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Comprehensive Assessment of Teaching Methods, Student Worksheet, Student Participation and Feedback in the Physics Classroom

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ABSTRACT

Effective learning in the context of physics is a growing challenge. This study aims to conduct a comprehensive evaluation of the relationship between teachers' teaching methods, the use of student worksheets, student participation, and the use of feedback in physics classes. Fifty-three respondents from four high schools in West Sumatra Province, Indonesia, participated in the study. Multiple linear regression analysis was used to explore the relationship between variables. The results showed that teachers' teaching methods (such as giving students daily problems and instructions for project assignments) had a significant relationship with student worksheets and participation. The use of student worksheets, both for project assignments and out-of-class practicum, was also positively correlated with student participation. Student participation in class contributes significantly to using feedback. However, no significant relationship was found between teaching methods and the use of student worksheets to the use of feedback, emphasizing that active student participation is key to improving the effectiveness of feedback in physics learning. Thus, this study contributes theoretically to the understanding of physics learning and offers practical insights for educators in designing more meaningful learning experiences for students.

INTRODUCTION

Physics education plays an important role in shaping students' understanding of fundamental scientific principles and their application in everyday life (Fadillah & Sahyar, 2023; Putri et al., 2024). Effective teaching methods are essential to engage students and encourage a deeper understanding of concepts. Traditional lecture-based teaching methods are often criticized for lacking interaction and engagement, thus encouraging educators to explore more dynamic and student-centered approaches (Usmeldi, 2015). One such approach involves using student worksheets, which serve as a structured guide for students during lessons (AS et al., 2024; Bakri et al., 2020; Kirschner et al., 2006). Student worksheets are

designed to facilitate active learning by providing step-by-step instructions and exercises that help students apply theoretical knowledge in a practical context (Sari et al., 2019). Studies have shown that student worksheets can improve problem-solving and critical thinking skills, encourage independent learning, and contribute to good learning outcomes (Kusumawati et al., 2020; Yanto, 2019).

Student participation is another critical factor in effective physics education. Active participation in class discussions and activities helps students better understand and remember information (Dallimore et al., 2004). It also encourages critical thinking and allows students to articulate their thoughts and questions, leading to a more interactive and engaging learning environment (Blyznyuk & Kachak, 2024). Research shows that students who are actively involved in their learning process tend to perform better academically and develop more positive attitudes towards the subject matter (Lin & Hou, 2024). Feedback is another important aspect of the learning process, providing students with insight into their performance and areas for improvement (Gomis et al., 2024). Effective feedback helps students correct their mistakes, improve their understanding, and achieve higher academic success. Teachers play an important role in providing constructive feedback that is timely, specific, and actionable (Kim et al., 2024). The relationship between feedback and student performance has been widely documented, with studies highlighting its importance in closing learning gaps and promoting continuous improvement.

While the importance of each of these elements in education has been recognized, a significant gap exists in understanding the interrelationships and combined impact of teaching methods, student worksheet use, student participation, and feedback utilization in high school physics classes. Existing research often addresses these variables in isolation, thus failing to capture the complexity and dynamic interactions in the classroom environment (Emiliannur et al., 2017; Festiyed et al., 2022; Kusmaryono & Wijayanti, 2023; Novitra et al., 2021). First, it is necessary to assess how the teaching methods applied by teachers affect students' use of student worksheets. Effective teaching methods present content and encourage active use of resources such as student worksheets, which can enhance understanding through guided practice and application. Student-centered teaching, such as inquiry-based and collaborative learning, can increase students' engagement with student worksheets and make them more active in learning (Strat et al., 2023; Urdanivia Alarcon et al., 2023). Understanding this relationship is important, as the effectiveness of student worksheets as a learning tool depends partly on how it is integrated and used within a teaching framework (Kirschner et al., 2006). Research shows that teaching approaches that facilitate active interaction and reflection can optimize the use of student worksheets and improve student learning outcomes (Hmelo-Silver et al., 2007). In addition, teacher involvement in providing constructive feedback and support as students use student worksheets can strengthen their understanding of the concepts learned (Kim et al., 2024). Thus, careful assessment of the teaching methods is necessary to ensure that student worksheets are used effectively as an integral part of a dynamic and interactive learning process.

Secondly, evaluating the relationship between using student worksheets and student participation in class is important. Student worksheets are designed to promote engagement, but their impact on participation levels needs to be investigated in depth. Active participation is a key indicator of student engagement and has been linked to better academic outcomes (Freeman et al., 2014). Research shows that well-structured student worksheets can increase student participation by allowing students to interact with content more deeply and actively

(Belland et al., 2017; Kusumawati et al., 2020). In addition, student worksheets that integrate collaborative elements and group discussions can improve students' communication and engagement in the learning process (Johnson et al., 2014). Active participation improves conceptual understanding and helps students develop important social and teamwork skills (Blyznyuk & Kachak, 2024; Hmelo-Silver et al., 2007). By examining this relationship, educators can better understand how to structure student worksheets to maximize student engagement and learning outcomes and identify best practices in their implementation to support more interactive and collaborative learning environments.

