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ORIGINAL ARTICLE

Computer-assisted Formative Feedback: Perspectives of Physics Students and Teachers - A Comprehensive Needs Analysis

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ABSTRACT

In physics learning that emphasizes a student-centered approach, formative feedback strategically improves students' conceptual understanding and learning motivation. However, implementing feedback in the learning environment still faces various obstacles, including time constraints, many students, and a lack of personalization in its delivery. Previous studies generally focus on developing media or feedback delivery models but pay little attention to analyzing student needs as a basis for system design. This study offers a novel contribution by examining students' needs for computer-based formative feedback in physics learning as a basis for developing a contextual and adaptive system. The main objectives of this study are to identify the interests and needs of students and teachers concerning the application of computer-assisted formative feedback, particularly in physics learning. This study used a descriptive survey method with a quantitative and qualitative approach, involving 104 high school students and 30 physics teachers in East Java Province. The research instruments comprised a Likert scale questionnaire and open-ended questions that experts had validated. The results showed that students and teachers agreed that digital feedback could improve conceptual understanding and motivation. However, there is still a gap in perception regarding the level of student independence in accessing and utilizing the feedback. Students tend to choose a simple multiple-choice test model, while teachers prefer an isomorphic test model with high diagnostic power. The type of feedback considered most effective by students and teachers is the interactive and video-based feedback model because it is considered more interesting, easy to understand, and positively impacts the learning process. This study contributes to developing a computer-based feedback system more responsive to user needs and encourages teachers to integrate digital media into physics learning practices more effectively and adaptively.

KEY WORDS: Computer-assisted, formative feedback, high school students, needs analysis, physics teachers

INTRODUCTION

In the context of student-centered learning, feedback is an inseparable element of the continuous evaluation process. Feedback plays a significant role in supporting the effectiveness of the learning process. It aligns with the constructivist learning approach that emphasizes the importance of feedback in actively building knowledge. As one of the key components in formative assessment, feedback provides clear information about student learning outcomes and offers concrete directions for improving learning (Molin et al., 2021). In addition to being beneficial for students, teachers can use feedback as a basis for reflecting and evaluating the learning strategies that have been implemented (Molin et al., 2021). In other words, feedback is a two-way tool supporting both parties in teaching and learning.

Through appropriate feedback, students can be encouraged to improve their learning process, set more focused learning goals, and enhance metacognitive awareness (Enu, 2021; Mejeh et al., 2024). Cavalcanti et al. (2021) emphasized that feedback provides opportunities for students to develop knowledge and skills that are not yet optimal. Furthermore, several studies have shown that feedback positively contributes to improving conceptual understanding (Khusaini et al., 2025; Waskito et al., 2022) and can increase student motivation and engagement in the learning process (Aslam et al., 2021; Aslam et al., 2021). Therefore, the application of feedback should be designed appropriately and contextually. Thus, feedback's strategic role lies in conveying information and in its capacity to foster reflective, adaptive, and meaningful learning experiences.

Various techniques can be applied to provide formative feedback that enhances the effectiveness of the learning process. One developing method is offering instant feedback through digital systems, such as smartphone applications, where feedback is automatically generated based on students' responses to multiple-choice questions (Molin et al., 2021). The feedback should be constructive to optimally achieve learning objectives, including specific directions and instructions, while using simple and clear language for students to grasp (Fong et al., 2024). In addition to this method, feedback can be structured in a loop model consisting of four main components: goals, tools, data, and inferences, which systematically guide students in reflection and improvement (Ole and Gallos, 2023). Furthermore, verbally delivered corrective feedback remains relevant, especially in direct and interactive learning contexts (Pasha et al., 2023). The diversity of these methods indicates that the provision of formative feedback must be tailored to the characteristics of the learning context, the media used, and the needs of students.

