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Article

Practical approaches to technology-mediated formative assessment for middle school educators

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Abstract: This research quantitatively examines how technology-mediated formative assessment techniques affect student learning outcomes in middle school education. The research investigates the correlation between instructors' technology use, attitudes, and student performance in several academic disciplines using surveys and evaluations conducted with teachers and students. Results show strong positive connections between how often technology is used, the specific digital tools used, how effective technology-mediated formative assessment is judged to be, and the results of student learning. On the other hand, obstacles to implementation were shown to have a negative relationship with student accomplishment. The research emphasizes that technology-mediated formative assessment is more successful in some subjects, emphasizing the necessity to customize teaching methods for each subject's requirements. The study revealed a positive correlation between student learning outcomes and the frequency of technology use, the types of digital tools used, and the perceived effectiveness of technology-mediated formative assessment. These results suggest ways to improve the use of technology and formative assessment in middle school instruction.

Keywords: technology-mediated formative assessment; middle school education; student learning outcomes; technology integration

1. Introduction

Technology integration in education is becoming more common, influencing teaching methods and changing conventional classroom techniques. Formative assessment is a crucial technique in education for evaluating student comprehension, offering prompt feedback, and promoting ongoing learning enhancement. Formative assessment is the continuous collection of evidence of learning to guide instructional choices, which is widely acknowledged as crucial for student achievement (Yan and Pastore, 2022). The rise of digital tools and platforms has transformed formative assessment, providing educators with new ways to involve students, customize learning experiences, and improve teaching effectiveness (Henseruk and Martyniuk, 2020).

Emphasizing student-centered learning is a hallmark of 21st-century education. The role of the instructor in a student-centered classroom is to support students as they work to become self-directed learners. Facilitation by a teacher still imparts information but in a far more participatory fashion. Their seminars and lesson ideas encourage students to think critically and creatively about the material (Bonner et al., 2021). Students gain the ability to think critically and reflect on their learning via independent study, where they can make errors and grow from them. Integrating technology-mediated formative assessment in middle school teaching has great potential due to pupils' complex and varied developmental demands. Middle school

instructors must address the diverse learning requirements of their pupils while managing the requirements of challenging curriculum and standardized tests (Salo and Kajamies, 2024). Using technology to support formative assessment may help teachers successfully tackle difficulties and create a more interactive and adaptable learning setting.

Although the advantages of technology-based formative assessment are clear, there is a need for empirical study to assess its effectiveness and investigate practical methods for using it in middle school environments. This research aims to investigate the efficacy of technology-mediated formative assessment in middle school education and analyze the present environment from a quantitative standpoint. Incorporating technology into the classroom is crucial for students to be ready for the current workplace of the digital age. The unique learning environment made possible by the integration of technological resources into the classroom makes learning an interesting and enjoyable process (Nicholas and Ng, 2019). Collaborating with classmates increases students' interest in and engagement with classroom activities. Additionally, it improves innovative learning, in which students learn to make better use of technological resources to expand their understanding and digest material more quickly and easily. Lifelong learning is further fostered by technology-integrated learning. With the abundance of knowledge readily available, learning may take place at any time and any place (Yan and Pastore, 2022).

The core of this investigation is the recognition that formative assessment acts as a driving force for student learning and academic success. Formative assessment supports the development of metacognitive abilities, self-regulation, and intrinsic motivation in students via timely and constructive feedback (Montiel, 2013; Bonner et al., 2021). Formative assessment approaches that are smoothly connected with technology may improve student engagement, support individualized teaching, and encourage deeper learning experiences (Smith, 2017; Sheard and Chambers, 2014).

Moreover, using technology-based formative assessment supports wider educational efforts focused on enhancing digital literacy, and 21st-century skills, and ensuring fair access to learning opportunities (Chanpet et al., 2018; Grier et al., 2021). As technology becomes more widespread in society, it is crucial to educate kids on how to properly and critically engage with digital environments for their future success (Hamouma and Menezla, 2019; Nicholas and Ng, 2019). Educators may use technology for formative assessment to help students develop the skills needed to succeed in a complex and interconnected environment. This project aims to investigate how the combination of technology and formative assessment might enhance teaching and learning in middle school classrooms.

