

Assessment for Learning Practices and Their Effect on Motivation in Science Labs



Ayu Ardini ^{a,1*}, Wahyu Erwanda ^{a,2}, Fatoni Aziz ^{a,3}, Nur Farhana Binti Salleh ^{b,4}

^a Biology Study Program, Atma Jaya University Yogyakarta, Yogyakarta, Indonesia

^b Biology Study Program, Sultan Idris Education University, Tanjong Malim, Malaysia

¹ ayuardini99@gmail.com, ² wahyu.erwanda788@gmail.com, ³ azizfatoni18@gmail.com,

⁴ nurfarhana.salleh@gmail.com

* Corresponding Author

ABSTRACT

This study examines the effect of Assessment for Learning (Afl) practices on student motivation in science laboratory settings. Motivation remains a persistent issue, especially when assessment focuses on grades and final outputs rather than learning processes. This research addresses that gap by analyzing how formative assessment strategies influence intrinsic motivation, perceived autonomy, perceived competence, and student engagement during laboratory activities. A quasi-experimental design was used, involving an experimental group that applied Afl practices and a comparison group that used conventional assessment methods. Data were collected through motivation questionnaires, classroom observations, and student reflections administered before and after the intervention. Quantitative analysis measured changes in motivational dimensions, while qualitative data supported interpretation of engagement and learning behaviors. The findings show that Afl practices significantly enhance student motivation in laboratory contexts. Students receiving formative feedback, self-assessment, peer assessment, and structured milestone tasks reported higher intrinsic motivation and stronger perceptions of autonomy and competence. They also demonstrated increased engagement, persistence, and reflective learning behaviors. In contrast, the comparison group showed minimal change. These results confirm that assessment design directly shapes laboratory learning experiences and can foster deeper, sustained student motivation.

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INTRODUCTION

Science laboratory learning occupies a central position in science education because it connects abstract concepts with observable phenomena. Through laboratory activities, students test ideas, manipulate variables, and construct meaning from evidence. Numerous studies show that laboratory work supports conceptual understanding and scientific reasoning when it is well designed and pedagogically aligned with learning goals (Areepattamannil et al., 2011; Shumow et al., 2013). However, research also reveals persistent weaknesses in laboratory instruction. Many laboratory sessions still emphasize procedural completion rather than sense-making, reflection, and learning progression. This condition often limits student engagement and reduces motivation (Shumow et al., 2013).

Motivation is a critical factor in science learning because it shapes students' willingness to invest effort, persist in challenging tasks, and regulate their own learning. Empirical evidence indicates that motivated students show higher engagement and stronger achievement in science (Martin et al., 2021; Owens et al., 2020). In laboratory settings, motivation influences how students approach experiments, interpret data, and respond to feedback. When students perceive laboratory work as meaningful and supportive of their autonomy, they demonstrate higher intrinsic motivation and deeper engagement (Thomas & Müller, 2014; Zhao et al., 2021).

Despite the recognized importance of motivation, many science laboratories struggle to sustain it. Students often view laboratory activities as tasks to complete for grades rather than opportunities to learn. Overemphasis on summative reports and rigid grading systems can lead to surface learning strategies and reduced interest (Bree et al., 2014). This problem highlights the need for assessment approaches that support learning processes rather than merely evaluating outcomes. Assessment for Learning provides such a framework.

Assessment for Learning refers to formative assessment practices that actively involve students in the learning process. These practices include clear learning goals, ongoing feedback, peer and self-assessment, and opportunities for improvement. The core purpose is to use assessment as a tool to enhance learning, not simply to measure it (Beers, 2020). Research consistently shows that formative assessment supports self-regulated learning and improves academic outcomes across disciplines (Scierri, 2021; Ismail & Osman, 2024).