Third, assessing how student participation affects the utilization of feedback to reach the right answer is critical. Participation often results in immediate feedback opportunities through teacher-student interactions or peer-to-peer discussions. Effective feedback utilization, facilitated by active participation, can significantly improve students' learning and ability to correct and learn from mistakes (Dallimore et al., 2004). Research shows that feedback provided in the context of active participation is more likely to be well received and processed by students, thus encouraging deep reflection and continuous improvement (Gomis et al., 2024; Shute, 2008). In addition, feedback in collaborative situations and group discussions can enrich students' understanding through multiple perspectives and problem-solving approaches (Aoun et al., 2018; Nicol & Macfarlane-Dick, 2006). Students who are actively engaged in the classroom tend to be more responsive to feedback as they are more motivated and committed to their learning process (Black & Wiliam, 2009; Wisniewski et al., 2020). Therefore, to maximize feedback benefits, educators must create a learning environment that encourages active participation and meaningful interaction.

Finally, there needs to be a comprehensive evaluation of the overall relationship between teaching methods and the use of student worksheets to student participation and feedback utilization. By understanding how these elements interact, educators can develop more effective teaching strategies that utilize each component to improve overall learning outcomes (Usmeldi et al., 2017). Innovative and student-centered teaching methods, such as problem-based and inquiry learning, can increase the use of student worksheets by making students more engaged and interactive. The active participation resulting from these methods also promotes more effective utilization of feedback, as engaged students tend to be more responsive to feedback and more motivated to correct their mistakes. In addition, well-designed student worksheets can facilitate greater participation and interaction, creating a positive learning cycle where students continue to participate and receive constructive feedback actively. The intertwined relationship between these variables suggests that improvements in one area can trigger improvements in other areas, creating a holistic approach to physics education that is more effective and sustainable. Therefore, thoroughly evaluating and integrating these strategies is essential to achieve optimal learning outcomes.

Given the importance of these factors, this study aims to evaluate their impact on physics education in high schools comprehensively. The research seeks to explore the interplay between several key elements of the learning process to enhance teaching effectiveness and improve student outcomes. Firstly, the study will assess the relationship between teachers' teaching methods and students' use of student worksheets. This investigation aims to understand how instructional strategies influence engagement with these learning tools, which are crucial for structuring student learning activities. Secondly, the research will examine the relationship between the use of student worksheets and student participation in class. By exploring this connection, the study seeks to uncover how these

worksheets foster active student involvement during lessons, a critical component of effective learning. Thirdly, the study will assess the relationship between student participation in class and the use of feedback. Feedback is an essential element of the learning process, and this analysis will help determine how active participation can influence, and be influenced by, the quality and frequency of feedback provided. Lastly, the research will analyze the combined relationship between teaching methods, the use of student worksheets, student participation, and the application of feedback. This holistic approach aims to identify best practices that effectively integrate these components to optimize learning environments in physics education. By examining these interrelationships, this study seeks to fill existing research gaps and provide a deeper understanding of the dynamics within high school physics education. Ultimately, the findings aim to offer practical insights that can guide educators in improving teaching strategies and fostering better learning outcomes.

METHODS

Participants

The data were gathered from four West Sumatra Province, Indonesia high schools. An online questionnaire was constructed using Google Forms, and the link was disseminated via social media groups, such as WhatsApp. The sample was selected using the convenience sampling method, and 53 students (aged 14-18 years) participated in the study, comprising 33.96% males and 66.04% females (Table 1). A statement of consent was included at the outset of the questionnaire to ensure the participants felt comfortable and were participating in the study voluntarily. It informed them of the study's purpose and their right to withdraw at any time, and it was clear from their responses that all students had filled it in without coercion. There were no incomplete or duplicate data sets, so all the responses were used for data analysis.

Table 1. Demographics

Criteria	Items	Frequency	Percentage
Gender	Male	18	33.96%
	Female	35	66.04%
Grade	X	12	22.64%
	XI	22	41.51%
	XII	19	35.85%

While the number of respondents in this study was only 53, the data collected from the four schools were considered adequate to provide comprehensive results. The selected schools were chosen to represent a diverse cross-section of the student population in the area. This sampling strategy aimed to capture a wide range of perspectives and experiences, thus enhancing the generalizability of the findings. Previous studies have shown that meaningful insights can be derived even with a limited number of respondents if the sample is representative and the data collection methods are rigorous (Kalafatis & Ledden, 2013; O'Connor & Mahony, 2023; Shakroum et al., 2018). In line with these precedents, the current study's methodology was designed to ensure the robustness and reliability of the results despite the modest sample size. Furthermore, an online questionnaire distributed via social media allowed a broader reach within the targeted population (Putranto, 2019). This method

facilitated easy access for students, contributing to a higher response rate and reducing potential biases related to accessibility (Dutwin & Buskirk, 2023).