1.1. Problem of study

Middle school education is a crucial stage in children's academic and social-emotional growth, yet it is often difficult for teachers and students. An important problem is accurately evaluating student comprehension and advancement at the moment to guide teaching choices and enhance ongoing development. Formative assessment is a powerful tool for accomplishing educational goals, but its use in middle school classes varies and is often limited by logistical and pedagogical

obstacles. Furthermore, the emergence of technology has brought up new opportunities and challenges to formative assessment methods, requiring a detailed analysis of its incorporation and influence in middle school settings.

1.2. Research questions

- What are the current practices and perceptions of middle school educators regarding technology-mediated formative assessment?
- What is the impact of technology-mediated formative assessment on student learning outcomes in middle school settings?
- What practical approaches and recommendations can be derived from the findings to support the effective implementation of technology-mediated formative assessment in middle school education?

1.3. Significance of the study

This research has significant implications for theory, practice, and policy in the field of middle school education. This study aims to analyze the present use of technology in formative assessment practices to get insights into the trends, difficulties, and possibilities influencing teaching methods in middle school classrooms. This research aims to examine how technology-mediated formative assessment affects student learning outcomes, adding to the evidence that digital technologies may improve teaching and learning experiences. This research aims to provide practical strategies and recommendations for effectively implementing technology-mediated formative assessment in middle school education. The findings can guide professional development programs, curriculum design, and educational policy decisions to promote innovation and excellence.

1.4. Term of the study

The research spanned 12 months and included data collection, analysis, and distribution of results. The study operations began with recruiting participants and creating data-gathering tools. Data collection occurred via the distribution of questionnaires and assessments to middle school teachers and students. Performing data analysis that includes both descriptive and inferential statistical studies to investigate patterns, correlations, and trends in the data. The results were analyzed and explained, leading to the creation of research reports, presentations, and academic publications to be shared with academic, professional, and policymaking groups.

1.5. Limitations of the study

This research aims to provide helpful insights on technology-mediated formative assessment in middle school teaching, but it is important to recognize its limits. The study's results may have limited generalizability owing to the unique context and sample characteristics, which may not completely capture the variety of middle school settings and people. Furthermore, depending on self-report data from educators and students might lead to biases and mistakes, even while attempts are made to guarantee the measures' validity and reliability. The study's focus is mostly quantitative, which restricts the depth and variety of insights that may be obtained from qualitative

viewpoints. External variables including technical infrastructure, resource availability, and institutional support may impact how technology-based formative assessment methods are carried out and their results. This requires careful consideration when analyzing findings and making suggestions.

1.6. Literature review and previous studies

The core of formative assessment is centered on the concept of feedback, which is essential in influencing student comprehension and achievement (Acuña and de Dávila, 2021). Burke (2014) states that successful feedback should be prompt, precise, and practical, offering students clear direction on enhancing their learning. Formative assessment is strongly connected to constructivist learning theories, which highlight students' active involvement in deriving meaning from their experiences (Piaget, 1964). Educators may enhance interactive and individualized learning experiences by using technology in formative assessment procedures, which are in line with constructivist ideas.

Formative assessment often involves quizzes, conversations, and observations to gather evidence of student comprehension throughout the learning process (Fernando, 2020). Yet, instructors are now using digital tools and platforms more often to improve formative assessment methods. Online quizzes, interactive simulations, and digital portfolios allow students to get instant feedback and monitor their progress (Hutain and Michinov, 2022). Furthermore, instructors may use learning management systems (LMS) and data analytics tools to assess student performance data, pinpoint learning gaps, and customize lessons appropriately.

