FLM-based AFL improves physics engagement and conceptual understanding

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ABSTRACT

Assessment for learning (AFL) is a pedagogical approach that enhances student learning outcomes through high-quality feedback. This study investigates the effectiveness of integrating the feedback loop model (FLM) with AFL to improve students' engagement and understanding of physics, specifically in kinematics and motion dynamics. The study employs a mixed-methods research design, combining quantitative and qualitative data to assess the impact of the FLM-based AFL approach. A one-group pretest-posttest design was used, supported by research instruments that measured student engagement and their conceptual grasp of physics. The findings indicate that integrating FLM into AFL led to significant improvements, evidenced by Cohen's effect size of 1.91, highlighting a substantial impact on student learning. These results affirm that FLM-based AFL positively affects student engagement and understanding of physics. The study contributes to the existing research on effective assessment methods, providing valuable insights for educators and policymakers in developing enhanced assessment and teaching strategies. This study emphasizes the potential benefits of incorporating FLM-based AFL in diverse educational settings to elevate student learning experiences and outcomes.

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1. INTRODUCTION

Learning and assessment are integral components of the educational process. The primary aim of education is to equip students with the knowledge and skills that enable them to fulfill their potential [1]. In alignment with 21st-century educational paradigms, contemporary teaching strategies focus on developing student-centered learning environments emphasizing critical thinking, individual learning, innovation, and creativity [2]–[4].

Assessment plays a critical role in realizing these educational goals. It serves multiple functions: as a measure of learning outcomes, a tool for enhancing learning, and a mechanism for self-directed learning [3], [5], [6]. Specifically, assessment in education can be categorized into three primary missions: assessment of learning, assessment for learning (AFL), and assessment as learning [7]–[9]. AFL has gained significant traction in recent years. AFL aims to use assessment data to directly enhance student learning [10], [11]. Research indicates that effective AFL implementation positively impacts various dimensions of learning, from students' metacognitive abilities to their learning engagement and conceptual understanding in subject areas like physics [12]–[14].

One innovative approach to AFL is the integration of the feedback loop model (FLM). FLM enhances the AFL strategy by systematically incorporating feedback at different stages of the learning process-observation, feedback provision, reflection, and action [15], [16]. Despite its promise, the effective implementation of FLM-based AFL presents challenges, including the need for teacher preparedness and potential misunderstandings between teachers and students [17], [18]. While numerous studies have investigated various aspects of AFL and FLM individually, little research exists that explicitly addresses their combined impact on high school students' learning engagement and understanding of physics concepts [16], [19], [20]. This represents a significant gap in literature, considering the centrality of physics in the high school curriculum and its relevance to a wide range of academic and professional fields.

This study addresses this gap by investigating the effectiveness of FLM-based AFL on high school students' learning engagement and conceptual understanding of physics. By doing so, this research seeks to contribute to the broader knowledge of effective assessment practices. It also aims to provide educators and policymakers with actionable insights for improving assessment systems and teaching strategies, enhancing students' learning experiences and outcomes.

2. METHOD

2.1. Research design

This study adopted a mixed-methods approach to understand the research problem comprehensively. The mixed-methods design incorporates quantitative and qualitative data for in-depth analysis and interpretation. Specifically, a one-group pretest-posttest design was utilized to gauge students' learning engagement and conceptual understanding of Physics before and after implementing AFL based on the FLM. The subjects of focus were kinematics and motion dynamics. The stages of this research design and the flow from observations to the assessment of impacts on students are depicted in Figure 1.

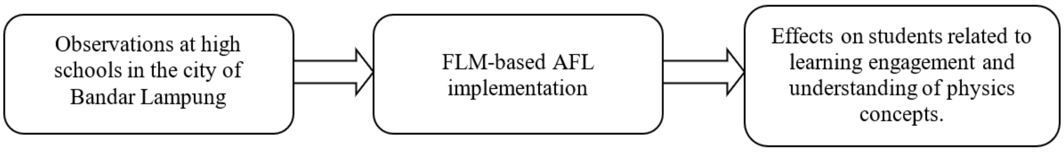

Figure 1. The frame of thinking [21]

2.2. Participants

The participants were eleventh-grade high school students in Bandar Lampung City, Indonesia. A sample of 62 students was selected using a simple random sampling technique. Additionally, two physics teachers were chosen to implement the FLM-based AFL in their classrooms. These teachers were part of the Indonesian Ministry of Education, Culture, Research, and Technology (*Kemendikbudristek*) drive school program. Detailed demographics of the student participants, including gender distribution across the two classrooms, are provided in Table 1.

