Category	%	Category
School A	M1	0.7	Currently	71	Quite effective
	M2	0.81	Tall	81	Effective
	M3	0.9	Tall	90	Effective
	M4	0.51	Currently	52	Less effective
	Total	0.77	Tall	78	Effective
School B	M1	0.89	Tall	90	Effective
	M2	0.97	Tall	98	Effective
	M3	0.98	Tall	98	Effective
	M4	0.75	Tall	76	Effective
	Total	0.91	Tall	92	Effective
School C	M1	0.8	Tall	80	Effective
	M2	0.79	Tall	80	Effective
	M3	0.49	Currently	49	Less effective
	M4	0.69	Currently	69	Quite effective
	Total	0.77	Tall	77	Effective
School D	M1	0.7	Currently	70	Quite effective
	M2	0.78	Tall	78	Effective
	M3	0.82	Tall	82	Effective
	M4	0.72	Currently	72	Quite effective
	Total	0.76	Tall	76	Effective

The results of the analysis in Table 4 show that the implementation of the Differentiated Instruction Formative Assessment Model (DIFAM) at School A, School B, School C, and School D produced varying N-Gain, but overall showed a significant increase in student learning achievement. Most schools recorded the N-Gain category, which fell in the high category, indicating that DIFAM was effective in increasing students' understanding and achievement in the subjects taught. In the context of Hake's N-Gain theory, N-Gain is a measure of increased learning outcomes that compares pretest and posttest scores to identify the extent to which learning has occurred (Hake, 1998). Hake defines the N-Gain categories as low (0-0.3), medium (0.3-0.7), and high (0.7-1) (Hake & Reece, 1999). Based on the results, which show that most schools are in the high category. This indicates that DIFAM has successfully produced a significant increase in student understanding, demonstrating the effectiveness of the model in enhancing learning outcomes.

Proving an increase in student learning achievement results is not sufficient to prove only the Gain value, but must be continued with the paired sample t-test. The purpose of the test is to determine whether student learning achievement results have increased significantly or not. The results of this significance test are presented in Table 5.

Table 5. Test of the Significance of Increasing Student Achievement Results

School Name	Material	t	P-value	Information
School A	M1	9,486	<.001	Increased significantly
	M2	13,221	<.001	Increased significantly
	M3	13,648	<.001	Increased significantly
	M4	7,460	<.001	Increased significantly
	Total	15,306	<.001	Increased significantly
School B	M1	10,687	<.001	Increased significantly
	M2	15,943	<.001	Increased significantly
	M3	18,126	<.001	Increased significantly
	M4	12,643	<.001	Increased significantly
	Total	22,966	<.001	Increased significantly
School C	M1	4,862	<.001	Increased significantly
	M2	8,955	<.001	Increased significantly
	M3	3,827	0.002	Increased significantly
	M4	5,814	<.001	Increased significantly
	Total	21,619	<.001	Increased significantly
School D	M1	9,982	<.001	Increased significantly
	M2	12,650	<.001	Increased significantly
	M3	11,688	<.001	Increased significantly
	M4	10,109	<.001	Increased significantly
	Total	36,611	<.001	Increased significantly

The results of the paired t-test in Table 5 show a significant increase in learning outcomes in the four schools tested. At School A, all materials (M1 to M4) showed a significant increase with t-values ranging from 7,460 to 13,648 and P-value < 0.001. Overall, the total results also show a significant increase with a t-value of 15.306 and a P-value <0.001. Similar results were also seen at School B, where all materials showed a significant increase with t values ranging from 10,687 to 18,126 and P-value < 0.001. The total results for this school have a t-value of 22.966 and a P-value < 0.001, indicating significant overall improvement. School C also experienced a significant increase for all materials, with t-values ranging from 3,827 to 8,955, and the P-value for all materials was below 0.01, indicating a significant increase. The total results show a very significant increase with a t value of 21.619 and a P-value <0.001. Finally, School D showed significant improvement in all materials, with t-values between 9,982 to 12,650 and P-value < 0.001. The total results show the most significant increase with a t-value of 36.611 and a P-value <0.001. Overall, the results of the paired t-test indicate a significant increase in learning outcomes across all materials and in total for the four schools tested. These findings indicate that the intervention or treatment provided in each school has a significant positive impact on student learning outcomes.