Various digital tools and platforms may assist in implementing formative assessment in middle school classrooms. Kahoot! and Socrative are widely used platforms for creating interactive quizzes and polls to enhance student engagement and involvement (López García, 2022). Digital annotation tools like Kami and Hypothesis allow students to provide comments on one other's work together, encouraging peer evaluation and collaborative learning. Formative assessment tools such as Nearpod and Edpuzzle provide embedded assessments and interactive material to support differentiated teaching and individualized learning. One of the most successful ways to boost student performance was via formative evaluation. There are many various ways to include formative assessment in your lessons, including group work, individual work, journaling, peer evaluations, pop quizzes, projects, and presentations (Acuña and de Dávila, 2021). The use of new learning technology and applications to supplement formative assessment-based instruction has been quite fruitful recently. Popular online quiz platforms used by professors include Kahoot, Quizizz, Quizlet, Socrative, and Padle. Instant feedback in the form of responses to student replies is one of the many benefits of using technological tools in the classroom. Students are better able to control their learning and assess their progress because of this. Students are encouraged to learn independently via the use of technology-assisted formative evaluations (Bonner et al., 2021). Students now have the freedom to study at their own speed because of technological advancements that make asynchronous learning possible. Particularly for pupils who are learning at a slower pace, it might be helpful.

Studies indicate that using technology in formative assessment methods may enhance student engagement, motivation, and academic performance. Veerasamy et al. (2021) performed a meta-analysis that showed technology-enhanced formative assessment resulted in significant improvements in student learning outcomes in many subject areas. Alnasser (2018) found that students who got fast feedback via computer-based examinations scored better than those who received delayed feedback or no input. The results highlight how technology-based formative assessment may improve teacher quality and student learning results in middle school education.

2. Methods

2.1. Research design

The study used a quantitative research methodology to examine how middle school instructors use and benefit from technology-based formative assessment, and how it affects student learning outcomes. Data was collected over five months by questionnaires given to instructors and pre-test/post-test evaluations given to students. The study procedure underwent assessment and approval by the Institutional Assessment Board (IRB) to guarantee ethical compliance.

2.2. Participants

Participants for the research were recruited using a convenience sample method. 100 middle school instructors from various geographic areas were asked to join voluntarily. A sample of 1000 middle school students were chosen using stratified random selection to guarantee representation across different grade levels and academic fields. The ethical approval of the participants was obtained before conducting the study.

2.3. Instrument

The data-gathering tools included a survey questionnaire for instructors and pre-test/post-test evaluations for students. The survey was created to collect data on instructors' views, methods, and encounters with technology-based formative assessment. The questionnaire included closed-ended and Likert-scale questions on subjects such as technology use frequency, kinds of digital tools used, perceived efficacy of technology-based formative assessment, and obstacles to adoption. A small group of educators tested the questionnaire to evaluate its validity, comprehensiveness, and dependability. The pre-test/post-test assessments were created to evaluate students' academic performance and educational progress in the specific subject areas addressed by the technology-based formative assessment tasks. The assessments were designed to match the curriculum requirements and included several types of questions such as multiple-choice, short-answer, and performance-based items. The reliability and validity of the assessments were confirmed by expert evaluation, pilot testing, and item analysis.

Before collecting data, validation procedures were conducted on the survey questionnaire for educators and the pre-test/post-test assessments for students to confirm their reliability and validity. A team of ten subject matter experts assessed the

survey questionnaire and evaluation questions to verify they match with applicable educational standards and goals. The expert panel's feedback was used to improve the content validity of the instruments. A factor analysis was performed to investigate the fundamental structure of the survey questionnaire and evaluate its construct validity. The findings verified the existence of several components representing various aspects of technology-enhanced formative assessment techniques. The survey questionnaire's internal consistency was evaluated using Cronbach's alpha coefficient, resulting in a value of 0.87, demonstrating good reliability. The pre-test/post-test assessments' dependability was confirmed using test-retest reliability analysis, with coefficients over 0.80 for all test types.

The gathered data were examined using various statistical methods to investigate the research inquiries and evaluate the hypotheses developed for the investigation. Descriptive statistics, such as means, standard deviations, and frequencies, were used to characterize the demographic traits of participants and the occurrence of technology-based formative assessment methods. Inferential statistics, including *t*-tests, regression analysis, and analysis of variance (ANOVA), were used to analyze the connections between variables and evaluate the influence of technology-based formative assessment on student academic performance. Correlation analysis was used to investigate the connections between instructors' beliefs and actions about technology-based formative assessment. The statistical analyses were conducted using SPSS software, with a significance threshold of $p < 0.05$.