Table 1. Student profile

Teacher	Number of students	
	Female	Male
1	18	14
2	16	14

2.3. Instruments

The study utilized two primary instruments for data collection: the student engagement questionnaire, which evaluates four aspects of engagement through a bipolar scale, and the physics conceptual understanding test, consisting of 30 multiple-choice items with high reliability and validity metrics.

a. Student engagement questionnaire: adapted from Gunuc and Kuzu [22], this tool measures four dimensions of student engagement: agent involvement, behavioural engagement, emotional involvement, and cognitive engagement. The questionnaire consists of a series of items, assessed on a bipolar scale ranging from "strongly disagree" to "strongly agree." Both pre- and post-implementation assessments were conducted using Google Forms.

b. The physics conceptual understanding test, developed by Lichtenberger *et al.* [23], comprises 30 multiple-choice kinematics and motion dynamics questions. This instrument's reliability and validity coefficients were 0.823 and 0.89, respectively.

2.4. Data collection procedure

After selecting the participating teachers and students, an electronic message was sent to inform the teachers of their roles in the study. The teachers were provided with a consent form detailing the study's objectives and ethical considerations, such as data anonymity. Students were then invited to complete a pre-survey based on the student engagement questionnaire. Teachers also maintained reflective journals during the implementation of FLM-based AFL. The pre- and post-tests for Physics conceptual understanding were administered before and after implementing FLM-based AFL. Similarly, post-surveys for student engagement were administered after the completion of the program.

2.5. Data analysis

In the study, the analysis of student engagement was conducted using the Wilcoxon signed-rank test on questionnaire responses, while a t-test and effect size calculations were utilized to assess shifts in students' conceptual understanding of kinematics and motion dynamics.

a. Student engagement data: data from the student engagement questionnaire were analysed using the Wilcoxon signed-rank test to measure changes in four aspects: student engagement, behavioural engagement, emotional engagement, and cognitive engagement.
b. Conceptual understanding data: a t-test and effect size calculations were employed to examine changes in students' conceptual understanding of kinematics and motion dynamics.

3. RESULTS AND DISCUSSION

3.1. Student engagement in learning

The results of engagement tests were compared before and after the implementation of FLM-based AFL on kinematics and motion dynamics material for high school students in this research. Because the data were not normally distributed, the Wilcoxon test was used to determine student learning engagement. The outcomes of student learning engagement are presented based on indicators such as agent, behavioral, emotional, and cognitive involvement. Table 2 displays the results of the descriptive statistics.

Table 2. Wilcoxon signed-rank test results of student engagement before and after FLM

Student involvement	Before (n = 62)			After (n = 62)			Wilcoxon signed-rank Test		
	M	SD	Interpretation	M	SD	Interpretation	Z	p-value	Interpretation
Agent involvement	3.29	1.53	SA	4.79	1.86	QA	-3.80	< 0.001	Si
Behavioral involvement	4.90	0.87	QA	5.47	1.27	A	-5.26	< 0.001	Si
Emotional involvement	4.36	1.07	N	4.66	1.38	QA	-3.90	< 0.001	Si
Cognitive involvement	4.19	1.16	N	4.60	1.60	QA	-3.81	< 0.001	Si

Note: QA is quite agree, SA is slightly agree, A is agree, N is neutral, and Si is significant

Table 2 displays that before implementing FLM-based AFL, the agent involvement indicator showed the students' overall score (M = 3.29 and SD = 1.53) with a slightly disagreeing interpretation. However, after implementing FLM-based AFL, the value of agent involvement increased (M = 4.79 and SD = 1.86) and was declared significant. Regarding behavioral engagement indicators, before implementing FLM-based AFL, the average student score was (M = 4.90 and SD = 0.87), with an entirely agreed interpretation. After implementation, the students' scores rose (M = 5.47 and SD = 1.27) and were deemed significant. For emotional engagement indicators, the students' overall score was (M = 4.36 and SD = 1.07), evaluated as neutral, but following FLM-based AFL implementation, the value of emotional involvement increased (M = 4.66 and SD = 1.38) and was considered significant. Before using FLM-based AFL, students had an average score of (M = 4.19 and SD = 1.16) with a neutral interpretation, but after its implementation, students' scores rose (M = 4.60 and SD = 1.60) and were deemed significant. Thus, it can be concluded that student learning engagement will improve after implementing FLM-based AFL during the learning process. These results align with Bramwell-Lalor and Rainford [24], who discovered that teacher involvement in AFL practice positively impacts students' self-knowledge learning engagement.