Profile of Student Learning Achievement

In the context of the theory of improving learning outcomes, this significant increase can be attributed to several main factors. First, a structured learning approach that focuses on students' individual needs can increase learning effectiveness (Marinescu et al., 2014). Learning strategies that are adaptive and responsive to student needs can increase student motivation, engagement and understanding of lesson material (Osuafor & Okigbo, 2013). This approach also provides more timely and specific feedback, helping students to more quickly identify and overcome learning difficulties (Afikah et al., 2022). Previous research supports these findings by showing that the use of differentiated and formative learning methods can significantly improve student learning outcomes. Research by Awofala and Lawani (2020) found that formative assessments carried out consistently and effectively can produce significant improvements in student learning outcomes. In addition, research by Koksalan and Ogan-Bekiroglu (2024) show that high-quality feedback is one of the most influential factors in improving student learning outcomes. These findings are also consistent with learning principles which emphasize the importance of students' active involvement in the learning process, implementation of student-centered learning strategies, and the use of formative assessments to direct and improve learning (Davis & Autin, 2020). An approach like this not only helps students understand the subject matter better, but also encourages them to develop critical and analytical thinking skills that are essential in the learning process (Bal, 2023; Thapliyal et al., 2022). Overall, the findings from the paired t-test confirm that adaptive and responsive learning strategies, such as those implemented in DIFAM, can have a significant positive impact on student learning outcomes. This is in line with previous research findings and educational theory, which emphasizes the importance of a learning approach that focuses on students' individual needs to achieve optimal learning outcomes.

Profile of Very Low Ability Students

Students with very low abilities have scores below 25 based on diagnostic test results and less than 40 based on formative test results. Students with very low abilities often have low scores on diagnostic and formative tests for several main reasons. First, they have a very limited understanding of basic physics concepts, which results in difficulty in following more complex lessons (Ningsi & Nasih, 2020). Second, physics material, which is often abstract, requires in-depth understanding and critical thinking skills (Juman et al., 2022). Low-ability students need more guidance and support from teachers and peers to understand these concepts. Third, physics often involves a lot of mathematical calculations, and students with a weak foundation in mathematics will struggle to carry out these calculations and apply physics concepts to solve problems (Mumthas & Abdulla, 2019). They often struggle to understand the material, carry out calculations, and apply physics concepts in solving problems, so their scores are usually far below the class average (Abtokhi et al., 2021). Very low ability can be caused by a lack of interest in physics subjects or a lack of learning support at home (Mngomezulu et al., 2022). In physics learning with wave material, students with very low abilities show unique behavior and forms of understanding in each material. When discussing vibrations, waves, and superposition, students often experience initial confusion with basic terms and difficulty in visualizing concepts. They remember definitions but cannot apply them in different contexts (Cynthia et al., 2023). During group discussions, their participation was low and they tended to repeat information without deep understanding, showing very short answers and often incorrectly using physics terms. The results of research by Soeharto (2021) and Kiray and Simsek (2021) show that many students have misconceptions about basic physics concepts which prevent them from applying their knowledge effectively. The combination of these factors causes students with very low ability to have grades well below the class average. Additional support, such as tutoring or remedial programs, may be needed to help them improve their understanding and performance in physics subjects. Overall, students with very low ability demonstrate limited understanding and struggle to apply physics concepts. They rely heavily on visual aids and demonstrations and require intensive guidance to overcome learning difficulties. These difficulties can be caused by a lack of interest in the subject, specific learning difficulties, or inadequate learning support at home.

Profile of Low-Ability Students

Low-ability students, who score in the interval 25 to 49 based on diagnostic test results and 41 to 65 based on formative test results, demonstrate basic but often incomplete or inaccurate understanding. They can solve simpler problems but struggle with more complex ones. Their scores are slightly below average, and they may require additional time and support to grasp more complex concepts. Factors that contribute to this may include less effective learning methods, lack of motivation, or limitations in accessing learning resources. In vibration, wave, and superposition material, students with low abilities often show partial understanding of basic concepts. They could define vibrations and waves but had difficulty understanding superposition. Their behavior reflects confusion when faced with questions that require a more complex application of concepts. These students tend to give incomplete or inaccurate answers when asked about the relationship between frequency, wavelength, and amplitude.