The implementation of formative feedback in learning still faces several significant obstacles. One of the main challenges is the limited learning time, particularly in classes with many students, which makes it difficult for teachers to provide comprehensive and individualized feedback (Maulidiani Rahma et al., 2020; Suryadi and Kusairi, 2021). In addition, delivering real-time and personalized feedback to each student is a complex issue, even in higher education (Tsai et al., 2020). In practice, the feedback given is often not easily understood by students; it is delivered too briefly and tends to be negative without offering clear directions for improvement (Burke, 2009). Other obstacles include the characteristics of the feedback itself, the delivery method, and the limited resources available (Adarkwah, 2021). For example, the results of multiple-choice tests are generally presented only in the form of percentages or final scores without accompanying in-depth explanations of the concepts that students have not mastered (Branaghan et al., 2021). Given these various challenges, innovative efforts are needed to overcome the barriers to applying formative feedback so that the feedback provided can effectively and meaningfully support the learning process.

To overcome these various obstacles, computers have great potential as a solution for implementing formative feedback in learning. Computer-assisted feedback offers many advantages, including improving the quality of feedback and making it easier for teachers to deliver feedback efficiently, especially in time-limited conditions (Đorić et al., 2021). In addition, computer technology allows for automatic and instant feedback, which contributes directly to improving student understanding. Kuklick et al. (2023) stated that automated feedback could support the assessment process effectively in the context of learning. Therefore, using computer systems and online platforms to deliver formative feedback opens up significant opportunities and is worthy of further research. However, developing a computer-based feedback system to present narrative and in-depth explanations requires a complex process and a relatively long development time (Branaghan et al., 2021). Thus, selecting media forms and types of feedback is an important aspect that must be considered in designing computer-assisted formative feedback to suit the needs of students and learning objectives.

Numerous studies have been conducted on computer-assisted formative feedback. Lachner et al. (2017) explored three different methods of providing computer-assisted feedback in a large class, revealing that feedback delivered through a specific concept map effectively enhanced students' ability to provide cohesive explanations. Suryadi and Kusairi (2021) advanced the concept of computer-assisted formative feedback by incorporating interactive student feedback. In addition, web-based formative feedback tools utilizing isomorphic questions were developed by Kusairi (2020). Many research publications have also addressed effective feedback design's theoretical frameworks and practical applications (Fuentes-Cimma et al., 2024). However, a review of the existing literature indicates that most studies have predominantly concentrated on developing feedback models and media. At the same time, analyzing student needs as a foundation for designing formative feedback has been somewhat overlooked. For instance, a study by Paterson et al. (2020) found that the quality of feedback is evaluated based on its clarity, timeliness, positive tone, and usefulness. However, the influence of student and teacher interests and needs on the quality of feedback has not been explained in detail. Similar research has been conducted by Haughney et al. (2020) found that the provision of quality feedback is influenced by factors such as timeliness, material specificity, and optimization of student engagement in the learning process. Therefore, it is important for current research to analyze how student and teacher interests and needs affect feedback preferences in learning. Future research should focus on explaining how feedback models based on interests and needs can improve the quality of feedback in the classroom. Consequently, this study introduces a novel approach by investigating student needs related to computer-assisted formative feedback. The findings aim to significantly contribute to the design of a feedback system that is more contextual, adaptive, and aligned with student needs.

This study aims to analyze the needs and interests of students regarding the application of computer-assisted formative feedback in physics learning. The primary objective is to comprehensively understand students' expectations and preferences concerning the design and implementation of effective and relevant formative feedback in their educational context. Specifically, this research addresses three key questions: (1) How do students and teachers perceive the use of computer-assisted formative feedback for learning physics today? (2) Which diagnostic test models (multiple choice or isomorphic) are considered most appropriate by students and teachers, and why? (3) Which feedback model is considered the most effective and preferred by students and teachers to support physics learning? What are the reasons for choosing one of the three options provided (text, interactive, or video)?

The results of this study will serve as the basis for developing formative feedback tailored to technological needs and developments that can support continuous learning. Implementing feedback in the learning cycle can include goal setting, tool selection, data collection, and interpreting results. This learning process can leverage developments in computer technology. Technology can facilitate the design and use of formative feedback for teachers and students. In addition, computer-assisted formative feedback aligns with self-regulated learning theory principles, which emphasize students' ability to independently monitor, evaluate, and regulate their learning strategies (Brenner, 2022). Thus, integrating formative feedback into technology can facilitate continuous physics learning and increase student engagement.