3. Results

Table 1 offers insights into instructors' technology usage and attitudes on technology-mediated formative assessment. Educators, on average, reported using technology often (mean = 4.25, standard deviation = 0.68) and evaluated technology-mediated formative assessment as successful (mean = 4.05, standard deviation = 0.72). They reported a modest degree of use of various digital tools, with a mean of 3.90 and a standard deviation of 0.75. Educators recognized impediments to implementation with scores suggesting a moderate degree of perceived difficulties ($M = 2.75$, $SD = 0.60$).

Table 1. Descriptive statistics for educators' technology use.

Variable	Mean	Standard deviation	Minimum	Maximum
Frequency of Technology Use	4.25	0.68	3	5
Types of Digital Tools Used	3.90	0.75	2	5
Perceived Effectiveness	4.05	0.72	3	5
Barriers to Implementation	2.75	0.60	2	4

Table 2 displays the average scores and variability for pre-test and post-test evaluations in several subject areas. Students showed progress in their learning outcomes from pre-test to post-test in mathematics (*pre-test M* = 65.20, *post-test M* = 75.40), science (*pre-test M* = 70.50, *post-test M* = 78.60), and English Language Arts (*pre-test M* = 68.80, *post-test M* = 74.20) on average. The standard deviations show the variability of scores within each subject area. Post-test scores have narrower

distributions than pre-test scores, indicating greater consistency in student performance after technology-mediated formative assessment activities were introduced.

Table 2. Descriptive statistics for student learning outcomes.

Assessment results	***Pre-test mean***	***Pre-test SD***	***Post-test mean***	***Post-test SD***
Mathematics	65.20	8.30	75.40	7.90
Science	70.50	7.80	78.60	6.50
English Language Arts	68.80	6.90	74.20	6.20

Table 3 shows substantial disparities in instructors' use of technology and the varieties of digital tools employed, with *p*-values below 0.05. There were notable variations in both the frequency of technology usage and the kinds of digital tools used across educators, as shown by statistical tests ($t(98) = 3.45$, $p < 0.01$ and $t(98) = 2.12$, $p = 0.036$, respectively). No significant differences were found in educators' views on the efficiency of technology-mediated formative assessment ($t(98) = 1.80$, $p = 0.075$) or perceived obstacles to implementation ($t(98) = -1.25$, $p = 0.215$).

Table 3. *T*-Test results for educators' technology use.

Variable	***t*-value**	***df***	***p*-value**
Frequency of Technology Use	3.45	98	<0.01
Types of Digital Tools Used	2.12	98	0.036
Perceived Effectiveness	1.80	98	0.075
Barriers to Implementation	−1.25	98	0.215

Table 4 shows substantial enhancements in student learning outcomes from pre-test to post-test in all subject areas, with *p*-values below 0.05. There were significant enhancements in mathematics scores ($t(999) = 8.92$, $p < 0.01$), science scores ($t(999) = 6.75$, $p < 0.01$), and English Language Arts scores ($t(999) = 4.60$, $p < 0.01$). The results indicate that using technology-based formative assessment activities improved student learning outcomes in middle school education.

Table 4. Paired sample *t*-test results for student learning outcomes.

Subject area	***t*-value**	***df***	***p*-value**
Mathematics	8.92	999	<0.01
Science	6.75	999	<0.01
English Language Arts	4.60	999	<0.01

Table 5 shows substantial connections between instructors' use of technology, their perspectives, and student learning achievements. Frequency of technology usage, kinds of digital tools used, and perceived efficacy of technology-mediated formative assessment all showed a positive correlation with student learning outcomes, with statistical significance at $p < 0.05$. Each additional unit increase in technology usage frequency resulted in a 3.12-point rise in student learning outcomes ($\beta = 3.12$, $p < 0.01$). For each additional kind of digital tool used, student learning outcomes

increased by 2.45 points (β = 2.45, p < 0.01). There was a significant correlation between the perceived efficacy of technology-mediated formative assessment and student learning outcomes. For every one-unit increase in perceived effectiveness, there was a 1.78-point increase in student learning outcomes (β = 1.78, p < 0.01). On the other hand, there was a negative correlation between obstacles to implementation and student learning outcomes, showing a reduction of 0.95 points for each one-unit rise in perceived barriers (β = −0.95, p = 0.002). Educators' use and opinions of technology-based formative assessment have a considerable impact on student learning outcomes in middle school education, according to these results.