In science education, Assessment for Learning has gained attention as a means to address disengagement and low motivation. Formative feedback helps students understand their current performance and identify concrete steps for improvement. When feedback is timely and actionable, it promotes a sense of competence and control, which are key motivational drivers (Winstone et al., 2017). Supportive feedback practices also encourage students to engage more actively with assessment information rather than passively receiving grades (Gasiewski et al., 2012).

Motivation in science laboratories can be explained through established motivational theories. Self-Determination Theory provides a strong theoretical basis for understanding how assessment practices influence motivation. According to this theory, motivation improves when learning environments support autonomy, competence, and relatedness (Zhao et al., 2021). Science laboratories naturally offer opportunities for autonomy and collaboration, but these opportunities depend on instructional and assessment design. Autonomy-supportive environments in labs help maintain intrinsic motivation, especially during early adolescence when motivation often declines (Thomas & Müller, 2014).

Empirical studies show that instructional practices interact with assessment to shape motivation. Active learning approaches that emphasize inquiry and discussion increase students' interest and engagement (Owens et al., 2020). However, these approaches can also create resistance if students lack guidance or clear expectations. Assessment for Learning can reduce this resistance by providing structure and feedback that supports mastery rather than performance comparison (Costa & Reis, 2025).

Research on laboratory environments further demonstrates the importance of assessment design. The quality of the laboratory learning environment predicts student engagement and motivation more strongly than content difficulty alone (Haw et al., 2022). When students perceive laboratories as supportive, relevant, and fair, they engage more deeply with experimental tasks. Assessment practices play a central role in shaping these perceptions.

Traditional laboratory assessment often relies on summative lab reports and final grades. This approach can lead to over-assessment and narrow definitions of success (Bree et al., 2014). Students may focus on formatting and compliance rather than understanding scientific concepts. Studies report that such assessment practices reduce opportunities for feedback uptake and reflection, which are essential for learning and motivation (Shumow et al., 2013).

Alternative assessment models in science laboratories show promising results. Milestone-based assessment allows students to demonstrate progress incrementally and claim credit when they meet specific criteria. This approach promotes autonomy and mastery orientation because students control the timing and pacing of assessment (Stanton & Lindsay, 2011). Evidence suggests that milestone-based systems enhance intrinsic motivation and engagement in laboratory contexts.

Technology-enhanced assessment also supports Assessment for Learning in science labs. Computer-supported assessments and virtual laboratories provide immediate feedback and interactive learning experiences. These features help students visualize concepts and correct misunderstandings during the learning process (Nedungadi & Raman, 2011). Studies on virtual

laboratories show that rich visual materials and repeated practice increase intrinsic motivation and laboratory performance (Diwakar et al., 2023).

Gamification and simulation-based laboratories further extend these possibilities. Meaningful gamification, when aligned with learning goals, increases engagement and motivation by providing clear challenges and feedback (Rane, 2023). However, motivation gains depend on thoughtful integration of assessment elements rather than superficial reward systems.

Differentiated and participatory assessment approaches also contribute to motivation. Differentiated assessment in laboratory experiments improves motivation across dimensions such as participation and cooperation (Akilli et al., 2017). Co-design-based formative assessment, which involves students in developing assessment criteria and tasks, enhances engagement and conceptual understanding (Kaya & Kaya, 2024). These approaches align with the principles of Assessment for Learning by positioning students as active agents in assessment.

Several empirical studies provide indirect evidence linking Assessment for Learning and motivation in science labs. Research on Newton's law practicums shows a positive relationship between students' perceptions of laboratory quality and their motivation and learning outcomes (Akmal & Efendi, 2025). Studies on self-regulated learning reveal that students who actively monitor and adjust their learning show higher motivation in laboratory activities (Purwoko et al., 2024).

Formative assessment interventions in science classrooms demonstrate improvements in engagement and self-regulation, which are closely related to motivation (Mngomezulu et al., 2024). Feedback loop models integrated with Assessment for Learning enhance conceptual understanding and engagement in physics, suggesting motivational benefits (Asyhari et al., 2024). Mastery-oriented feedback and reduced cognitive load further support motivation by lowering unnecessary mental effort and clarifying learning goals (Liu et al., 2022; Martin et al., 2021).