METHODS

The study was conducted across several schools in East Java, involving 104 high school students, 21 males and 83 females. The sample was selected using convenience sampling, considering the most accessible and available respondents at the time of the study. The survey encompassed three institutions: one public high school, one private high school, and one private Islamic high school. Given their varied characteristics and cultures, the selection of these three distinct schools aimed to yield more comprehensive and authentic results. The study included 30 physics teachers who are members of the subject teacher working group in physics.

The study gathered data using questionnaires featuring a Likert scale and open-ended questions supported by explanations. The research instrument was validated through a content validity process involving physics education experts who focus on physics learning assessment research. Thus, the questionnaire meets the specified quality standards and reliability. This tool was employed to assess the implementation of computer-assisted formative feedback in schools, determine the preferred diagnostic test models and the justifications for those choices, and identify the preferred forms of feedback and the corresponding reasons for their selection.

The study commenced with an explanation of computer-assisted formative feedback and the completion of a questionnaire regarding its implementation in schools. Respondents were also presented with several examples of computer-assisted formative feedback. The researchers demonstrated each formative feedback model to the respondents. The demonstration covered each component of the feedback in detail. Then, each respondent indicated which diagnostic test model they preferred and explained their reasons. They also indicated which feedback model they considered most effective and explained their reasons.

The prototype features two distinct diagnostic test models: the multiple-choice question model and the isomorphic question model. Multiple-choice questions consist of one question with five answer options, while isomorphic questions contain three questions, each with five answer options. The feedback includes three different models: text, interactive, and video. The text model offers feedback to students in the form of slides containing explanatory text. The interactive model delivers feedback in the form of true-false questions accompanied by discussions to enhance student understanding. The video model presents feedback through short videos with animations and verbal explanations. The subsequent step involves students completing a questionnaire about the diagnostic test model, the feedback model they are interested in, and their reasons. Data analysis was conducted using two distinct methods. Likert scale data were analyzed by calculating the percentage of responses given by respondents. Answers to open-ended questions were qualitatively analyzed with NVIVO and described in detail. The NVIVO analysis was conducted by displaying words that occurred frequently according to the respondents' answers. In addition, identical responses were grouped under specific codes. These codes were tailored to the variety of responses and validated by physics education experts.

RESULTS

Implementing formative feedback in the learning process is crucial, as it allows students to recognize their progress and correct mistakes. A survey was conducted to gather responses from students and teachers to assess the effectiveness of formative feedback implementation. Tables 1 and 2 present summary results from the questionnaire, reflecting students' perspectives on applying formative feedback in their schools. Table 1 provides data regarding students' views on implementing formative feedback.

The questionnaire results revealed that students frequently sought computer-assisted formative feedback online. Both students and teachers indicated that such feedback can enhance conceptual understanding and boost learning motivation. However, students believed they could not learn independently from formative feedback without teacher support. This perspective contrasts with the findings from the teacher questionnaire, which indicated that formative feedback can be utilized independently of teacher assistance. This discrepancy arises from students' lack of understanding regarding effectively implementing formative feedback in their learning processes. In addition, the findings suggest that while teachers can develop their computer-assisted formative feedback, it has not been optimally applied or implemented in physics learning.

Table 1: Summary of student questionnaire results

No	Question items	SA (%)	A (%)	DA (%)	SDA (%)
1	Computer-assisted tests and feedback are frequently utilized by teachers in the learning process.	4	66	25	5
2	I often come across computer-assisted text and explanations of physics lessons when searching for learning materials on the internet.	7	40	46	7
3	Computer-assisted testing and providing (explanation) is useful for improving students' understanding of physics concepts.	30	54	11	5
4	With tests and explanations provided by the computer, I can learn physics material independently without help from teachers.	3	26	51	20
5	Computer-assisted testing and offering explanations can enhance my learning motivation.	16	68	12	4

SA: Strongly agree, A: Agree, DA: Disagree, SDA: Strongly disagree

Responses to open-ended questions regarding how good computer-assisted formative feedback are presented in Figure 1.

Students and teachers expressed differing perceptions about effective formative feedback. Students believe that good formative feedback should incorporate computer-assisted digital technology. As a result, various opinions emerged regarding the development of formative feedback in the form of videos enhanced by animations, music, or specific instruments. Conversely, teachers feel that effective formative feedback should focus on providing guidance that enhances student learning with formative feedback. Despite these differing views, students and teachers agreed on the ease of using computer-assisted formative feedback. The study included a questionnaire analysis assessing interest in utilizing multiple-choice and isomorphic diagnostic tests. Students and teachers selected the model they found more effective for teaching physics in schools, providing justifications. A summary of the questionnaire results is displayed in Figure 2.