Measurement

The measurement is done through four main variables: the teacher's teaching method, the use of student worksheets, student participation, and the use of feedback. These variables were selected based on their relevance to educational practices and potential impact on student outcomes. We employed a four-point Likert scale, consisting of "strongly disagree" (1), "disagree" (2), "agree" (3), and "strongly agree" (4), allowing respondents to express their opinions honestly and accurately, thus strengthening criterion validity (Taherdoost, 2022).
To ensure the robustness of our measurement instruments, we used SmartPLS (V.4) to conduct a confirmatory factor analysis of each variable utilized in this study. The results of this analysis are presented in Table 2 and indicate that all items used have strong psychometric properties, aligning with recommendations from the literature (Dash & Paul, 2021; Hair et al., 2019, 2020, 2021). Specifically, all items demonstrated good factor loadings, with values exceeding 0.50, a common threshold for indicating adequate item performance. Additionally, the composite reliability (CR) and Cronbach's alpha (CA) for all variables showed values greater than 0.60, reflecting a high level of internal consistency in the measurements. It suggests that the items within each variable reliably measure the same underlying construct. The average variance extracted (AVE) for each variable also exceeded the value of 0.60, confirming that a substantial amount of variance in the items is accounted for by the latent construct they are intended to measure. It further supports the adequacy of our measurement model's reliability and validity, enhancing the credibility of the data for subsequent analyses.

Table 2. Properties of Research Instruments

Variables	Codes	Items	Outer Loading	CR	CA	AVE
Teacher's Teaching Method	TTM1	The teacher presents everyday problems that we have to solve while learning physics	0.928	0.861	0.865	0.768
	TTM2	After learning physics, the teacher instructs us to do project work	0.821			
Use of Student Worksheets	USW1	I use the Student Worksheet to facilitate the completion of project assignments	0.792	0.797	0.798	0.665
	USW2	I use the Student Worksheets as a guide or instructions for carrying out practicum or observation outside the classroom	0.837			

Variables	Codes	Items	Outer Loading	CR	CA	AVE
Student Participation	SPT1	I enjoy participating in class discussions to understand physics concepts	0.619	0.846	0.856	0.604
	SPT2	I am happy when I get the opportunity to answer questions from both the teacher and friends	0.912			
	SPT3	My physics teacher allowed me to express my opinion	0.840			
	SPT4	I can convey my ideas and opinions clearly when involved in problem-solving	0.705			
Use of Feedback	UFB	I can use feedback to get accurate answers	1.000	1.000	1.000	1.000

Data Analysis

Data analysis was conducted using SPSS (V.22). This software was selected due to its comprehensive statistical capabilities and user-friendly interface, making it well-suited for our analytical needs. SPSS was employed to identify the relationships between the teacher's teaching method, student worksheets, student participation, and feedback through multiple regression analysis (univariate) utilizing the ENTER model. This model was chosen because it allows for a thorough examination of the relationships between the independent and dependent variables, providing a deeper understanding of the patterns and findings of this study. Multiple regression analysis explored how each independent variable contributes to the dependent variable (Nayebi, 2020). By using the ENTER method, we could assess each predictor's unique contribution while controlling for the others, thus offering a more comprehensive insight into the dynamics at play. These analyses provided valuable information about the impact of teaching methods, student worksheets, participation, and feedback on educational outcomes, which can inform future educational practices and policies.

RESULTS AND DISCUSSION

This study aims to evaluate teaching methods, the use of student worksheets, student participation, and the use of feedback in physics classes. In the following discussion, we will outline the findings from the multiple linear regression test, which includes the Coefficient (B) value to measure the influence of each independent variable, the standard error (SE) to indicate the level of uncertainty, as well as the significance to assess the influence of the independent variables statistically. In addition, the summary output will include R-square and F-values to test the overall model and its significance, thus providing a comprehensive picture of how these factors influence physics learning.

The Relationship Between Teachers' Teaching Methods and Student Worksheets

The results of the analysis of the relationship between teacher teaching methods (TTM1-TTM2) and student worksheet usage (USW1-USW2) are presented in Table 3, showing that the teacher teaching methods variable explains 43.3% and 72.3% of the variation in the student worksheet usage variable, with a highly statistically significant F value ($p < 0.001$). The teacher teaching method has two main dimensions measured in this study, namely TTM1 (giving daily problems for students to solve) and TTM2 (instructing students to do project work after learning physics). Both dimensions have different relationships with the use of student worksheets. The first dimension, TTM1, which emphasizes giving students everyday problems, is positively related to using student worksheets as a guide for practicum or observation outside the classroom (USW2). It is because methods that encourage students to apply knowledge in everyday situations will trigger the need to use student worksheets to record their observations and problem-solving.

Table 3. The Results of the Analysis of The Teacher's Teaching Method and Student Worksheets

Codes	USW1		USW2	
	B	SE	B	SE
TTM1	0.200	0.177	0.800***	0.118
TTM2	0.477**	0.155	0.083	0.103
Output Summary				
USW1: R-square=0.433, F=19.124***				
USW2: R-square=0.723, F=65.274***				

Note: **$p < 0.01$, ***$p < 0.001$.

Meanwhile, the second dimension, TTM2, which includes instructions to students to work on project tasks after learning physics, has a different relationship with the use of student worksheets. This instruction was positively associated with the increased use of student worksheets to facilitate the completion of project tasks (USW1). This is understandable as project tasks tend to require good organization and meticulous record keeping, which can be facilitated by using student worksheets as a tool to plan and record the steps in completing the project.