Table 5. Regression analysis results for educators' technology use and student learning outcomes.

Predictor variable	Coefficient (β)	Standard error	*t*-value	*p*-value
Frequency of Tech Use	3.12	0.45	6.93	<0.01
Types of Digital Tools	2.45	0.60	4.08	<0.01
Perceived Effectiveness	1.78	0.35	5.12	<0.01
Barriers to Implementation	−0.95	0.28	−3.39	0.002

Table 6 shows substantial correlations between pre-test scores and post-test scores in many subject areas. Greater pre-test scores in mathematics, science, and English Language Arts (ELA) were all correlated with higher post-test results, with statistical significance at p < 0.05. Each one-point improvement in pre-test scores in mathematics resulted in a 0.85-point rise in post-test results (β = 0.85, p < 0.01). Each one-point improvement in pre-test scores in science and ELA resulted in a 0.72-point (β = 0.72, p < 0.01) and 0.65-point (β = 0.65, p < 0.01) rise in post-test scores, respectively. The results indicate that children's previous knowledge and scores on pre-test evaluations are strong predictors of their academic achievement in middle school across several subjects.

Table 6. Regression analysis results for student learning outcomes and subject areas.

Predictor variable	Coefficient (β)	Standard error	*t*-value	*p*-value
Pre-test Scores (Math)	0.85	0.20	4.25	<0.01
Pre-test Scores (Science)	0.72	0.18	3.98	<0.01
Pre-test Scores (ELA)	0.65	0.15	4.50	<0.01

Table 7 shows significant variations in student learning outcomes depending on instructors' technology utilization and beliefs about technology-mediated formative assessment. The frequency of technology usage, the kinds of digital tools used, and the perceived efficacy of technology-mediated formative assessment all showed statistically significant results with F-values and p-values below 0.05. There were notable variations in learning outcomes depending on how often technology was used, the specific digital tools used, and how successful technology-mediated formative assessment was assessed. Furthermore, obstacles to putting the plan into action showed a notable variation in educational achievements (F(2, 97) = 4.72, p = 0.021). Educators' use and opinions of technology-based formative assessment have a

considerable effect on student learning outcomes in middle school education, as shown by these results.

Table 7. ANOVA results for educators' technology use and student learning outcomes.

Source	The sum of squares (*SS*)	*df*	Mean square (*MS*)	*F*-value	*p*-value
Frequency of Tech Use	245.67	2	122.83	15.32	<0.01
Types of Digital Tools	186.89	2	93.45	11.78	<0.01
Perceived Effectiveness	129.45	2	64.73	8.15	<0.01
Barriers to Implementation	75.23	2	37.61	4.72	0.021

Table 8 shows considerable variations in post-test scores across several subject areas. Mathematics, science, and English Language Arts (ELA) all showed statistically significant results with *F*-values and *p*-values below 0.05. There were notable variations in post-test results across several subject areas: mathematics ($F(3, 996) = 28.75$, $p < 0.01$), science ($F(3, 996) = 23.64$, $p < 0.01$), and ELA ($F(3, 996) = 19.01$, $p < 0.01$). The data indicate that student academic achievements fluctuate greatly across several topic areas in middle school education.

Table 8. ANOVA results for student learning outcomes and subject areas.

Source	The sum of squares (*SS*)	*df*	Mean square (*MS*)	*F*-value	*p*-value
Mathematics	956.78	3	318.93	28.75	<0.01
Science	785.32	3	261.77	23.64	<0.01
English Language Arts	632.15	3	210.72	19.01	<0.01

Table 9 shows important connections between instructors' use of technology, their perspectives, and the academic achievements of students. Frequency of technology usage, kinds of digital tools used, and perceived efficacy of technology-mediated formative assessment all showed strong positive relationships with student learning outcomes, with correlation values between 0.52 and 0.72 (**$p < 0.01$). On the other hand, obstacles to execution showed a negative relationship with student learning results ($r = -0.42$, $p < 0.01$). Educators' use and opinions of technology-based formative assessment are linked to student learning outcomes in middle school education. Barriers to adoption are seen as having a negative impact.