Table 2: Summary of teacher questionnaire results

No	Question items	SA (%)	A (%)	DA (%)	SDA (%)
1	Teachers often use computer-assisted formative feedback in physics education at school.	6	20	37	37
2	I often encounter computer-assisted formative feedback in Physics lessons while searching for information online.	7	36	37	20
3	I frequently use computer-assisted formative feedback to enhance my understanding of fundamental physics concepts.	17	13	40	30
4	Computer-assisted formative feedback effectively enhances students' understanding of physics concepts.	60	37	3	0
5	Students can learn about computer-assisted formative feedback independently, with little assistance from the teacher.	20	50	27	3
6	Computer-assisted formative feedback can enhance students' learning motivation.	30	70	0	0
7	I have incorporated computer-assisted formative feedback into physics learning.	7	23	37	33
8	I can create my own computer-assisted formative feedback.	7	46	20	27

SA: Strongly agree, A: Agree, DA: Disagree, SDA: Strongly disagree

Variations in preferences between students and teachers emerge when selecting a diagnostic test model. Students typically prefer a multiple-choice diagnostic test model, whereas teachers prefer an isomorphic one. Figure 3a and b illustrate the rationale behind the choices made by students and teachers when selecting a diagnostic test model.

Students choose multiple-choice diagnostic tests because they offer direct, simple, and easy-to-use explanations. They pay less attention to other aspects, such as the instrument's accuracy in measuring understanding. This differs from what the teacher conveyed: isomorphic questions were selected because they measure understanding more effectively, leading to more accurate results. The following are examples of quotes that reinforce the reasons given by students and teachers.

Student respondents:

> "*Using multiple choice makes it easier.*"
>
> "*After doing it, I receive feedback and an explanation.*"

Teacher respondents:

> "*When students give the wrong answer, they can try again until they get it right. This provides a better understanding than other models.*"

Figure 4 shows the diagnostic test display with formative feedback. Questions are given in multiple-choice format. The multiple-choice model uses one question per indicator. The Isomorphic model uses three questions per indicator.

The questionnaire analysis concerns using text, interactive, and video feedback models. Students and teachers explained why they selected a more effective feedback model for learning physics in school. Figure 5 summarizes the questionnaire results.

The feedback models most preferred by students and teachers show a similar trend. Video is the leading model

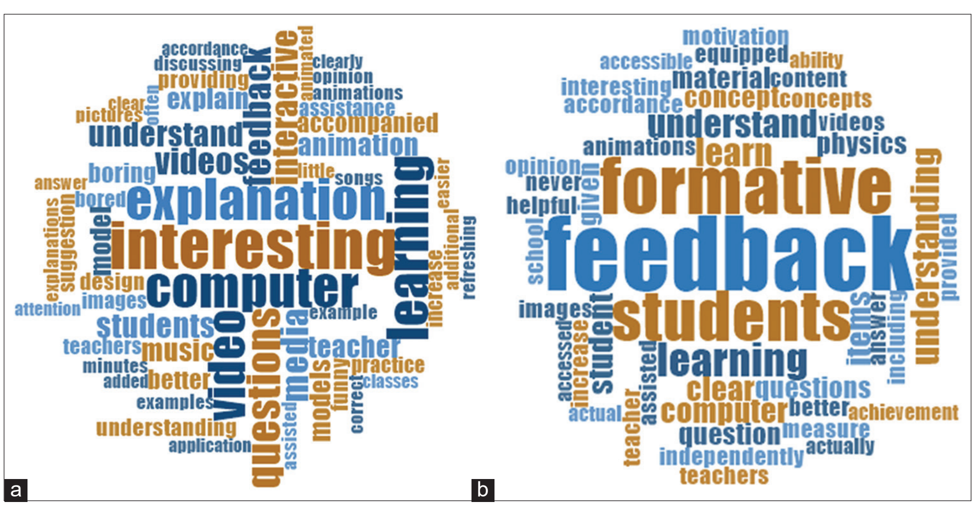

Figure 1: (a) Effective formative feedback as perceived by students. (b) Effective formative feedback from teachers

with the highest percentage. Both students and teachers also demonstrate a strong interest in interactive models. Other findings indicate that students and teachers favor the text feedback model less. The reasons behind the choice of effective feedback models, as identified by students and teachers, are illustrated in Figure 6.