Students with very low abilities often have low scores in diagnostic and formative tests because a lack of interest in physics subjects also affects academic performance. According to Self-Determination Theory, intrinsic interest is crucial in the learning process (Durward et al., 2020). Students who are less interested in physics may not try to understand the material well or take assignments seriously, resulting in lower grades (Hadi et al., 2015). Munfaridah et al. (2021) state that students with learning difficulties often require special teaching strategies to help them overcome their learning barriers. Overall, students with lower abilities need a more structured learning approach and additional support to strengthen their understanding. They demonstrate a basic but not in-depth understanding, require visual demonstrations, and often struggle to apply concepts to more complex problems. More effective learning methods, increased motivation, and better access to learning resources can help improve their performance.

Profile of Medium Ability Students

Students with moderate abilities, who have scores in the interval 50 to 74 based on diagnostic test results and 66 to 80 based on formative test results, demonstrate a good understanding of the basic and intermediate concepts of physics. They were able to do most of the questions correctly and demonstrated adequate analytical skills. Their grades are around the class average, and they typically perform well in class, consistently demonstrating strong performance. In vibration, wave, and superposition materials, students with moderate abilities demonstrate a deep understanding of the basic concepts. They can explain and define vibrations and waves well and understand the concept of superposition. Their behavior reflects confidence in solving problems that require the application of concepts, although they may need a little additional guidance for more complex problems (Abtokhi et al., 2021). These students tend to be active in class discussions and can provide precise and comprehensive answers. Overall, students with moderate abilities demonstrate a good understanding of physics concepts and can follow lessons well. They have quite good analytical skills and consistently deliver strong performance. These students are actively engaged in class discussions, able to solve most problems correctly, and require minimal additional guidance to understand more complex concepts. They show confidence in their learning and can effectively connect theory with practice.

Profile of High-Ability Students

Students with high abilities, who have a minimum score above 75 based on diagnostic test results and 81-100 based on formative tests, demonstrate a deep and comprehensive understanding of physics material. They can tackle complex problems and apply physics concepts in various situations. Their grades are usually above average, often reaching the highest marks in the class. Factors that support high ability include deep interest in the subject, highly effective learning methods, and strong support from teachers and family (Payaprom & Payaprom, 2020). In vibration, wave, and superposition material, students with high abilities demonstrate a very deep understanding of these basic concepts. They can explain and define vibrations and waves very well, and understand the concept of superposition down to more complex details. Their behavior reflects high self-confidence in solving problems, including those that require the application of more difficult concepts (Odden et al., 2019). These students often act as leaders in group discussions and can provide appropriate, complete answers and accompanied by logical explanations.

Overall, high-ability students demonstrate a deep and comprehensive understanding of physics material. They have highly effective learning strategies, show a deep interest in the subject, and receive strong support from teachers and family. These students can work on complex problems, apply physics concepts in a variety of situations, and often achieve the highest grades in class. Their behavior reflects independence, self-confidence, and high analytical skills, as well as the ability to act as a leader and source of reference for classmates.

Feedback and Future Learning Plans for Very Low-Ability Students

For students with very low abilities in physics, teachers will employ an individualized approach and provide intensive mentoring. This approach involves individual tutoring sessions or intensive guidance focused on the student's specific needs. Additionally, teacher-led small group discussions will be used to provide more attention to these students. The use of additional resources, such as video-format materials, simulations, or interactive applications, is also highly recommended to facilitate an understanding of complex physics concepts (Susac et al., 2018). Detailed and frequent feedback, including explanations of mistakes made and guidance on how to correct them, is essential to help students understand and improve concepts they have not yet mastered (Atasoy & Kaya, 2022). A clear rubric and detailed guide steps will be used to complete the assignment, allowing students to follow each step more easily (Lockyer & Sargeant, 2022). Collaboration between students and small group discussions will be used to solve problems together, providing opportunities for students to learn from their classmates (Zhong & Wang, 2021). In addition, online resources will be utilized for interactions outside the classroom, so students can access additional materials and communicate with teachers or classmates whenever necessary (Pürbudak & Usta, 2021). With this approach, it is hoped that very low-ability students can increase their understanding of physics concepts and improve their academic performance.