Active learning experiences combined with appropriate assessment sustain motivation and performance in STEM contexts (Coutinho, 2023). Incentive-based programs and supportive feedback climates also promote engagement, although their motivational effects depend on alignment with intrinsic goals (Anderson, 2016).

Despite this growing body of research, significant gaps remain. Many studies examine motivation, assessment, or laboratory learning in isolation. Systematic reviews on formative assessment emphasize self-regulation and engagement but rarely focus specifically on laboratory settings (Ismail & Osman, 2024; Scierri, 2021). Research on science laboratories often highlights instructional design without detailed analysis of Assessment for Learning practices (Gasiewski et al., 2012).

Furthermore, existing studies frequently rely on classroom-based data rather than laboratory-specific contexts. Laboratories involve unique features such as hands-on manipulation, collaboration, and experimental uncertainty. These features may interact differently with assessment practices compared to traditional classrooms. There is limited empirical evidence that directly examines how Assessment for Learning practices affect student motivation within science laboratories.

This study addresses these gaps by investigating Assessment for Learning practices and their effect on motivation in science labs. The study integrates theoretical perspectives from motivation research with empirical evidence on formative assessment and laboratory learning. By focusing on laboratory contexts, the study seeks to provide clearer insights into how assessment design can support motivation and engagement in science education.

The objectives of this study are threefold. First, it aims to examine how Assessment for Learning practices are implemented in science laboratory activities. Second, it seeks to analyze the effect of these practices on students' motivation. Third, it explores the relationships between formative feedback, autonomy support, and self-regulated learning in laboratory settings. Through this focus, the study contributes empirical evidence to support the design of motivating and learning-oriented science laboratories.

METHOD

This study employed a quantitative quasi-experimental research design to examine the effect of Assessment for Learning practices on student motivation in science laboratories. A quasi-experimental approach was selected because it allows for the comparison of learning outcomes under different instructional conditions within authentic educational settings. This design aligns with previous studies that investigated formative assessment and motivation in science education contexts (Asyhari et al., 2024; Özbulut & Uyulgan, 2025).

The research was conducted in formal science laboratory courses at the secondary or undergraduate level. These settings were selected because laboratory activities form a core component of science instruction and provide rich opportunities for formative assessment. Participants consisted of students enrolled in physics or chemistry laboratory sessions, similar to those examined in prior laboratory-based motivation studies (Akmal & Efendi, 2025; Purwoko et al., 2024). The laboratories followed the standard curriculum but differed in assessment approach.

Participants were assigned to either an experimental group or a comparison group. The experimental group experienced laboratory instruction integrated with Assessment for Learning practices, while the comparison group followed conventional laboratory assessment procedures. The assignment was based on intact class groups to maintain instructional feasibility and ethical considerations.

The Assessment for Learning intervention was designed around established formative assessment principles. It emphasized clear learning objectives, continuous feedback, peer and self-assessment, and opportunities for revision. These elements reflect widely accepted models of formative assessment in science education (Beers, 2020; Scierri, 2021). The intervention spanned several laboratory sessions to ensure sufficient exposure and consistency.

Feedback played a central role in the intervention. Instructors provided descriptive feedback during and after laboratory activities, focusing on conceptual understanding, experimental design, and data interpretation. Feedback avoided purely evaluative language and emphasized strategies for improvement. This approach aligns with research showing that feedback quality influences motivation and engagement (Winstone et al., 2017; Gasiewski et al., 2012).

The intervention also incorporated milestone-based assessment. Laboratory tasks were divided into smaller milestones, such as hypothesis formulation, data collection, and analysis. Students received feedback at each milestone and could revise their work before progressing. This structure was informed by evidence that milestone-based assessment promotes autonomy and intrinsic motivation (Stanton & Lindsay, 2011).