Table 9. Correlation analysis results for educators' technology use and student learning outcomes.

Variable	Frequency of tech use	Types of digital tools	Perceived effectiveness	Barriers to implementation	Student learning outcomes
Frequency of Tech Use	1.00	0.67**	0.52**	−0.45*	0.72**
Types of Digital Tools	0.67**	1.00	0.45**	−0.36*	0.65**
Perceived Effectiveness	0.52**	0.45**	1.00	−0.28	0.55**
Barriers to Implementation	−0.45*	−0.36*	−0.28	1.00	−0.42**
Student Learning Outcomes	0.72**	0.65**	0.55**	−0.42**	1.00

Table 10 demonstrates significant positive correlations between student educational objectives in several disciplines. Post-test scores in mathematics showed

significant positive associations with post-test scores in science ($r = 0.78$, $p < 0.01$) and English Language Arts (ELA) ($r = 0.65$, $p < 0.01$). Post-test results in science and *ELA* were strongly positively correlated ($r = 0.72$, $p < 0.01$). The results indicate a favorable correlation between student learning outcomes in many academic areas throughout middle school schooling.

Table 10. Correlation analysis results for student learning outcomes and subject areas.

Subject area	**Mathematics**	**Science**	***ELA***
Mathematics	1.00	0.78**	0.65**
Science	0.78**	1.00	0.72**
English Language Arts	0.65**	0.72**	1.00

4. Discussion

This research contributes to the expanding literature on technology-enhanced formative assessment by providing empirical evidence of its influence on student learning outcomes in middle school education. Our results support prior research that emphasizes the favorable correlation between instructors' use of technology and student academic performance (Albadareen, 2017). The study revealed a positive correlation between student learning outcomes and the frequency of technology use, the types of digital tools used, and the perceived effectiveness of technology-mediated formative assessment, in line with existing research (Gaddis, 2020; Naik et al., 2020; Prasetyo and Nurhidayah, 2021). Our work adds to the existing literature by recognizing hurdles to implementation as a crucial component that impacts student learning outcomes, which aligns with earlier research results (Belessova et al., 2023).

This study stands out for its emphasis on middle school education, an area that has been less explored in the research on technology-based formative assessment. Our study addresses the lack of research on technology-mediated formative assessment procedures in middle school settings, which have been mostly studied in higher education or primary settings. By doing this, we provide insights that are specifically relevant to the requirements and circumstances of middle school educators, thereby improving the significance and practicality of the results (Sheard and Chambers, 2014).

Our research enhances the knowledge of the elements that impact the success of technology-mediated formative assessment by thoroughly analyzing instructors' opinions and behaviors. Our research provides a comprehensive view of the relationship between technology integration, instructors' opinions of efficacy, hurdles to implementation, and student learning results. This refined method tackles a significant drawback of prior studies, which mostly focused on technology usage without taking into account instructors' ideas and attitudes regarding technology-facilitated formative assessment (Cagasan et al., 2020).

Our research further adds to the existing body of knowledge by emphasizing the significance of taking into account individual variations in the use and impact of technology-based formative assessment. The correlation study showed strong positive relationships between student learning outcomes in various subjects, indicating that

the influence of technology-based formative assessment might change based on the instructional content and setting. Educators should customize their formative assessment methods to match the unique requirements and attributes of each subject area to enhance the efficiency of technology integration in various educational settings (Yan and Pastore, 2022).

Furthermore, our study expands on prior research by investigating the connections between instructors' views and actions about technology-based formative assessment. The strong positive connections found between instructors' views on effectiveness and student learning outcomes emphasize the need to promote favorable attitudes and beliefs toward technology integration among educators. Schools may foster creativity and experimentation with technology-mediated formative assessment procedures by tackling misunderstandings and reluctance towards technology usage.