These results align with previous research highlighting the importance of using student-oriented teaching methods and learning aids in enhancing students' learning experience (Asrizal et al., 2023; Novitra et al., 2021; Usmeldi et al., 2017). Previous research has shown that student-oriented teaching methods, such as project-based learning or cooperative learning, can increase students' motivation, understanding, and engagement in learning (Barron & Darling-Hammond, 2008; Johnson et al., 2014). In addition, the importance of using learning aids, such as student worksheets, to support effective learning has also been emphasized in previous literature (Musante & DeWalt, 2010).

Thus, these findings provide new insights into the relationship between teachers' teaching methods and student worksheet usage in the context of physics learning. It reinforces the urgency for teachers to choose appropriate methods and use relevant learning aids to enhance student learning. By understanding the impact of teaching methods on student worksheet usage, teachers can be more effective in designing learning experiences that meet needs and facilitate the achievement of learning objectives.

The Relationship Between Student Worksheets and Student Participation

The results of the relationship analysis between the use of student worksheets (USW1-USW2) and student participation (SPT1-SPT4) are presented in Table 4, showing that the student worksheet use variable explained 35.7% to 63.4% of the variation in the student participation variable, with a highly statistically significant F value ($p < 0.001$). The use of student worksheets to facilitate the completion of project tasks (USW1) had a fairly strong impact on two aspects of student participation, namely SPT2 (happy when getting the opportunity to answer questions from the teacher and friends) and SPT3 (feeling allowed to express opinions).

Table 4. The Results of the Analysis Between Student Worksheets and Student Participation

Codes	SPT1		SPT2		SPT3		SPT4	
	B	SE	B	SE	B	SE	B	SE
USW1	0.164	0.176	0.279*	0.110	0.317*	0.144	0.065	0.145
USW2	0.602**	0.185	0.575***	0.115	0.430**	0.152	0.710***	0.152
Output Summary								
SPT1: R-square=0.357, F=13.874***								
SPT2: R-square=0.634, F=43.263***								
SPT3: R-square=0.430, F=18.842***								
SPT4: R-square=0.470, F=22.190***								

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

The positive effect of using student worksheets in this context may result from several factors. Previous research suggests that the use of student worksheets can assist students in preparing and planning project tasks better, increasing their confidence in completing such tasks (Kusumawati et al., 2020; Yanto, 2019). Students who feel more confident in completing project tasks tend to be more motivated to actively participate in class discussions (Lin & Hou, 2024). In addition, using student worksheets can also create a supportive classroom environment where students feel more valued and encouraged to express their opinions (Rimm-Kaufman et al., 2009). It is important as it allows students to feel more comfortable interacting with the teacher and classmates, ultimately increasing their participation in class discussions (Deci & Ryan, 2000). Thus, the use of student worksheets has the potential to not only improve students' academic outcomes but also reinforce a positive classroom climate.
Furthermore, the use of student worksheets as a guide for practicum or observation outside the classroom (USW2) also had a significant impact, especially on four aspects of student participation: SPT1 (enjoying participating in class discussions to understand physics concepts), SPT2, SPT3, and SPT4 (being able to convey ideas and opinions clearly when engaged in problem-solving).

In this context, the positive influence of using student worksheets may be because practicum or observation outside the classroom often provides opportunities for students to engage in more practical and applied learning activities (Usmeldi, 2015). Using student worksheets as a guide, students can be more focused on understanding the concepts taught in class and applying them in a real context outside the classroom (Kohtamäki et al., 2012). It improves their understanding of the subject matter and enhances their communication skills and ability to convey ideas and opinions clearly when engaging in problem-solving (Kusumawati et al., 2020; Sari et al., 2019; Yanto, 2019). Therefore, using student worksheets

in this context can encourage students' participation in class discussions and improve the quality of their contributions to overall physics learning.

Thus, these findings suggest that student worksheets play an important role in shaping students' participation in physics learning, both in the context of project task completion and in practical experiences outside the classroom. Therefore, considering using student worksheets as a tool in designing effective learning strategies can be important for educators to improve the quality of learning and student achievement in physics.

The Relationship Between Students' Participation and the Use of Feedback

The results of the analysis of the relationship between student participation (SPT1-SPT4) and the use of feedback (UFB) are presented in Table 5, showing that the student participation variable explains 72.4% of the variation in the use of feedback variable, with a highly statistically significant F value ($p < 0.001$). The analysis results show that SPT1, SPT3, and SPT4 have a positive and significant influence on the use of feedback, while SPT2 has a negative and insignificant influence.

Table 5. The Results of The Analysis of Student Participation and the Use of Feedback

Codes	UFB	
	B	SE
SPT1	0.247**	0.087
SPT2	-0.076	0.144
SPT3	0.430**	0.126
SPT4	0.380**	0.104
Output Summary		
UFB: R-square=0.724, F=31.523***		

Note: **$p < 0.01$, ***$p < 0.001$.

These findings highlight the importance of student participation in improving the effectiveness of using feedback in the learning process. First, the positive relationship between SPT1 (enjoying participating in class discussions to understand physics concepts) and the use of feedback suggests that students who are active in discussions tend to be more open to feedback provided by the teacher. When students feel comfortable and excited to participate in discussions, they are more receptive and appreciative of teacher feedback (Kim et al., 2024), thus increasing positive interactions between students and teachers in the learning process.