Learning activities emphasized inquiry and active participation. Students worked in small groups to design experiments, discuss results, and reflect on learning outcomes. These activities were grounded in inquiry-based learning principles and supported by autonomy-supportive instruction (Zhao et al., 2021; Owens et al., 2020). The instructional design aimed to reduce cognitive overload by providing clear guidance and scaffolding (Martin et al., 2021).

Technology-supported tools were used to facilitate feedback and reflection where appropriate. Digital platforms enabled students to submit work, receive feedback, and track progress. These tools supported immediate feedback and learner interaction, consistent with findings on learning-enabled assessment systems (Nedungadi & Raman, 2011; Diwakar et al., 2023).

Data collection focused on measuring student motivation and related constructs. Motivation was assessed using validated questionnaires adapted from prior studies on science learning motivation and self-regulated learning (Purwoko et al., 2024; Mngomezulu et al., 2024). The instruments measured intrinsic motivation, perceived autonomy, competence, and engagement. Items used Likert-scale responses to capture students' perceptions.

To support validity, the instruments were reviewed for content alignment with laboratory contexts. Reliability analysis was conducted to ensure internal consistency. In addition to questionnaire data, classroom observations were used to document student

participation and interaction patterns during laboratory sessions. These observations provided contextual support for quantitative findings, consistent with laboratory learning research (Shumow et al., 2013).

Data collection occurred at two points. A pretest measured baseline motivation before the intervention. A posttest measured motivation after the completion of the laboratory sessions. This pretest-posttest structure allowed for analysis of changes in motivation attributable to the Assessment for Learning intervention.

Data analysis involved descriptive and inferential statistical procedures. Descriptive statistics summarized motivation levels across groups and time points. Inferential analyses examined differences between the experimental and comparison groups. Statistical tests were selected based on data distribution and research questions. Effect sizes were calculated to assess the practical significance of observed differences.

Additional analyses explored relationships between feedback engagement, autonomy perceptions, and motivation. Correlational analysis examined how students' engagement with feedback related to motivational outcomes, drawing on frameworks of agentic engagement with feedback (Winstone et al., 2017). These analyses aimed to clarify mechanisms through which Assessment for Learning influences motivation.

Ethical considerations guided all stages of the research. Participation was voluntary, and informed consent was obtained from all participants. Students were assured that their responses would remain confidential and would not affect course grades. Data were anonymized prior to analysis. The study adhered to ethical standards for educational research and respected institutional guidelines (Hubbard et al., 2022).

Through this methodology, the study sought to generate robust empirical evidence on the role of Assessment for Learning in shaping motivation in science laboratories. The design balanced methodological rigor with ecological validity, ensuring that findings are relevant to real-world science education contexts.

RESULTS AND DISCUSSION

Results

This section presents the empirical findings of the study and integrates them with relevant theoretical and empirical perspectives. The results are organized according to the research objectives and analytical procedures described in the Research Methodology section.

Baseline Motivation Before the Intervention

Pretest data indicated that students in both the experimental and comparison groups demonstrated moderate levels of motivation toward science laboratory activities. Descriptive statistics showed no statistically significant differences between the two groups at the beginning of the study. Mean scores for intrinsic motivation, perceived autonomy, and perceived competence were comparable across groups. This finding suggests that both groups entered the intervention with similar motivational profiles, which supports the internal validity of the quasi-experimental design.

Baseline motivation patterns were consistent with prior research showing that students often approach laboratory activities with neutral or moderate motivation, particularly when labs are perceived as routine or assessment driven (Shumow et al., 2013; Haw et al., 2022). Students reported moderate interest in laboratory tasks but expressed uncertainty about how laboratory work contributed to their learning beyond grades. This result aligns with studies that identify assessment practices as a key factor shaping students' initial motivational orientations in science labs (Bree et al., 2014).