This study examines the effects of FLM-based AFL implementation on high school students' learning engagement in kinematics and motion dynamics. Table 2 indicates that integrating learning and teaching through FLM-based AFL significantly influences student learning engagement, as evidenced by the interaction and collaboration between teachers and students during the learning process. AFL adoption is crucial in learning, as it can considerably impact students' potential and make learning more meaningful [25]. The teacher must ensure students achieve the established learning goals during AFL practice. Consequently, teachers must be attentive to learning activities, such as monitoring student behavior, communication, responding, and respecting one another [26]. AFL practice cannot be considered a practical assessment without formative feedback.

Formative assessments require feedback as information about student learning activities that can be used to evaluate teaching and learning systems. This feedback can help enhance student quality and provide insight into how students utilize the feedback given [27]. Research by Gan *et al.* [25] propose several strategies for AFL practice, including i) assigning tasks to students using a meaningful learning approach to help them reach their full potential, ii) having the teacher focus on the feedback process to stimulate students' interest in understanding learning by encouraging them to seek, generate, and apply feedback, and iii) assisting students in establishing self-quality to achieve good assessment results. Therefore, for the AFL plan to be successful, students must engage and receive support from formative evaluation. If AFL is considered an effective assessment tool, it will aid in improving the quality of student learning [3]. Learning engagement can be promoted through dialogue activities integrating the learning process [28].

In this study, learning engagement is indicated by agent participation, behavioral involvement, emotional involvement, and cognitive involvement. The findings of the study on the impact of FLM-based AFL on student involvement are explained as follows:

a. Agent involvement
   Before using FLM-based AFL, students did not participate in class activities and were not fully engaged in discussions, according to teacher 1. Teacher 2 expressed feelings of failure and disinterest in teaching when students did not respond. However, after implementing FLM-based AFL, a shift in agent involvement occurred. Teacher 1 observed students participating in demonstrations and simulations, offering their interpretations of scenarios, and sharing relevant prior knowledge. Meanwhile, teacher 2 reported that students attempted to answer questions and engage in debates, which made them happy to see their students trying and actively participating in the classroom.
b. Behavioral involvement
   Before implementing FLM-based AFL, teacher 1 observed that some students showed responsibility when given tasks and homework, but not all did. Teacher 2 noted that not all students seemed interested in the content and did not fully understand the instructions. After implementing FLM-based AFL, both teachers noticed a change in behavioral engagement. Teacher 1 found that almost all students demonstrated responsibility when given assignments and homework, performing well in their tasks. Teacher 2 reported that the instructions were more accessible for students, and they committed to doing their best on the subject matter.
c. Emotional involvement
   Before using FLM-based AFL, teacher 1 perceived students as uninterested in the lessons, and some seemed disengaged. Teacher 2 expressed frustration that some students appeared disrespectful to their peers when expressing their ideas. After implementing FLM-based AFL, both teachers observed a change in emotional involvement. Teacher 1 felt respected as a teacher, noting that students respected differences of opinion when conveying ideas and actively participated in group activities. Teacher 2 found that most students could respect their peers while expressing their views and became more enthusiastic about following simulations and discussing the topic.
d. Cognitive involvement
   Before using FLM-based AFL, teacher 1 believed that while students rarely had issues understanding kinematics, they could have been more motivated. Teacher 2 noticed that some students still completed their homework just before the class began, and their at-home efforts remained unclear. After implementing FLM-based AFL, a change in cognitive engagement emerged. Teacher 1 observed students being more content when learning was nearly finished, with an increasing number actively engaging in conversations and responding to each other. Using FLM allowed for improved student engagement and conceptual kinematics modeling in physics class discussions. Students paid attention in class and actively practiced uniformly changing motion, making predictions about an object's regular movement. Teacher 2 reported that most students enjoyed learning physics and continued to give their all. After using FLM, students became more invested in discussions, and their thinking abilities improved.

Moreover, this study's findings align with previous research emphasizing the importance of implementing FLM in AFL to enhance student learning engagement. Subheesh and Sethy [29] stressed the benefits of involving students and teachers in AFL, leading to more mature learning, self-efficacy, critical thinking skills, and creative abilities development. Tay and Lam [26] highlighted that feedback could increase learning engagement by helping students understand their capacities and skills and effectively apply the teacher's comments. The use of technology to implement AFL more efficiently is another crucial factor to consider, as it helps students adapt to the digital environment and saves valuable class time [16]. In this context, Vattøy *et al.* [30] emphasized the importance of feedback quality and its connection to specific assessment criteria, which prevents confusion and contributes to students' enthusiasm for learning.