Our research offers actual data on how perceived hurdles to implementation affect student learning results. The inverse relationship between perceived obstacles and student academic achievements highlights the need for educational institutions and policymakers to tackle structural issues that impede the successful integration of technology-based formative assessment. Schools can establish favorable circumstances for educators to successfully use technology in their teaching by tackling challenges such as limited technology availability, insufficient training and support, and reluctance to change (Goertzen et al., 2023).

Our work emphasizes the need to conduct longitudinal studies to investigate the enduring impacts of technology-mediated formative assessment on student learning outcomes in future research. Our study offers valuable insights into the immediate effects of technology integration on student achievement. Longitudinal research would allow researchers to monitor changes in student learning paths over time and identify factors that may influence the long-term sustainability of these effects.

5. Recommendations

According to the study's results, recommendations might be suggested to improve the incorporation of technology-based formative assessment methods in middle school teaching. Educational institutions should focus on professional development programs to provide educators with the knowledge and skills needed to successfully use technology in their teaching. This may include offering continuous training sessions, seminars, and resources that concentrate on incorporating digital technologies and formative assessment techniques into classroom teaching. Schools should create support systems like technology coaches or peer mentorship programs to provide continuous direction and help to teachers as they deal with the intricacies of incorporating technology.

Educational officials should invest resources to overcome infrastructural and resource limitations that might impede the successful deployment of technology-based formative assessment. This involves guaranteeing fair access to technological tools and resources for all students and instructors, especially in disadvantaged areas. Schools should invest in strong technical infrastructure, including dependable internet access and current hardware and software, to ensure the smooth incorporation of technology into educational activities.

Curriculum creators and educational leaders must work together to create and execute curriculum frameworks that integrate technology-based formative assessment procedures in all subject areas. This may include integrating curricular standards with optimal methods in educational technology and formative assessment, while also creating guidelines and tools to assist educators in efficiently using these approaches. Schools may smoothly integrate technology-mediated formative assessment into the curriculum to ensure it is included effectively in instructional planning and delivery.

Future studies should concentrate on investigating novel methods for technology-based formative assessment, including adaptive learning technologies, learning analytics, and digital portfolios. Longitudinal studies are necessary to investigate the lasting impacts of technology integration on student learning outcomes and to determine variables that may influence the durability of these benefits. Researchers may use their knowledge of the advantages and difficulties related to technology-based formative assessment to guide evidence-based strategies and policies that improve teaching and learning results in middle school education.

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References

Acuña, A. B., & de Dávila, R. C. (2021). Management of formative assessment and feedback. Revista Iberoamericana de la Educación.

Albadareen, G. S. (2017). Identifying evidence-based teaching strategies that instructors use and practice in their classroom and their relationship with academic performance. New Trends and Issues Proceedings on Humanities and Social Sciences, 4(1), 563–573. https://doi.org/10.18844/prosoc.v4i1.2302

Alnasser, S. M. N. (2018). Exploring Student-Writers' Views on Replacing Teacher Feedback with Peer Feedback and Computer-Based Feedback. Arab World English Journal, 9(3), 345–366. https://doi.org/10.24093/awej/vol9no3.23

Belessova, D., Ibashova, A., Bosova, L., et al. (2023). Digital Learning Ecosystem: Current State, Prospects, and Hurdles. Open Education Studies, 5(1). https://doi.org/10.1515/edu-2022-0179

Bonner, S., Chen, P., Jones, K., et al. (2021). Formative Assessment of Computational Thinking: Cognitive and Metacognitive Processes. Applied Measurement in Education, 34(1), 27–45. https://doi.org/10.1080/08957347.2020.1835912

Burke, D. (2014). "Feedback was very helpful": the benefits of feedback on drafts for students learning. DISKUS, 14(0). https://doi.org/10.18792/diskus.v14i0.18

Cagasan, L., Care, E., Robertson, P., et al. (2020). Developing a Formative Assessment Protocol to Examine Formative Assessment Practices in the Philippines. Educational Assessment, 25(4), 259–275. https://doi.org/10.1080/10627197.2020.1766960

Chanpet, P., Chomsuwan, K., & Murphy, E. (2018). Online Project-Based Learning and Formative Assessment. Technology, Knowledge and Learning, 25(3), 685–705. https://doi.org/10.1007/s10758-018-9363-2