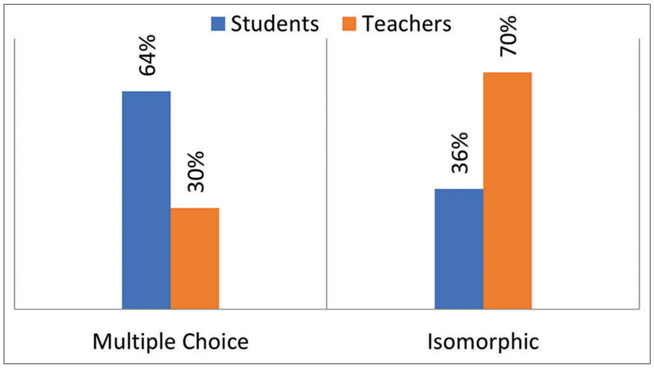

Figure 2: The percentage of respondents' interest in the diagnostic test model

The interactive model emphasizes the interaction process between students and media and engaging presentations. This aligns with the reasons provided by both students and teachers. Both groups also believe that the interactive model is easy to comprehend, enhances understanding, and that its application is effective and efficient. Students noted using true-false questions and animations in interactive media as advantages influencing their choice. In addition, suitability, ease, and learning motivation are specific reasons provided by teachers. Figure 7 shows the interactive feedback provided in the form of true-false questions accompanied by explanations.

Students and teachers expressed various arguments regarding their choice of video feedback. Video feedback includes

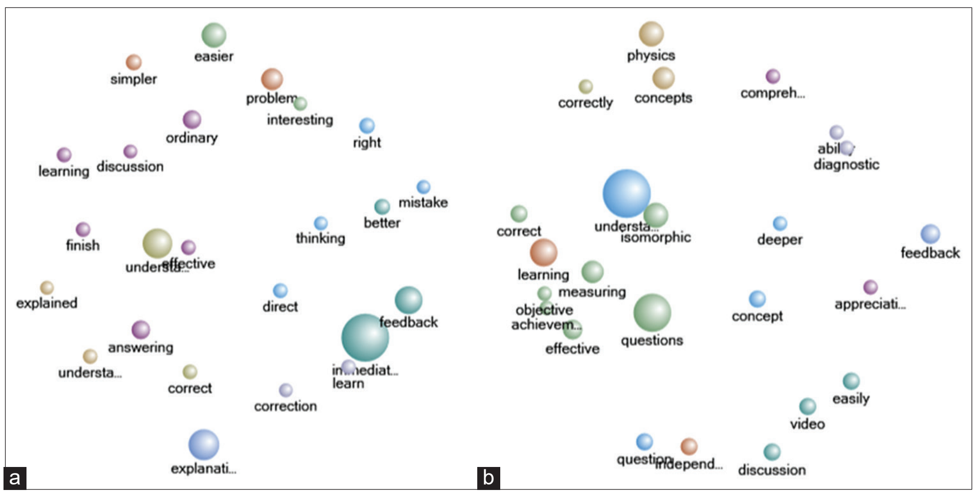

Figure 3: (a) Reasons students prefer multiple-choice format. (b) Reasons teachers choose isomorphic question forms