The positive impact of FLM in AFL on overall student learning outcomes is supported by Ole [31], as it provides quality feedback based on assessment criteria, motivating students to improve their learning performance. Furthermore, teacher involvement in implementing AFL can foster the development of students' critical thinking abilities, creativity, and self-efficacy [29]. Technology in AFL implementation also helps maximize class time and familiarize students with the digital world [32], streamlining the feedback process and tracking student learning outcomes in real-time.

Implementing FLM in AFL can enhance teachers' ability to manage student learning outcomes classification, enabling students to independently understand and evaluate their learning progress through high-quality feedback on assessment criteria [25]. This encourages students to become more engaged in learning and increases their interest in studying. Using FLM also improves the overall quality of learning [33], allowing teachers to help students identify their strengths and weaknesses and encourage them to enhance their learning performance.

In support of these findings, several studies have shown positive effects on student engagement when assessments were offered [34] and when teamwork was implemented in extensive enrollment courses [35]. Similarly, Current [36] emphasized the need for feedback in formative assessments to evaluate teaching and learning systems, while Geletu [37] found that teacher participation positively affects students' learning engagement in science. Ma and Luo [38] demonstrated that engaging in student and peer assessment can positively impact learning performance, and Kim *et al.* [39] showed that clustering algorithms could effectively assess student engagement in asynchronous online learning. Ndihokubwayo *et al.* [40] and Petričević *et al.* [41] also found that active learning environments and contextual and individual factors can influence student engagement in physics.

However, this study shows that using FLM-based AFL helps students get more engaged in learning. This method gives students helpful feedback and helps teachers assess how well their teaching methods work. Good use of AFL should include effective learning techniques, focusing on feedback, and helping students improve themselves. Feedback is crucial for getting students more involved and helping them learn better. Using FLM in this way can make learning more organized, get students more involved, and improve the quality of education.

3.2. Conceptual understanding

Students' physics concepts understanding tests were administered in this study to determine the effect of introducing FLM-based AFL on high school students. The mean, standard deviation, N-Gain, and t-test results were used to examine the data. The data is utilized to interpret teacher practices on implementing FLM-based AFL by comparing the average scores of students' pretest and post-test. Table 3 will offer statistics on the results of the pretest and post-test.

Table 3. Descriptive statistics and t-test results from the pretest and post-test

Pretest		Post-test		Gain			t-test Results		
M	SD	M	SD	M	SD	n	t	df	p-value
4.16	1.79	14.19	4.68	10.03	4.30	62	17.76	57	< 0.001

Table 3 shows that the pretest results (M = 4.16 and SD = 1.79) are lower than the post-test results (M = 14.19 and SD = 4.68) for high school students, implying that the use of FLM-based AFL can increase students' knowledge of physics concepts in kinematics material and motion dynamics. The N-Gain test was then used to decide the difference between the pretest and post-test results on the conceptual understanding test, yielding an average of 10.03 with a standard deviation of 4.30. As a result, it is possible to conclude that learning through FLM-based AFL significantly affects high school student's knowledge of physics ideas. The t-test is used to figure out whether the data is significant. Based on the results in Table 3, it is possible to conclude that there is a significant difference between the pretest and post-test scores of high school students, as evidenced by a calculated p-value of less than 001 with t (57) equal to 17.76, indicating a value less than the significance level of α, which is 0.05.

The impact of utilizing feedback loop model (FLM)-based AFL on high school students' comprehension of physics concepts can be observed in Table 4 through the effect size of Cohen's d test. With a significant effect size of 1.91, this study suggests that FLM-based AFL can notably enhance students' conceptual comprehension. This finding aligns with Jufriadi and Andinisari [42] research, which revealed AFL 's positive influence on student conceptualization during learning through discussion activities and exploration of new information.

Table 4. Cohen's d effect size

Variable	Mean difference	SD	N	Cohen's d effect size	Interpretation
Pretest	5.26	1.92	62	1.91	Large effect

This investigation focused on how FLM-based AFL improved high school students' conceptual understanding of kinematics and motion dynamics in physics and their learning engagement. The results indicate that the collaborative approach between teachers and students employing FLM-based AFL significantly affected students' conceptual knowledge. Teacher feedback is a practical assessment tool for evaluating students' understanding of FLM-based AFL concepts. Successful AFL implementation requires active interaction between teachers and students during learning. Self-evaluation can benefit from constructive peer, instructor, and student feedback [43]. Professional supervision is considered essential for ensuring the effectiveness of the feedback process and fostering students' reflection on their assessment outcomes [24].