Feedback and Future Learning Plans for Low-Ability Students

For students with low ability in physics, the approach used will be similar to that for very low-ability students, but with certain adjustments. The focus will be more on small group discussions guided by the teacher to facilitate understanding and knowledge sharing between students. The use of additional resources, such as videos, simulations, or interactive applications, will still be employed, but not as intensively as with students who have very low abilities (López & Mazarío, 2016). Detailed and frequent feedback is provided, emphasizing understanding of difficult physics concepts and providing concrete suggestions for improvement. Students will be encouraged to ask questions and participate actively in group discussions, allowing them to learn from their peers (Charalambous & Praetorius, 2022; Liu, 2022). The next learning plan will involve repeating basic concepts in more depth, accompanied by varied practice questions to strengthen understanding (Almuntasheri, 2023). Teachers will also provide clear assessment rubrics and step-by-step guides for certain assignments, allowing students to follow the completion process more easily (White et al., 2022). Additional support, such as short tutoring sessions or consultation time, will also be available for students who require further assistance. With this approach, it is hoped that students with low abilities can improve their understanding and academic performance in physics subjects.

Feedback and Future Learning Plans for Medium Ability Students

Students of moderate ability need additional challenges to develop a deeper understanding and expand their skills in physics. For this reason, subsequent learning plans will include additional material or more challenging projects, designed to deepen their understanding of the concepts they have learned. Assignments that expand and deepen concepts will be provided, along with more advanced discussions or group activities to further explore these concepts. Creative projects, such as experiments or presentations that make original and innovative use of physics concepts, will be designed to enable students to apply their knowledge in a practical way (Malinverni et al., 2021). In-depth and detailed feedback will be provided to maintain students' motivation and encourage them to think critically (Lipnevich & Smith, 2022). In addition, further guidance will be provided to help develop specific skills aligned with the student's interests and to offer additional support in areas where they demonstrate a special interest or talent (Serravallo, 2010; Spencer-Waterman, 2020). With this approach, it is hoped that students with moderate abilities can continue to develop, expand their knowledge, and improve their skills in physics.

Feedback and Future Learning Plans for High-Ability Students

For high-ability students, an in-depth, project-based learning approach is highly recommended. Future learning plans will involve the assignment of advanced projects or research designed to challenge and expand their understanding of physics material. Additional material or advanced topics that are not generally taught in class will be introduced to broaden their horizons (Afikah et al., 2022). Advanced discussions or debate forums on in-depth and challenging topics will encourage students to consider different perspectives, present complex arguments, and develop their critical thinking skills (White et al., 2022). A peer-to-peer learning approach will be utilized, allowing students to assist their peers in understanding difficult concepts and collaborating in a more in-depth exchange of ideas and problem-solving (Zhong & Wang, 2021). In addition, advanced technologies such as physics analysis software or sophisticated online platforms will be used for further exploration and learning, while access to online resources will support students' independent research and knowledge development (Stanja et al., 2023). With this approach, it is hoped that students with high abilities can continue to enhance their understanding, explore concepts more deeply, and apply their knowledge in more innovative and creative ways.

Theoretical, Empirical Contributions, and Research Limitations

This research provides a theoretical contribution by strengthening the understanding of the importance of implementing learning strategies that are responsive to students' individual needs, particularly in the context of physics education. The findings support educational theories that emphasize adaptive and formative learning as critical pathways to improving student learning outcomes. Compared to previous studies that have focused primarily on either differentiated instruction or formative assessment in isolation, this research offers a novel integration of both through the DIFAM. The uniqueness of DIFAM lies in its structured application of multiple assessment types of diagnostics, formative, self-assessment, and peer-assessment throughout the learning process. This combination enables teachers to continuously monitor and respond to individual student needs with targeted instructional strategies and feedback, which is often overlooked in conventional assessment approaches.

Empirically, this study offers concrete evidence of the model's effectiveness in enhancing the learning achievement of students across a range of ability levels. It provides practical insights for educational practitioners by offering a replicable model that can be integrated into curriculum design. Unlike prior research that often evaluates assessment models with a focus on either summative outcomes or homogeneous student groups, this study highlights the importance of ongoing, individualized support and the value of feedback in real-time. Furthermore, DIFAM has been specifically designed and tested in the context of physics learning, a subject often perceived as abstract and difficult, thus adding to the limited body of research on differentiated assessment strategies in science education.

Despite its strengths, this study has several limitations. The relatively limited student sample may not fully represent the diversity of the broader student population, and the short duration of implementation may affect the generalizability and sustainability of the findings. Thus, future research is encouraged to involve more diverse samples across multiple regions and extend the study duration to further examine the long-term impact and adaptability of the DIFAM model. Additionally, follow-up studies could investigate how technology can be leveraged to scale and support the implementation of DIFAM in resource-constrained environments.