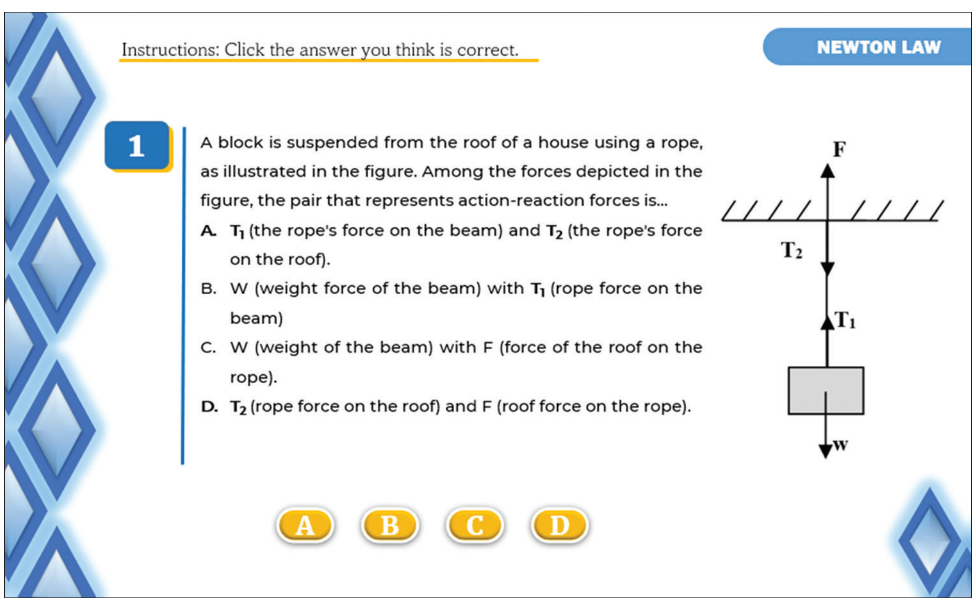

Figure 4: Diagnostic test display in formative feedback

material pages with animations and verbal explanations. Students specifically mentioned enjoying its engaging, fun, and complete nature. In addition, teachers emphasized the importance of literacy, suitability, and the user-friendly aspects of video feedback models. The following are examples of reasons given by students and teachers for choosing video feedback.

Students: "*Because the video model is more fun, interesting, and easier for viewers to understand.*"

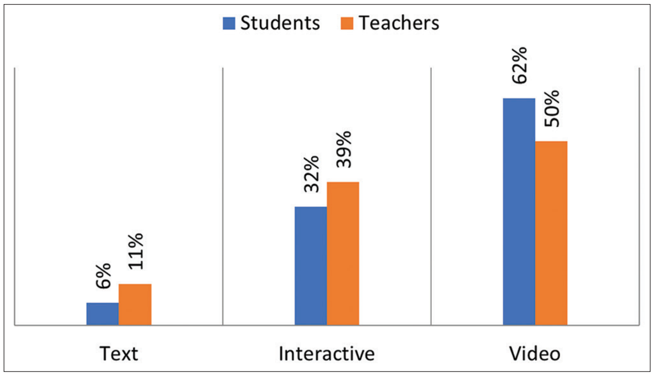

Figure 5: Respondents' interest in the feedback model (percentage)

Teachers: "*Because video feedback is more effective in terms of time usage, improves student literacy, and is easier for students.*"

Beyond these points, students and teachers share similar views on attractiveness, ease of understanding, effectiveness, enhancing comprehension, and alignment with diverse learning styles.

DISCUSSION

The study's results indicate that teachers and students consider formative feedback significant in supporting students' learning in physics. However, the study also revealed that using formative feedback in physics education was suboptimal. Teachers believe that students can use computer-assisted formative feedback models independently, while students feel that this type of feedback still requires teacher guidance. Regarding interest in the test model, the study highlights differences in the utilization and test models employed in formative feedback. Nonetheless, students and teachers are interested in the feedback model, particularly the interactive and video models. In this context, teachers and students express a similar desire for more interactive feedback and explanations