Recent studies have emphasized that implementing FLM-based AFL can heighten students' comprehension of physics concepts, leading to increased engagement and improved learning outcomes. Aykutlu *et al.* [44] highlighted the importance of providing teachers with a solid conceptual foundation in physics to teach complex subjects effectively. Bouchée *et al.* [45] underscored the necessity of identifying and addressing conceptual difficulties to enhance students' learning experiences in quantum physics. De Winter and Airey [46] explored the vital connection between mathematics and physics in cultivating future physics teachers' ability to integrate mathematics into their instruction, resulting in deeper conceptual understanding for their students. Hernandez *et al.* [47] provided insights into students' perception and comprehension of electric and magnetic interactions, which could assist teachers in tailoring their lesson plans to accommodate their students' conceptual perspectives better. McGregor and Pleasants [48] suggested reorganizing Snell's law instruction to develop conceptual knowledge before introducing mathematical aspects could lead to a more profound understanding of the subject matter.

FLM-based AFL implementation enables students to assess their learning progress, identify potential learning barriers, and develop valuable learning skills. Furthermore, it assists teachers in effectively managing the learning process and enhancing student learning outcomes. Although many students find physics challenging, its principles must be applied daily [42]. Students with a robust conceptual understanding can more effectively comprehend physics theories, principles, and laws [49].

This study identified changes in students' conceptual knowledge of physics before and after FLM-based AFL implementation. Teacher 1 noted that engaging activities could stimulate students' interest in kinematics discussions. Students can learn more effectively through guided conversation; setting clear objectives is vital for achieving those goals. Feedback and practice can also benefit students and teachers in teaching and learning. In contrast, teacher 2 observed that despite posing questions to encourage higher-order thinking, students merely listened during the previous discussion. Consequently, the teacher insisted that students engage with the subject matter to aid their understanding.

The findings of this study demonstrate the potential benefits of FLM-based AFL in high school physics education, particularly in kinematics and motion dynamics, where its implementation can significantly elevate students' conceptual understanding and learning engagement. However, caution must be exercised when implementing FLM-based AFL to avoid negative consequences, such as placing excessive pressure on students and teachers. Resource availability, a conducive learning environment, a high-quality curriculum, student motivation, and solid teacher-student collaboration are crucial when implementing FLM-based AFL.

This study's results align with previous research demonstrating that AFL can enhance students' conceptual knowledge of physics. The research cited in this study offers additional evidence supporting the notion that AFL can improve student learning outcomes in physics education. It is essential to recognize that other aspects of the learning process, including emotional engagement and creativity, should also be considered, and not solely assessed through AFL.

Further supporting the findings of this study, earlier research suggests that AFL through FLM can improve students' conceptual understanding of physics. Research by Elisa *et al.* [49] team identified a significant difference in students' understanding of physics concepts between pretest and post-test scores. This study supports the idea that learning connected to AFL can enhance students' understanding of essential physics concepts, particularly those related to work and energy. However, some students still struggle to articulate their ideas concerning the use of mathematical concepts swiftly. Jufriadi and Andinisari [42] argue that integrated learning with AFL is critical for increasing students' conceptual understanding. In this study, AFL is used to aid students in comprehending physics concepts, specifically kinematics, through a blended learning approach linked to just in time teaching (JITT). The research reveals that students encountered difficulties in understanding kinematic concepts, such as differentiating between distance and displacement or identifying the direction of acceleration. These challenges may arise if students do not fully comprehend a concept or theory. However, students demonstrated an improved understanding of kinematics after learning was combined with AFL.

The results of this study indicate that FLM-based AFL can increase student learning engagement and enhance their grasp of physics concepts. Nevertheless, for the feedback process to function effectively and for students to reflect on AFL evaluation results to elevate the quality of learning, FLM-based AFL must be employed under supervision [50]. Moreover, implementing FLM-based AFL can assist teachers in efficiently managing the learning process. Teachers may find it beneficial to utilize FLM-based AFL to control the learning process and improve student learning outcomes effectively.