CONCLUSION

The findings of this study indicate that the Differentiated Instruction Formative Assessment Model (DIFAM) holds significant implications for enhancing the quality of learning in schools. This model integrates various forms of assessment, including diagnostic tests, formative assessments, self-assessments, and peer assessments, with a focus on evaluating student understanding through pre-tests and post-tests. One of the main features of DIFAM is its ability to categorize students' ability profiles from very low to high, allowing teachers to implement instructional approaches tailored to the students' level of understanding and analytical skills. With its logical and empirically grounded structure, DIFAM has proven to be effective in improving student learning achievement. However, the successful implementation of this model depends significantly on the shared commitment and responsibility between teachers and students in consistently managing the learning process. Teachers are required to actively identify students' strengths and weaknesses to ensure instruction is truly adaptive to individual needs.

Practically, this study contributes to guiding teachers in using assessment not only for grading but also as a means to support and direct student learning. For schools, DIFAM offers a more inclusive and equitable approach to classroom assessment. Theoretically, DIFAM enriches the discourse on formative assessment and differentiated instruction by presenting a structured and measurable framework. Nevertheless, this study has certain limitations, particularly in its sample scope, which only involved students from one city, thereby limiting the results less generalizable to broader populations. Additionally, implementing DIFAM requires adequate time and resources, which may present challenges for schools with limited capacity.

Therefore, future research is encouraged to expand the scope of the subject by involving more schools from diverse regions and educational levels to test the effectiveness and adaptability of the model in various contexts. Further studies could also explore the integration of digital technologies in the implementation of DIFAM to enhance the efficiency of the assessment process. Moreover, it is important to assess the impact of DIFAM not only on cognitive achievement but also on students' critical thinking, problem-solving, and creativity. In conclusion, DIFAM has the potential to be an innovative assessment model that not only enhances learning outcomes but also supports the comprehensive development of 21st-century competencies.

DISCLOSURE STATEMENT

The authors declare that they have no conflicts of interest to disclose.

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ETHICS APPROVAL

This study complied with ethical standards and data privacy regulations. All data were used solely for research, kept confidential, and handled securely.

REFERENCES

Abtokhi, A., Jatmiko, B., & Wasis, W. (2021). Evaluation of self-regulated learning on problem-solving skills in online basic physics learning during the Covid-19 pandemic. *Journal of Technology and Science Education*, *11*(2), 541–555. https://doi.org/10.3926/jotse.1205

Afikah, A., Rohaeti, E., & Jumadi, J. (2022). Innovative learning in improving high-order thinking skills and communication skills: A systematic review. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2229–2234. https://doi.org/10.29303/jppipa.v8i5.2091

Alhameedyeen, R. A. B. (2023). Exploring faculty perspectives on implementing differentiated instruction. *International Journal of Education in Mathematics, Science and Technology*, *12*(2), 318–333. https://doi.org/10.46328/ijemst.3964

Almuntasheri, S. (2023). The impact of a formative assessment-based inquiry model on science student understanding and explanations of chemical and physical changes. *Problems of Education in the 21st Century*, *81*(6), 729–741. https://doi.org/10.33225/pec/23.81.729

Atasoy, V., & Kaya, G. (2022). Formative assessment practices in science education: A meta-synthesis study. *Studies in Educational Evaluation*, *75*(2), 1–12. https://doi.org/10.1016/j.stueduc.2022.101186

Awofala, A. O. A., & Lawani, A. O. (2020). Increasing mathematics achievement of senior secondary school students through differentiated instruction. *Journal of Educational Sciences*, *4*(1), 1–19. https://doi.org/10.31258/jes.4.1.p.1-19

Bal, A. P. (2023). Assessing the impact of differentiated instruction on mathematics achievement and attitudes of secondary school learners. *South African Journal of Education*, *43*(1), 1–10. https://doi.org/10.15700/saje.v43n1a2065

Black, P., & Wiliam, D. (2018). Classroom assessment and pedagogy. *Assessment in Education: Principles, Policy and Practice*, *25*(6), 551–575. https://doi.org/10.1080/0969594X.2018.1441807

Box, C. (2019). *Formative assessment in united states classrooms: Changing the landscape of teaching and learning*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-03092-6

Charalambous, C. Y., & Praetorius, A. K. (2022). Synthesizing collaborative reflections on classroom observation frameworks and reflecting on the necessity of synthesized frameworks. *Studies in Educational Evaluation*, *75*(4), 1–11. https://doi.org/10.1016/j.stueduc.2022.101202

Creswell, J. W. (2022). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications.