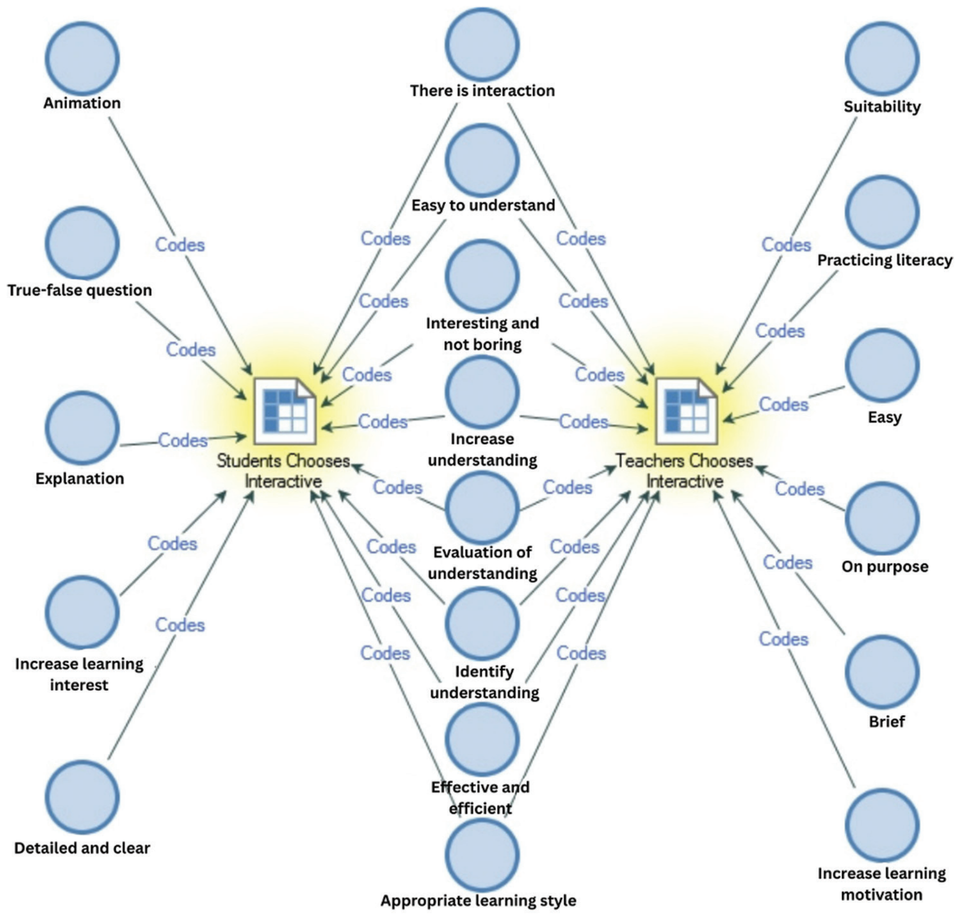

Figure 6: Reasons students and teachers prefer interactive feedback

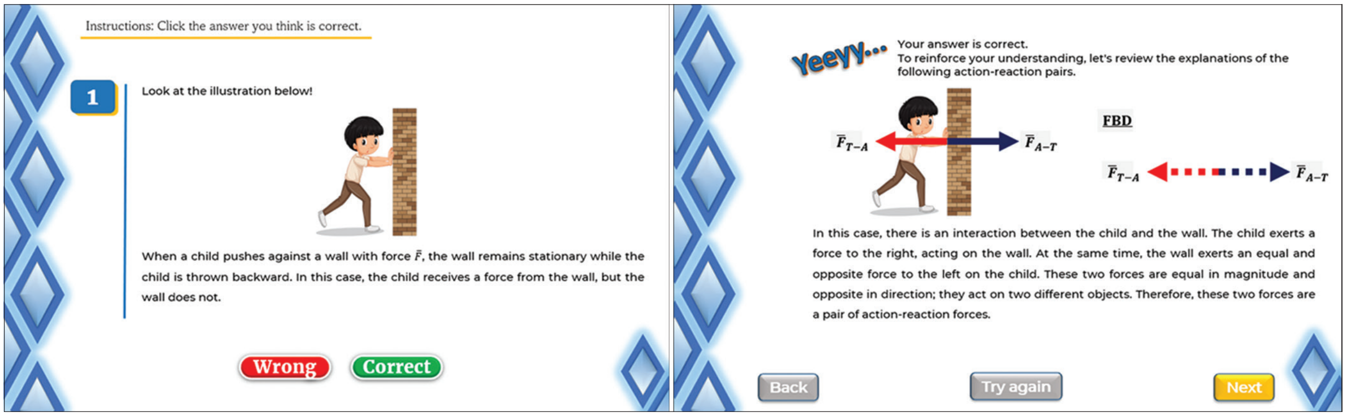

Figure 7: Interactive model feedback display

of the material using a blend of audio and visual elements through video.