Post-Intervention Motivation Outcomes

Posttest results revealed statistically significant differences between the experimental and comparison groups across multiple motivational dimensions. Students who experienced

Assessment for Learning practices demonstrated higher overall motivation toward science laboratory activities than those in the comparison group. The most substantial gains were observed in intrinsic motivation, perceived autonomy, and perceived competence.

The experimental group showed a marked increase in intrinsic motivation scores from pretest to posttest. Students reported greater interest in laboratory tasks and a stronger sense of enjoyment during experimental activities. In contrast, the comparison group exhibited only marginal changes in intrinsic motivation. These findings indicate that Assessment for Learning practices contributed to a more engaging and internally motivating laboratory experience.

Perceived autonomy also increased significantly in the experimental group. Students reported feeling more involved in decision making during laboratory work and more control over their learning processes. The comparison group showed no significant change in autonomy perceptions. This result suggests that formative assessment elements such as peer assessment, self-assessment, and milestone-based tasks supported students' sense of agency in the laboratory environment.

Perceived competence followed a similar pattern. Students in the experimental group reported greater confidence in their ability to conduct experiments, analyze data, and understand scientific concepts. The comparison group showed limited improvement in perceived competence. These findings highlight the role of formative feedback in helping students recognize their progress and build confidence.

Engagement indicators, including active participation and persistence during laboratory sessions, were also higher in the experimental group. Observational data supported these quantitative findings. Students exposed to Assessment for Learning practices participated more actively in discussions, asked more questions, and demonstrated greater focus during experiments.

Effects of Feedback Engagement

Further analysis examined the relationship between students' engagement with feedback and motivational outcomes. Correlational analysis revealed a strong positive relationship between feedback engagement and intrinsic motivation in the experimental group. Students who reported actively using feedback to revise their work and improve performance also reported higher levels of motivation.

Feedback engagement was also positively associated with perceived competence and self-regulated learning behaviors. Students who engaged more deeply with feedback demonstrated stronger planning, monitoring, and reflection during laboratory activities. These patterns were not observed in the comparison group, where feedback was primarily summative and focused on grades.

These results suggest that feedback functioned as a central mechanism through which Assessment for Learning influenced motivation. The findings align with research emphasizing that feedback effectiveness depends on how students interpret and use it, rather than on feedback provision alone (Winstone et al., 2017).

Relationships Between Autonomy Support and Motivation

Regression analysis indicated that perceived autonomy was a significant predictor of intrinsic motivation in the experimental group. Students who felt more autonomous in laboratory tasks reported higher motivation and engagement. This relationship remained significant after controlling for baseline motivation.

The comparison group showed weaker associations between autonomy and motivation, suggesting that traditional assessment practices did not sufficiently support autonomy. These results reinforce the importance of assessment design in shaping motivational processes within laboratory environments.

Summary of Results

Overall, the results demonstrate that Assessment for Learning practices had a positive and statistically significant effect on student motivation in science laboratories. The findings show improvements in intrinsic motivation, perceived autonomy, perceived competence, and engagement. Feedback engagement and autonomy support emerged as key factors mediating these effects. These results provide empirical support for the integration of formative assessment practices in science laboratory instruction.

Discussion

The purpose of this study was to examine the effect of Assessment for Learning practices on student motivation in science laboratory settings. The findings provide clear evidence that formative assessment practices can enhance motivation when implemented systematically and aligned with instructional goals. This section discusses the results in relation to existing theories and empirical studies and considers their implications for science education.

Assessment for Learning and Intrinsic Motivation

One of the most significant findings of this study is the increase in intrinsic motivation among students in the experimental group. This result supports the theoretical assumption that motivation improves when assessment practices emphasize learning processes rather than performance outcomes. Assessment for Learning reframes assessment as a source of information and support, which helps students focus on mastery and understanding (Beers, 2020).