Cynthia, C., Arafah, K., & Palloan, P. (2023). Development of interactive physics e-module to improve critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3943–3952. https://doi.org/10.29303/jppipa.v9i5.2302

Davis, T. C., & Autin, N. P. (2020). The cognitive trio: Backward design, formative assessment, and differentiated instruction. *Research Issues in Contemporary Education*, *5*(2), 55–70. https://www.leraweb.net/ojs/index.php/RICE/article/view/9

Dochy, F. J. R. C., Moerkerke, G., & Martens, R. (1996). Integrating assessment, learning and instruction: Assessment of domain-specific and domain-transcending prior knowledge and progress. *Studies in Educational Evaluation*, *22*(4), 309–339. https://doi.org/10.1016/0191-491X(96)00018-1

Durward, D., Blohm, I., & Leimeister, J. M. (2020). The nature of crowd work and its effects on individuals' work perception. *Journal of Management Information Systems*, *37*(1), 66–95. https://doi.org/10.1080/07421222.2019.1705506

Frey, N., & Fisher, D. (2011). *The formative assessment action plan: Practical steps to more successful teaching and learning*. ASCD.

Gregory, R. J. (2015). Psychological testing: History, principles and applications. *Pearson Education* (Seventh). Pearson Education.

Hadi, S., Ismara, K. I., & Tanumihardja, E. (2015). Pengembangan sistem tes diagnostik kesulitan belajar kompetensi dasar kejuruan siswa SMK. *Jurnal Penelitian dan Evaluasi Pendidikan*, *19*(2), 168–175. https://doi.org/10.21831/pep.v19i2.5577

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1). https://doi.org/10.1119/1.18809

Hake, R. R., & Reece, J. (1999). *Analyzing change/gain scores*. American Education Research Association's Division D, Measurement and Research Methodology.

Heritage, M. (2010). *Formative assessment: Making it happen in the classroom*. Corwin.

Joseph, A. A., & Winberg, C. (2024). Inclusive formative assessment in work-integrated learning from the perspectives of students with disabilities. *International Journal of Work-Integrated Learning*, *25*(1), 141–154.

Juman, Z. A. M. S., Mathavan, M., Ambegedara, A. S., & Udagedara, I. G. K. (2022). Difficulties in learning geometry component in mathematics and active-based learning methods to overcome the difficulties. *Shanlax International Journal of Education*, *10*(2), 41–58. https://doi.org/10.34293/education.v10i2.4299

Kelly, A. E. (2013). When is design research appropriate? In T. Plomp & N. Nieveen (Eds.), *Educational design research* (pp. 134–151). Netherlands Institute for Curriculum Development. http://international.slo.nl/publications/edr/

Khajuria, G., & Khan, N. (2021). Literature review of instruments measuring organisational commitment. *Journal of Positive School Psychology*, *2022*(3), 1352–1365. https://www.journalppw.com/index.php/jpsp/article/view/1665

Kiray, S. A., & Simsek, S. (2021). Determination andevaluation of the science teacher candidates' misconceptions about density by using four-tier diagnostic test. *International Journal of Science and Mathematics Education*, *19*(5), 935–955. https://doi.org/10.1007/s10763-020-10087-5

Koksalan, S., & Ogan-Bekiroglu, F. (2024). Examination of effects of embedding formative assessment in inquiry-based teaching on conceptual learning. *Science Insights Education Frontiers*, *20*(2), 3223–3246. https://doi.org/10.15354/sief.24.or512

Kusairi, S. (2013). Analisis asesmen formatif fisika SMA berbantuan komputer. *Jurnal Penelitian dan Evaluasi Pendidikan*, *16*(3), 68–87. https://doi.org/10.21831/pep.v16i0.1106

Lipnevich, A. A., & Smith, J. K. (2022). Student – feedback interaction model: Revised. *Studies in Educational Evaluation*, *75*(September), 1–11. https://doi.org/10.1016/j.stueduc.2022.101208