Furthermore, the finding that SPT3 (feeling allowed to express opinions) has a significant positive influence on the use of feedback suggests that creating a classroom environment that supports self-expression can increase the effectiveness of feedback. When students feel that their opinions are valued and cared for by the teacher, they are likelier to take the feedback well and use the information to improve their understanding. Positive interactions between teachers and students, which include respect for students' opinions, are an important factor in improving the effectiveness of feedback in the learning process (Hattie & Timperley, 2007; Wisniewski et al., 2020).

Meanwhile, the positive influence of SPT4 (conveying ideas and opinions clearly when engaging in problem-solving) on feedback highlights the importance of communication skills in facilitating an effective learning process. When students can convey their ideas and opinions clearly, teachers can provide feedback that is more targeted and beneficial to the development of students' understanding. Good communication skills enable students to

convey their thoughts clearly and effectively to teachers and fellow students (Khoiriah et al., 2023). It creates an environment where feedback can be given more appropriately, and students can more easily interpret and apply the feedback to improve their understanding of physics learning (Panadero & Lipnevich, 2022; Wisniewski et al., 2020).

Thus, these findings not only confirm the importance of student participation in improving the effectiveness of feedback use in physics learning but also highlight some specific factors that may influence the relationship between student participation and feedback use. Understanding these dynamics can assist educators in designing more effective learning strategies and improving students' learning experience in physics.

The Overall Relationship Between Variables

We also analyzed the relationship between teaching methods and student worksheet use on student participation and feedback in physics learning to provide important insights into the complex dynamics involved in the learning process. The analysis is important because it provides information on how the factors are interrelated and delves deeper into the influence of each variable on student participation and feedback use. In this analysis, we formed elements such as giving students everyday problems (TTM1), instructions to do project work after learning physics (TTM2), use of student worksheets for project work (USW1), and use of student worksheets as a guide for practicum or observation outside the classroom (USW2) into one overall variable to determine the important role of each item on student participation and use of feedback. The analysis results are presented in Table 6, where the overall variable explained 39.45% to 70.1% of the variation. The F value was highly statistically significant ($p < 0.001$), indicating that a holistic learning approach, which integrates various teaching methods and tools such as student worksheets, can significantly influence student engagement in learning.

Table 6. The Results of the Analysis Between Teaching Methods and the Use of Student Worksheets on Student Participation and the Use of Feedback

Codes	SPT1		SPT2		SPT3		SPT4		UFB	
	B	SE	B	SE	B	SE	B	SE	B	SE
TTM1	0.489	0.305	0.464*	0.177	0.320	0.247	0.012	0.241	0.093	0.273
TTM2	-0.035	0.208	0.053	0.120	0.141	0.168	0.387*	0.164	0.152	0.185
USW1	0.170	0.189	0.253*	0.110	0.261	0.153	-0.076	0.149	0.158	0.169
USW2	0.222	0.284	0.170	0.165	0.097	0.230	0.504*	0.224	0.344	0.254
Output Summary										
SPT1: R-square=0.396, F=7.853***										
SPT2: R-square=0.701, F=28.176***										
SPT3: R-square=0.479, F=11.051***										
SPT4: R-square=0.542, F=14.206***										
UFB: R-square=0.395, F=7.846***										

Note: *$p < 0.05$, ***$p < 0.001$.

It is important to note that the findings show that TTM1 (giving students everyday problems to solve) and TTM2 (instructing students to do project work after learning physics) have a significant influence on certain aspects of student participation, namely SPT2 (happy when getting the opportunity to answer questions from teachers and friends) and SPT4 (able

to convey ideas and opinions clearly when engaged in problem-solving). It highlights the importance of presenting problems relevant to everyday life and providing clear instructions to students to stimulate their active learning participation. When students are presented with challenges that they find meaningful and relevant to their daily experiences, as in TTM1, they tend to feel more engaged and motivated. These problems allow students to see a direct connection between the material they are learning and its practical application in real life, thus increasing their interest and engagement in class discussions (Irfandi et al., 2023). In addition, when students are given clear directions about the project task, as in TTM2, they can better understand what is expected of them and how they should do it. These clear instructions reduced confusion and increased students' confidence in completing the task, increasing their participation in discussions and other classroom activities.

In addition, the finding that the use of student worksheets to facilitate the completion of project tasks (USW1) and as guides for practicum or observation outside the classroom (USW2) also had a significant influence on student participation, particularly in SPT2 and SPT4, suggests that the use of aids such as student worksheets can be an important factor in stimulating student engagement in learning. The student worksheets used to facilitate the completion of project tasks (USW1) assisted students in planning and organizing their work more effectively. With structured guidance, students can better understand the steps required to complete the task, which increases their confidence and participation (Almasri, 2022). In addition, these worksheets provide a clear framework for students to follow, thus reducing confusion and increasing learning effectiveness. Using worksheets as a guide for practicum or observation outside the classroom (USW2) is also important as it provides students with clear guidance on what to observe and record during practicum activities. This guide not only assists students in directing their attention to important aspects of the experiment or observation but also encourages them to participate actively in practical activities (Sari et al., 2019; Usmeldi, 2015). Thus, students feel more engaged in learning and can better convey their ideas and opinions clearly when problem-solving, as reflected in SPT4. These findings suggest that a learning approach incorporating problems relevant to daily life, clear instructions, and tools such as worksheets can significantly improve students' participation in physics learning.