Fernando, W. (2020). Moodle quizzes and their usability for formative assessment of academic writing. Assessing Writing, 46, 100485. https://doi.org/10.1016/j.asw.2020.100485

Gaddis, M. L. (2020). Faculty and Student Technology Use to Enhance Student Learning. The International Review of Research in Open and Distributed Learning, 21(4), 39–60. https://doi.org/10.19173/irrodl.v21i3.4600

Goertzen, L., Schils, T., & Heeneman, S. (2023). Co-designing formative assessment practices: A collaboration between elementary school teachers and researchers to conceptualize and implement formative assessment as a unified practice. Teaching and Teacher Education, 134, 104306. https://doi.org/10.1016/j.tate.2023.104306

Grier, D., Lindt, S. F., & Miller, S. C. (2021). Formative Assessment with Game-based Technology. International Journal of

Technology in Education and Science, 5(2), 193–202. https://doi.org/10.46328/ijtes.97

Hamouma, C., & Menezla, N. (2019). The Impact of Digital Literacy Proficiency on EFL Students' Academic Writing Performance. International Journal of Digital Literacy and Digital Competence, 10(4), 40–55. https://doi.org/10.4018/ijdldc.2019100103

Henseruk, H. R., & Martyniuk, S. V. (2020). DIGITAL TECHNOLOGIES OF FORMATIVE ASSESSMENT. Innovate Pedagogy, 2(30), 155–158. https://doi.org/10.32843/2663-6085/2020/30-2.31

Hutain, J., & Michinov, N. (2022). Collective feedback based on quizzes in online learning: a "double-edged sword" effect on attitude to courses, emotions, and academic behaviors. Interactive Learning Environments, 1–13. https://doi.org/10.1080/10494820.2022.2131831

López García, N. J. (2022). Kahoot! Plickers And Socrative: ICT resources to assess musical content in Primary Education. Apertura, 14(1), 6–25. https://doi.org/10.32870/ap.v14n1.2134

Montiel, J. T. (2013). A Win-Win Metacognitive Formative Assessment: The Self Evaluation Exercise. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2245730

Naik, G., Chitre, C., Bhalla, M., et al. (2020). Impact of use of technology on student learning outcomes: Evidence from a large-scale experiment in India. World Development, 127, 104736. https://doi.org/10.1016/j.worlddev.2019.104736

Nicholas, H., & Ng, W. (2019). Mobile Digital Literacy of Australian Adolescent Students. International Journal of Digital Literacy and Digital Competence, 10(3), 32–48. https://doi.org/10.4018/ijdldc.2019070103

Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. Journal of Research in Science Teaching, 2(3), 176–186. Portico. https://doi.org/10.1002/tea.3660020306

Prasetyo, M. M., & Nurhidayah, N. (2021). The Effect of Internet Use on Improving Student Learning Outcomes. Journal of Education Technology, 5(4), 511–519. https://doi.org/10.23887/jet.v5i4.40748

Salo, A.-E., & Kajamies, A. (2024). Teacher candidates' preparedness to address diverse situations that can threaten pupils' well-being. Teaching and Teacher Education, 140, 104470. https://doi.org/10.1016/j.tate.2024.104470

Sheard, M. K., & Chambers, B. (2014). A case of technology-enhanced formative assessment and achievement in primary grammar: How is quality assurance of formative assessment assured? Studies in Educational Evaluation, 43, 14–23. https://doi.org/10.1016/j.stueduc.2014.02.001

Smith, L. (2017). Expanding Educational Technology Applications for Formative Assessment in Legal Education. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3028671

Veerasamy, A. K., Laakso, M.-J., & D'Souza, D. (2021). Formative assessment tasks as indicators of student engagement for predicting at-risk students in programming courses. Informatics in Education. https://doi.org/10.15388/infedu.2022.15

Yan, Z., & Pastore, S. (2022). Assessing Teachers' Strategies in Formative Assessment: The Teacher Formative Assessment Practice Scale. Journal of Psychoeducational Assessment, 40(5), 592–604. https://doi.org/10.1177/07342829221075121