Liu, J. (2022). Exploring the dynamic self-assessment process of students across different competency groups. *Studies in Educational Evaluation*, *75*, 1–9. https://doi.org/10.1016/j.stueduc.2022.101215

Lockyer, J., & Sargeant, J. (2022). Multisource feedback: An overview of its use and application as a formative assessment. *Canadian Medical Education Journal*, *13*(4), 30–35. https://doi.org/10.36834/cmej.73775

López, A. G., & Mazarío, F. G. (2016). The use of technology in a model of formative assessment. *Journal of Technology and Science Education*, *6*(2), 91–103. https://doi.org/10.3926/jotse.190

Malinverni, L., Valero, C., Schaper, M. M., & de la Cruz, I. G. (2021). Educational Robotics as a boundary object: Towards a research agenda. *International Journal of Child-Computer Interaction*, *29*(1), 1–13. https://doi.org/10.1016/j.ijcci.2021.100305

Marinescu, G., Tudor, V., Mujea, A.-M., & Băisan, C. (2014). The improvement of strength in mentally disabled pupils through the use of differentiated instruction in the physical education lesson. *Procedia - Social and Behavioral Sciences*, *117*, 529–533. https://doi.org/10.1016/j.sbspro.2014.02.257

Marks, A., Woolcott, G., & Markopoulos, C. (2021). Differentiating instruction: Development of a practice framework for and with secondary mathematics classroom teachers. *International Electronic Journal of Mathematics Education*, *16*(3), 1–19. https://doi.org/10.29333/iejme/11198

Means, B., & Neisler, J. (2021). Teaching and learning in the time of Covid: The student perspective. *Online Learning Journal*, *25*(1), 8–27. https://doi.org/10.24059/olj.v25i1.2496

Mngomezulu, H., Ramaila, S., & Dhurumraj, T. (2022). Pedagogical strategies used to enact formative assessment in science classrooms: Physical sciences teachers' perspectives. *International Journal of Higher Education*, *11*(3), 158-167. https://doi.org/10.5430/ijhe.v11n3p158

Morris, R., Perry, T., & Wardle, L. (2021). Formative assessment and feedback for learning in higher education: A systematic review. *Review of Education*, *9*(3), 1–26. https://doi.org/10.1002/rev3.3292

Mumthas, N., & Abdulla, S. U. (2019). Substandard performance in mathematical problem solving in physics among higher secondary school students in Kerala - An investigation on teacher perceptions and student difficulties. *Issues and Ideas in Education*, *7*(1), 35–43. https://doi.org/10.15415/iie.2019.71005

Munfaridah, N., Avraamidou, L., & Goedhart, M. (2021). The use of multiple representations in undergraduate physics education: What do we know and where do we go from here? *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(1), 1–19. https://doi.org/10.29333/ejmste/9577

Ningsi, A. P., & Nasih, R. (2020). Mendeskripsikan keterampilan proses sains mahasiswa pendidikan fisika universitas Jambi pada metari pembiasan pada lensa cembung dengan menggunakan e-modul. *Jurnal Penelitian Dan Pembelajaran MIPA*, *5*(1), 1–9. https://jurnal.um-tapsel.ac.id/index.php/eksakta/article/view/1160

Odden, T. O. B., Lockwood, E., & Caballero, M. D. (2019). Physics computational literacy: An exploratory case study using computational essays. *Physical Review Physics Education Research*, *15*(2), 1–22. https://doi.org/10.1103/PhysRevPhysEducRes.15.020152

Osuafor, A. M., & Okigbo, E. C. (2013). Effect of differentiated instruction on the academic achievement of Nigerian secondary school biology students. *Educational Research*, *4*(7), 555–560. https://www.interesjournals.org/articles/effect-of-differentiated-instruction-on-the-academic-achievement-of-nigerian-secondary-school-biology-students.pdf

Palieraki, S., & Koutrouba, K. (2021). Differentiated instruction in information and communications technology teaching and effective learning in primary education. *European Journal of Educational Research*, *10*(3), 1487–1504. https://doi.org/10.12973/EU-JER.10.3.1487

Payaprom, S., & Payaprom, Y. (2020). Identifying learning styles of language learners: A useful step in moving towards the learner-centred approach. *Journal of Language and Linguistic Studies*, *16*(1), 59–72. https://doi.org/10.17263/JLLS.712646