However, a surprising finding was that none of the items from the overall variables significantly influenced the use of feedback. A plausible explanation is that feedback cannot be directly influenced by teaching methods or student worksheets but depends on students' active participation in the learning process (Aoun et al., 2018). In this context, the finding in Table 5 that student participation significantly influences the use of feedback confirms the importance of evoking students' active participation as the first step to improving the effectiveness of feedback used in learning. Previous research has shown that student engagement in the learning process is a key factor in the effectiveness of feedback. For example, Hattie and Timperley (2007) explained in their study that feedback is more effective when students are actively involved in learning and when the feedback is focused on specific tasks related to students' understanding and skills. In this case, students' active participation allows them to receive and internalize the feedback more meaningfully, thus improving their understanding and performance.

Furthermore, Wisniewski et al. (2020) suggested that effective feedback should involve students in self-evaluation and improvement. Active participation in learning encourages students to be more reflective and critical of their work, making teacher feedback more

relevant and useful (Blyznyuk & Kachak, 2024). This study's finding that student participation significantly influences the use of feedback supports this view, suggesting that active participation is necessary for feedback to have the desired impact.

In addition, Nicol and Macfarlane-Dick (2006) emphasize that feedback should be an integral part of the ongoing learning dialogue between teachers and students. Students' active participation creates an environment where this dialog can flourish, allowing feedback to be received and used more effectively. In physics learning, where concepts are often complex and require deep understanding, active participation is essential to ensure that feedback can assist students in improving their understanding and overcoming difficulties encountered (Novitra et al., 2021). A study by Wagner et al. (2024) also found that students actively engaged in learning tend to be more responsive to formative feedback, which is feedback given to help them improve their performance during the learning process. It is in line with the findings of this study, where student participation significantly affects the use of feedback, suggesting that teaching methods and student worksheets need to be geared towards increasing student engagement before feedback can be effective. In the context of this study, teaching methods such as the provision of everyday problems (TTM1) and instructions for project tasks (TTM2), as well as the use of student worksheets for project tasks (USW1) and as guides for practicum (USW2), are all designed to increase student participation. However, students must first be actively engaged in learning for feedback to be well received and utilized by students. Educators should focus on strategies that encourage active participation as a prerequisite for effective use of feedback.

Overall, the results of this analysis make an important contribution to our understanding of the factors that influence student participation and feedback used in physics learning. Understanding the interrelationships between teaching methods, the use of student worksheets, student participation, and the use of feedback can assist educators in designing more effective learning strategies and improving students' learning experience in the subject of physics. In addition, the results of this study emphasize that students' active participation is key to improving the effectiveness of feedback in physics learning. Teaching methods and tools such as student worksheets can help increase participation. However, the full impact of feedback can only be achieved when students are actively involved in the learning process. By understanding this linkage, educators can design more effective learning strategies, which increase student participation and ensure that feedback is used in ways that are most beneficial to students' academic development.

Implications and Limitations

This study has several important implications for educational practice, particularly in teaching physics in senior high schools. Firstly, the findings confirm the importance of implementing teaching methods that focus on providing everyday problems and project instruction. These methods proved effective in increasing students' use of student worksheets, which, in turn, increased students' participation in class. Teachers can utilize these results to design teaching strategies that are more interesting and relevant to student's daily lives, thus encouraging them to be more active and engaged in the learning process. Secondly, the use of student worksheets is proven to have a significant impact on student participation. These worksheets help students plan and organize their work and increase their confidence and ability to participate in class actively. Student worksheets are effective learning tools and must be integrated more widely into the physics curriculum. Thus, schools and educators need to

consider investing in developing and providing quality student worksheets that meet learning needs. Third, the finding that student participation significantly influences the effectiveness of using feedback emphasizes the importance of creating a classroom environment that supports active participation. Teachers should focus on strategies encouraging student participation, such as providing opportunities for students to discuss, express opinions, and engage in problem-solving. This active participation improves student understanding and makes feedback more meaningful and useful. Therefore, training teachers in classroom management techniques to encourage active participation is very important.

This study also has some limitations that need to be considered. First, using a convenience sampling method with a limited sample size may limit the generalizability of the findings. The sample taken from four high schools in West Sumatra Province may only partially represent the student population in other areas. Therefore, the results of this study should be interpreted with caution. Secondly, this study used an online survey design, which, although efficient, has limitations in ensuring the accuracy and honesty of respondents' responses. Students gave expected or not entirely honest answers, which may affect the validity of the data. In addition, the online survey may only reach students with adequate internet access or devices, thus reducing the inclusiveness of the sample. Third, this study did not examine other variables affecting student worksheet use, student participation, and feedback use, such as student intrinsic motivation, teacher communication skills, and school infrastructure support. These variables could be important factors affecting learning outcomes and must be considered in further research. Fourthly, this study is cross-sectional, meaning data was collected at one specific time (Maier et al., 2023). This design limits the ability to observe changes and developments in student worksheet use, student participation, and feedback effectiveness over time. Longitudinal studies are needed to evaluate the long-term impact of teaching methods and student worksheet use on student learning. By understanding these implications and limitations, educators and researchers can design more effective learning strategies and develop more comprehensive follow-up research to improve the quality of physics education in high schools.