The data findings related to the low usage of formative and computer-assisted learning feedback support previous research. According to Kusairi (2020), the implementation of formative feedback is constrained by various factors, such as limited time and the generally large number of students in each class in Indonesia. The obstacles to implementing formative feedback can be addressed by leveraging the advantages of computers. This is because digital technology can provide feedback tailored to the diverse learning environments of students (Maier and Klotz, 2022). The implementation of formative assessment and feedback should also be initiated early by teachers to build students' knowledge (Pals et al., 2023). The belief that computer-assisted formative feedback can enhance understanding and motivation to learn underlines the need for efforts to develop and implement such feedback in schools to tackle the challenges that arise.

However, students and teachers have different opinions about implementing formative feedback in the classroom. Teachers believe that formative feedback provides students with an opportunity to improve their understanding independently. However, students' results are contradictory. Students lack the confidence to use formative feedback independently. This may be because some students have low self-confidence and tend to withdraw from the learning process (Athirathan, 2025). Student activity level is also an important factor in successful learning (Hai et al., 2021). Addressing and resolving this challenge is essential to achieving optimal results.

In this study, there were also differences in teacher and student preferences regarding the type of test deemed more suitable for formative feedback. Students favored the regular multiple-choice format for its simplicity, while teachers leaned towards isomorphic multiple-choice, finding it more effective in diagnosing student difficulties. The multiple-choice format allows students to answer correctly just by guessing, which diminishes its reliability in assessing student competence. Consequently, this can lead to misleading conclusions about student understanding. Research indicates that isomorphic multiple-choice questions more accurately identify student comprehension since they require consistent responses to each question (Kusairi et al., 2017). In isomorphic multiple-choice assessments, students are considered to have a solid grasp of the concept if they can answer all three questions correctly. The use of isomorphic multiple-choice items can provide a more precise diagnosis of student competence and minimize instances of correct answers derived solely from guessing. Although isomorphic multiple-choice questions may take longer to complete, they are recommended for use in formative feedback.

The video and interactive feedback models are among the most popular and highly effective for various reasons. Videos provide a distinct and more realistic perspective, enabling them to have a greater impact than other media (Noetel et al., 2021). The use of videos fosters effective learning and contributes to a positive learning environment, allowing for optimal understanding of information (Sablić et al., 2021). A key advantage of the interactive model is the strong interaction between students and formative feedback. The implementation of interactive media in delivering material can enhance interest, motivation, and understanding (Daryanes et al., 2023).

The study's results revealed that the implementation of computer-assisted formative feedback significantly influences students' interest in the type of feedback considered the most effective. Interactive and video model formative feedback offer new learning opportunities because they are tailored to students' interests and needs. Previous studies have not integrated videos into their feedback. One study Kusairi (2020) developed formative feedback based on questions in the form of a website. In addition, Khusaini et al. (2025) and Suryadi and Kusairi (2021) researched formative feedback with text and interactive models. Therefore, using videos can be an innovative way to suit the interests of students and teachers alike. It has the potential to enhance students' motivation and enthusiasm for learning. Thus, understanding can be effectively developed through the application of computer-assisted formative feedback.

Further research can explore the development of computer-assisted formative feedback, particularly in interactive and video formats. In addition, testing the effectiveness of each model is essential to ascertain the success rate of computer-assisted formative feedback in enhancing students' understanding. Moreover, teachers can incorporate computer-assisted formative feedback during lessons, serving as supplementary media for students' independent learning and improvement in comprehension.

CONCLUSION

The study revealed that students are strongly interested in multiple-choice diagnostic tests, while teachers prefer the isomorphic model. Although there are different perceptions regarding the diagnostic test model, students and teachers are interested in the same feedback approach, namely, interactive and video formats. In addition, the application of formative feedback in physics learning is still not optimal, as evidenced by the low usage and implementation of formative feedback in the classroom. Students also feel they cannot learn independently with computer-assisted formative feedback without teacher assistance. While the study has provided information on the interest and need for computer-assisted formative feedback, a larger sample is necessary for more accurate results. A larger sample size allows for the generalization of results to a broader population. Future researchers can develop computer-assisted formative feedback based on interactive and video models and analyze the effectiveness of each model. An experimental research design involving a large number of respondents spread across various regions must be conducted. Various implementation scenarios can also be carried out, including individual, paired, and group formative feedback. These scenarios will provide an overview of the most effective formative feedback implementation method for the classroom.

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