Plomp, T. (2013). Educational design research: An introduction. In T. Plomp & N. Nieveen (Eds.), *Educational design research* (pp. 10–51). Netherlands Institute for Curriculum Development. http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766

Pürbudak, A., & Usta, E. (2021). Collaborative group activities in the context of learning styles on web 2.0 environments: An experimental study. *Participatory Educational Research*, *8*(2), 407–420. https://doi.org/10.17275/per.21.46.8.2

Retnawati, H., Kartowagiran, B., Arlinwibowo, J., & Sulistyaningsih, E. (2017). Why are the mathematics national examination items difficult and what is teachers' strategy to overcome it? *International Journal of Instruction*, *10*(3), 257–276. https://doi.org/10.12973/iji.2017.10317a

Röck, M., Saade, M. R. M., Balouktsi, M., Rasmussen, F. N., Birgisdottir, H., Frischknecht, R., Habert, G., Lützkendorf, T., & Passer, A. (2020). Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. *Applied Energy*, *258*(3), 1–12. https://doi.org/10.1016/j.apenergy.2019.114107

Sagi, D., Spitzer-Shohat, S., Schuster, M., Daudi, L., & Rudolf, M. C. J. (2021). Teaching plain language to medical students: Improving communication with disadvantaged patients. *BMC Medical Education*, *21*(1), 407. https://doi.org/10.1186/s12909-021-02842-1

Saleh, M. A., Quazi, A., Keating, B., & Gaur, S. S. (2017). Quality and image of banking services: A comparative study of conventional and Islamic banks. *International Journal of Bank Marketing*, *35*(6), 878–902. https://doi.org/10.1108/IJBM-08-2016-0111

Serravallo, J. (2010). *Teaching reading in small groups: Differentiated instruction for building strategic, independent readers*. HEINEMANN.

Soeharto, S. (2021). Development of a diagnostic assessment test to evaluate science misconceptions in terms of school grades: A Rasch measurement approach. *Journal of Turkish Science Education*, *18*(3), 351–370. https://doi.org/10.36681/tused.2021.78

Spencer-Waterman, S. (2020). Types and examples of differentiated assessments. *Differentiating assessment in middle and high school mathematics and science* (pp. 11–32). Routledge. https://doi.org/10.4324/9781315854281-2

Stanja, J., Gritz, W., Krugel, J., Hoppe, A., & Dannemann, S. (2023). Formative assessment strategies for students' conceptions—The potential of learning analytics. *British Journal of Educational Technology*, *54*(1), 58–75. https://doi.org/10.1111/bjet.13288

Susac, A., Planinic, M., Klemencic, D., & Milin Sipus, Z. (2018). Using the Rasch model to analyze the test of understanding of vectors. *Physical Review Physics Education Research*, *14*(2), 1–6. https://doi.org/10.1103/PhysRevPhysEducRes.14.023101

Swaffield, S., & Rawi, R. (2023). Assessment for learning. *International encyclopedia of education* (4th ed.), pp. 21-34. https://doi.org/10.1016/B978-0-12-818630-5.09011-4

Thapliyal, M., Ahuja, N. J., Shankar, A., Cheng, X., & Kumar, M. (2022). A differentiated learning environment in domain model for learning disabled learners. *Journal of Computing in Higher Education*, *34*(1), 60–82. https://doi.org/10.1007/s12528-021-09278-y

Tomlinson, C. A. (2017). *How to differentiate instruction in academically diverse classrooms* (3rd ed., Vol. 3). Association for Supervision and Curriculum Development.

White, M., Luoto, J., Klette, K., & Blikstad-Balas, M. (2022). Bringing the conceptualization and measurement of teaching into alignment. *Studies in Educational Evaluation*, *75*(2), 1–8. https://doi.org/10.1016/j.stueduc.2022.101204

Xuan, Q., Cheung, A., & Sun, D. (2022). The effectiveness of formative assessment for enhancing reading achievement in K-12 classrooms: A meta-analysis. *Frontiers in Psychology*, *13*(August), 1–17. https://doi.org/10.3389/fpsyg.2022.990196

Zhong, B., & Wang, Y. (2021). Effects of roles assignment and learning styles on pair learning in robotics education. *International Journal of Technology and Design Education*, *31*(1), 41–59. https://doi.org/10.1007/s10798-019-09536-2