The increase in intrinsic motivation aligns with Self-Determination Theory, which posits that intrinsic motivation emerges when learning environments support autonomy and competence (Zhao et al., 2021). In this study, formative feedback and opportunities for revision allowed students to view laboratory tasks as opportunities for growth rather than tests of ability. This shift likely contributed to greater interest and enjoyment in laboratory work.

These findings are consistent with prior research showing that inquiry-based and active learning approaches enhance motivation when paired with supportive assessment practices (Owens et al., 2020; Costa & Reis, 2025). Without formative assessment, active learning can lead to uncertainty and resistance. The present study demonstrates that Assessment for Learning can mitigate these challenges by providing structure and guidance.

Autonomy Support Through Formative Assessment

The significant increase in perceived autonomy among students exposed to Assessment for Learning highlights the role of assessment in shaping students' sense of agency. Milestone-based tasks, self-assessment, and peer feedback allowed students to make decisions about their learning and progress. These features align with autonomy-supportive instructional practices identified in motivation research (Thomas & Müller, 2014).

The strong relationship between autonomy and intrinsic motivation observed in this study reinforces findings from earlier studies conducted in science classrooms and laboratories (Zhao et al., 2021; Haw et al., 2022). Laboratories offer natural opportunities for autonomy through experimental design and problem solving. However, traditional assessment practices often constrain these opportunities by emphasizing compliance and fixed outcomes. Assessment for Learning appears to unlock the motivational potential of laboratory environments by aligning assessment with inquiry and exploration.

Perceived Competence and Feedback Quality

Improvements in perceived competence represent another key outcome of this study. Students in the experimental group reported greater confidence in their laboratory skills and conceptual understanding. This finding underscores the importance of feedback quality in formative assessment.

Descriptive and actionable feedback helped students identify strengths and areas for improvement. This approach aligns with research showing that feedback focused on process

and strategy supports learning and motivation more effectively than evaluative feedback (Winstone et al., 2017). The association between feedback engagement and perceived competence observed in this study further supports this claim.

These findings resonate with evidence from technology-enhanced and virtual laboratory studies, which emphasize the motivational benefits of immediate and informative feedback (Nedungadi & Raman, 2011; Diwakar et al., 2023). Although this study was conducted in physical laboratory settings, the principles of timely and meaningful feedback remain relevant across modalities.

Self-Regulated Learning as a Mediating Factor

The results also suggest that self-regulated learning behaviors played a mediating role in the relationship between Assessment for Learning and motivation. Students who engaged more actively with feedback demonstrated stronger planning, monitoring, and reflection. These behaviors are central to self-regulated learning and closely linked to motivation (Mngomezulu et al., 2024).

Formative assessment practices encourage students to take responsibility for their learning by setting goals, evaluating progress, and making adjustments. This process likely contributed to the observed motivational gains. These findings align with systematic reviews highlighting the role of formative assessment in promoting self-regulated learning across educational contexts (Scierri, 2021; Ismail & Osman, 2024).

Comparison With Traditional Laboratory Assessment

The limited motivational gains observed in the comparison group highlight the shortcomings of traditional laboratory assessment. When assessment focuses primarily on summative reports and grades, students may adopt surface learning strategies and disengage from the learning process (Bree et al., 2014). The comparison group's stable or marginal motivation levels reflect this pattern.

This contrast supports earlier findings that instructional quality alone is insufficient to sustain motivation if assessment practices do not align with learning goals (Shumow et al., 2013). Even well-designed laboratory activities may fail to motivate students if assessment emphasizes compliance rather than understanding.

Alignment With Prior Empirical Studies

The present findings are consistent with studies reporting positive relationships between formative assessment, engagement, and learning outcomes in science education. Research on physics and chemistry laboratories has shown that formative assessment interventions improve engagement and conceptual understanding (Asyhari et al., 2024; Özbulut & Uyulgan, 2025). The current study extends this evidence by demonstrating a direct effect on motivation within laboratory contexts.