CONCLUSION

This study showed a significant relationship between teachers' teaching methods and the use of student worksheets, between the use of student worksheets and student participation, and between student participation and the use of feedback. Specifically, teaching methods that focused on providing daily problems and project instruction were shown to increase the use of student worksheets, which in turn contributed to increased student participation in the class. Active student participation in the classroom positively influenced the effectiveness of feedback use, but teaching methods and student worksheet use only directly influenced feedback use with active student participation. It suggests that active student participation is key to improving the effectiveness of feedback, emphasizing the need for teaching strategies that encourage student engagement as an important prerequisite. Overall, a learning approach that integrates various teaching methods and student worksheets can significantly improve student engagement and effective use of feedback in physics learning.

REFERENCES

Almasri, F. (2022). Simulations to Teach Science Subjects: Connections Among Students' Engagement, Self-Confidence, Satisfaction, and Learning Styles. *Education and Information Technologies*, *27*(5), 7161–7181.

Aoun, C., Vatanasakdakul, S., & Ang, K. (2018). Feedback for thought: examining the influence of feedback constituents on learning experience. *Studies in Higher Education*, *43*(1), 72–95.

AS, N., Handayani, P., & Hidayati, -. (2024). Increasing Student Activity Through The Implementation Of Limited-Time Practice Questions In Physics Learning. *Jurnal Penelitian Pembelajaran Fisika*, *10*(1), 56.

Asrizal, A., N, A., Festiyed, F., Ashel, H., & Amnah, R. (2023). STEM-integrated physics digital teaching material to develop conceptual understanding and new literacy of students. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(7), em2289.

Bakri, F., Permana, H., Wulandari, S., & Muliyati, D. (2020). Student worksheet with AR videos: Physics learning media in laboratory for senior high school students. *Journal of Technology and Science Education*, *10*(2), 231.

Barron, B., & Darling-Hammond, L. (2008). Teaching for Meaningful Learning: A Review of Research on Inquiry-Based and Cooperative Learning. Book Excerpt. *George Lucas Educational Foundation*.

Belland, B. R., Walker, A. E., & Kim, N. J. (2017). A Bayesian Network Meta-Analysis to Synthesize the Influence of Contexts of Scaffolding Use on Cognitive Outcomes in STEM Education. *Review of Educational Research*, *87*(6), 1042–1081.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, *21*(1), 5–31.

Blyznyuk, T., & Kachak, T. (2024). Benefits of Interactive Learning for Students' Critical Thinking Skills Improvement. *Journal of Vasyl Stefanyk Precarpathian National University*, *11*(1), 94–102.

Dallimore, E. J., Hertenstein, J. H., & Platt, M. B. (2004). Classroom participation and discussion effectiveness: student-generated strategies. *Communication Education*, *53*(1).

Dash, G., & Paul, J. (2021). CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting. *Technological Forecasting and Social Change*, *173*, 121092.

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, *11*(4), 227–268.

Dutwin, D., & Buskirk, T. D. (2023). A Deeper Dive into the Digital Divide: Reducing Coverage Bias in Internet Surveys. *Social Science Computer Review*, *41*(5), 1902–1920.

Emiliannur, E., Hamidah, I., Zainul, A., & Wulan, A. R. (2017). Using Performance Assessment Model in Physics Laboratory to Increase Students' Critical Thinking Disposition. *Journal of Physics: Conference Series*, *895*, 012143.

Fadillah, M. A., & Sahyar, S. (2023). Development of Higher Order Thinking Skills (HOTS) Test Instruments on Parabolic and Circular Motion Materials in High Schools. *Berkala Ilmiah Pendidikan Fisika*, *11*(3), 329–338.

Festiyed, F., Novitra, F., Yohandri, Y., & Asrizal, A. (2022). Networked-based Inquiry: An Effective Physics Learning in the New Normal COVID-19 Era in Indonesia. *International Journal of Instruction*, *15*(2), 997–1016.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415.

Gomis, K., Saini, M., Arif, M., & Pathirage, C. (2024). Enhancing the assessment and the feedback in higher education. *Quality Assurance in Education*, *32*(2), 165–179.

Hair, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of Business Research*, *109*, 101–110.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. Springer International Publishing.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24.

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, *42*(2), 99–107.

Irfandi, I., Sudarma, T. F., Festiyed, F., Yohandri, Y., Diliarosta, S., Surahman, D., & Siregar, A. M. (2023). E-learning and Physics Teaching Materials Based on Malay Ethnoscience on the East Coast. *Jurnal Pendidikan IPA Indonesia*, *12*(3), 366–376.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching*, *25*(4), 1–26.