Careful implementation of FLM-based AFL is also crucial, as improper use can lead to various adverse outcomes, including stress or pressure on students and teachers. Overemphasis on AFL might cause students to lose sight of other facets of the learning process, such as emotional engagement and creativity, and become overly focused on AFL evaluation outcomes [25]. Research by Deelay [16] contends that implementation positively impacts the learning process. It must be balanced and not excessive. Additionally, each student's unique characteristics must be considered when implementing FLM-based AFL. As students have different learning preferences and needs, AFL should be tailored for everyone [51]. To provide students with relevant and helpful feedback, teachers must first understand the characteristics of their pupils. Consequently, employing FLM-based AFL can benefit students and teachers fully.

The implementation of FLM-based AFL should encompass additional elements that aid in learning. A conducive learning environment is a crucial factor. Students can maximize their learning potential in a supportive, positive learning environment [52]. According to William [27], a conducive learning environment can also increase student involvement in the learning process and aid teachers in better managing the learning process. As a result, FLM-based AFL implementation must be accompanied by a supportive learning environment to optimize the benefits for both students and teachers.

Furthermore, when implementing FLM-based AFL, additional components must be in place, such as a high-quality curriculum and learning materials [2]. An effective curriculum will guide teachers in optimally managing the learning process and help them determine the learning objectives and materials to be taught. Teachers' ability to provide curriculum-based and student-centered learning materials will enhance the effectiveness of the learning process [3]. FLM-based AFL should be implemented with a high-quality curriculum and learning materials to maximize student and teacher benefits.

In addition to a high-quality curriculum and learning materials, implementing FLM-based AFL must consider the availability of necessary resources. To effectively manage the learning process, FLM-based AFL requires resources such as sufficient time, effort, and tools [24]. When implementing FLM-based AFL, teachers must ensure adequate resources are available to manage the learning process. It is also essential for teachers to guarantee that students have access to necessary resources, such as textbooks or other instructional materials, to facilitate learning. FLM-based AFL should be supported by appropriate resources to serve students and teachers best.

Other factors supporting the learning process, such as student motivation and teacher-student collaboration, must also be considered while adopting FLM-based AFL. Student motivation will influence student engagement in the learning process and the quality of learning outcomes, as indicated by Elisa et al. [49]. Therefore, based on the analysis of assessment results, teachers must ensure that students are adequately motivated to learn and actively participate in the learning process [21]. To facilitate more effective learning and produce more valuable learning outcomes, teachers and students must engage in successful collaboration throughout the learning process [25]. As a result, implementing FLM-based AFL must be supported by strong collaboration and student motivation to provide the most significant possible benefit to both students and teachers.

4. CONCLUSION

This study has demonstrated the potential benefits of implementing FLM-based AFL in high school physics education, particularly in kinematics and motion dynamics. FLM-based AFL has significantly increased students' conceptual understanding and learning engagement in physics. However, caution must be exercised when implementing FLM-based AFL to avoid potential adverse effects, such as placing excessive pressure on students and teachers. When implementing FLM-based AFL, it is crucial to consider the availability of resources, a supportive learning environment, a high-quality curriculum, student motivation, and solid teacher-student collaboration. By considering these factors, FLM-based AFL can be optimally utilized to enhance student learning outcomes and improve the overall quality of physics education.

However, caution must be exercised when implementing FLM-based AFL to avoid potential adverse effects, such as placing excessive pressure on students and teachers. When implementing FLM-based AFL, it is crucial to consider the availability of resources, a supportive learning environment, a high-quality curriculum, student motivation, and solid teacher-student collaboration. By considering these factors, FLM-based AFL can be optimally utilized to enhance student learning outcomes and improve the overall quality of physics education.

Despite the promising findings, this study is not without its limitations. First, the study focused on high school students' comprehension of physics ideas, specifically kinematics and motion dynamics. Thus, the generalizability of the findings to other subject areas or age groups may be limited. Second, the study relied on a single assessment method, which may not capture all student learning and engagement aspects. Lastly, the study did not explore potential differences in the effectiveness of FLM-based AFL among students with varying learning styles, aptitudes, or backgrounds.

Future studies should look at how well FLM-based AFL works in different subjects and for different kinds of students. Researchers should also use different ways of measuring its impact, like interviews or watching classes. They should investigate how to best adapt this method for each student's needs. Plus, it would be good to see if the benefits of using FLM-based AFL last long and help students use what they've learned in new situations. This research would help us understand how FLM-based AFL can improve teaching and learning in many ways.

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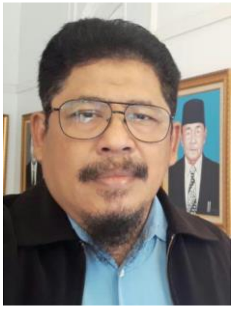

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