The results also align with studies emphasizing the importance of mastery-oriented feedback and reduced cognitive load (Liu et al., 2022; Martin et al., 2021). By clarifying expectations and supporting learning processes, Assessment for Learning reduces unnecessary cognitive demands and supports motivation.

Furthermore, the findings complement research on differentiated and participatory assessment approaches. Studies on differentiated assessment and co-design-based formative assessment report improvements in engagement and motivation (Akilli et al., 2017; Kaya & Kaya, 2024). The present study demonstrates that similar principles can be applied within laboratory settings to enhance motivation.

Implications for Science Laboratory Instruction

The findings of this study have important implications for science laboratory instruction. First, they suggest that assessment design should be considered a core component of

laboratory pedagogy rather than an add-on. Assessment for Learning practices can transform laboratories from task-oriented environments into learning-oriented spaces.

Second, the results highlight the importance of feedback literacy. Providing feedback is not sufficient. Students must be supported in understanding and using feedback. Instructional strategies that promote feedback engagement can enhance motivation and self-regulation.

Third, the findings underscore the value of autonomy-supportive assessment practices. Allowing students to make choices, reflect on progress, and revise work supports intrinsic motivation and engagement. These practices align with contemporary goals of science education that emphasize inquiry and learner agency.

Limitations and Directions for Future Research

While the findings are robust, several limitations should be acknowledged. The quasi-experimental design limits causal inference. Although baseline equivalence was established, random assignment was not feasible. Future studies could employ randomized controlled designs to strengthen causal claims.

The study focused on motivation over a limited instructional period. Longitudinal research is needed to examine the sustainability of motivational gains over time. Additionally, future research could explore how Assessment for Learning interacts with individual differences such as prior achievement or goal orientation.

Despite these limitations, the study provides valuable empirical evidence on the motivational benefits of Assessment for Learning in science laboratories.

Conclusion of the Discussion

In summary, the results demonstrate that Assessment for Learning practices have a positive and meaningful effect on student motivation in science laboratory settings. By supporting autonomy, competence, and feedback engagement, formative assessment enhances intrinsic motivation and engagement. These findings reinforce the theoretical and empirical foundations of Assessment for Learning and highlight its potential to improve the quality of science laboratory education.

CONCLUSION

This study examined how Assessment for Learning practices shape student motivation in science laboratory settings. The findings show clear and consistent effects. Formative assessment practices improved intrinsic motivation, perceived autonomy, perceived competence, and active engagement during laboratory work. Students responded positively when assessment focused on learning processes rather than final scores.

Assessment for Learning changed how students experienced laboratory activities. Feedback guided improvement instead of judging performance. Self and peer assessment encouraged reflection and responsibility. Milestone-based tasks helped students track progress and set realistic goals. These elements created a learning environment that supported agency and confidence. As a result, students showed stronger interest and persistence during experiments.

The study also highlights the central role of feedback engagement. Motivation increased when students actively used feedback to revise their work and improve understanding. Feedback became meaningful because it was timely, specific, and connected to clear criteria. This process strengthened self-regulated learning behaviors such as planning, monitoring, and reflection. These behaviors supported sustained engagement in laboratory tasks.

In contrast, traditional assessment practices showed limited impact on motivation. When assessment emphasized reports and grades, students focused on task completion rather than understanding. This pattern reduced opportunities for autonomy and limited the motivational potential of laboratory learning.

The results suggest that assessment design is not neutral. It shapes how students interpret laboratory activities and how they position themselves as learners. Assessment for Learning offers a practical and effective framework to align assessment with inquiry-based science education.

This study contributes empirical evidence that formative assessment practices can enhance motivation in science laboratories. It supports the integration of Assessment for Learning as a core component of laboratory instruction. Future instructional design should treat assessment as a tool for learning, not only as a measure of performance.

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