Kalafatis, S., & Ledden, L. (2013). Carry-over effects in perceptions of educational value. *Studies in Higher Education*, *38*(10), 1540–1561.

Khoiriah, K., Suyatna, A., Abdurrahman, A., & Jalmo, T. (2023). Reviewing of Indonesian students' scientific communication skills: A structural equation modeling analysis. *International Journal of Evaluation and Research in Education (IJERE)*, *12*(1), 292.

Kim, J., Li, X., & Bergin, C. (2024). Characteristics of effective feedback in teacher evaluation. *Educational Assessment, Evaluation and Accountability*, *36*(2), 201–223.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*, *41*(2), 75–86.

Kohtamäki, M., Kraus, S., Mäkelä, M., & Rönkkö, M. (2012). The role of personnel commitment to strategy implementation and organisational learning within the relationship between strategic planning and company performance. *International Journal of Entrepreneurial Behavior & Research*, *18*(2), 159–178.

Kusmaryono, I., & Wijayanti, D. (2023). Exploration of Students' Mathematics Learning Experiences and Engagement Outside the Classroom. *International Journal of Education*, *16*(2), 75–84.

Kusumawati, T. R. D., Supeno, & Lesmono, A. D. (2020). Student worksheet based on inquiry with vee map to improve writing skills in physics learning. *Journal of Physics: Conference Series*, *1465*(1), 012034.

Lin, Y.-C., & Hou, H.-T. (2024). The evaluation of a scaffolding-based augmented reality educational board game with competition-oriented and collaboration-oriented mechanisms: differences analysis of learning effectiveness, motivation, flow, and anxiety. *Interactive Learning Environments*, *32*(2), 502–521.

Maier, C., Thatcher, J. B., Grover, V., & Dwivedi, Y. K. (2023). Cross-sectional research: A critical perspective, use cases, and recommendations for IS research. *International Journal of Information Management*, *70*, 102625.

Nayebi, H. (2020). *Multiple Regression Analysis* (pp. 1–46).

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199–218.

Novitra, F., Festiyed, F., Yohandri, Y., & Asrizal, A. (2021). Development of Online-based Inquiry Learning Model to Improve 21st-Century Skills of Physics Students in Senior High School. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(9), 1-20.

O'Connor, Y., & Mahony, C. (2023). Exploring the Impact of Augmented Reality on Student Academic Self-Efficacy In Higher Education. *Computers in Human Behavior*, *149*, 107963.

Panadero, E., & Lipnevich, A. A. (2022). A Review of Feedback Models and Typologies: Towards an Integrative Model of Feedback Elements. *Educational Research Review*, *35*, 100416.

Putranto, L. S. (2019). The Use of An Online Survey to Speed Up the Data Collection Process. *IOP Conference Series: Materials Science and Engineering*, *508*, 012013.

Putri, A. P., Darvina, Y., Desnita, -, Gusnedi, -, & Amir, H. (2024). Validity and Practicality of Student Worksheet on Project-Based Learning Based Renewable Energy Material for Phase E. *Jurnal Penelitian Pembelajaran Fisika*, *10*(1), 1.

Sari, Y. S., Selisne, M., & Ramli, R. (2019). Role of Students Worksheet in STEM Approach to Achieve Competence of Physics Learning. *Journal of Physics: Conference Series*, *1185*, 012096.

Shakroum, M., Wong, K. W., & Fung, C. C. (2018). The influence of Gesture-Based Learning System (GBLS) on Learning Outcomes. *Computers & Education*, *117*, 75–101.

Shute, V. J. (2008). Focus on Formative Feedback. *Review of Educational Research*, *78*(1), 153–189.

Strat, T. T. S., Henriksen, E. K., & Jegstad, K. M. (2023). Inquiry-Based Science Education in Science Teacher Education: A Systematic Review. *Studies in Science Education*, 1–59.

Taherdoost, H. (2022). What Is the Best Response Scale for Survey and Questionnaire Design; Review of Different Lengths of Rating Scale/Attitude Scale/Likert Scale. *International Journal of Academic Research in Management*, *8*(1), 1–10.

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023). Science and Inquiry-Based Teaching and Learning: A Systematic Review. *Frontiers in Education*, *8*.

Usmeldi, U. (2015). The Effectiveness of Physics Based Research in Learning Engineering Physics. *Jurnal Pendidikan IPA Indonesia*, *4*(1), 79–85.

Usmeldi, U., Amini, R., & Trisna, S. (2017). The Development of Research-Based Learning Model with Science, Environment, Technology, and Society Approaches to Improve Critical Thinking of Students. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 318.

Wagner, S., Sibley, L., Weiler, D., Burde, J.-P., Scheiter, K., & Lachner, A. (2024). The More, the Better? Learning with Feedback and Instruction. *Learning and Instruction*, *89*, 101844. https://doi.org/10.1016/j.learninstruc.2023.101844

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The Power of Feedback Revisited: A Meta-Analysis of Educational Feedback Research. *Frontiers in Psychology*, *10*.

Yanto, F. (2019). Development of Problem-Based Student Worksheet with Authentic Assessment to Improve Student's Physics Problem Solving Ability. *Journal of Physics: Conference Series*, *1185*, 012075.