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AUTOMATED ASSESSMENT AND FEEDBACK IN DIFFERENTIAL CALCULUS AT THE MATHEMATICS EDUCATION DEPARTMENT

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Abstract

Assessment and feedback are essential components in the learning process, particularly in Differential Calculus courses, which are characterized by complex conceptual and procedural content. This study aims to explore the implementation of technology-based automatic assessment and feedback systems in Differential Calculus learning within the Mathematics Education department. A descriptive qualitative method was employed through a case study approach involving digital platforms that offer automatic evaluation features and instant feedback. The results show that this system helps students quickly recognize errors, increases learning enthusiasm, and speeds up evaluation for lecturers. In addition, students are more active in assessing their mathematical thinking process through feedback generated by the system. These findings suggest that integrating automatic assessment technology can improve the effectiveness and efficiency of Differential Calculus instruction in higher education settings.

Keywords: *automatic assessment, feedback, differential calculus, mathematics education, learning technology*

Abstrak

Penilaian dan umpan balik merupakan komponen penting dalam proses pembelajaran, khususnya dalam mata kuliah Kalkulus Diferensial yang memiliki karakteristik konseptual dan prosedural yang kompleks. Penelitian ini bertujuan untuk mengkaji penerapan sistem penilaian dan umpan balik otomatis berbasis teknologi dalam pembelajaran Kalkulus Diferensial di jurusan Pendidikan Matematika. Metode yang digunakan adalah studi kualitatif-deskriptif dengan pendekatan studi kasus terhadap penggunaan platform digital yang menyediakan fitur evaluasi otomatis dan pemberian umpan balik instan. Hasil menunjukkan bahwa sistem ini membantu mahasiswa dengan cepat mengenali kesalahan, meningkatkan semangat belajar, dan mempercepat evaluasi bagi dosen. Di samping itu, mahasiswa lebih aktif berpartisipasi dalam menilai proses pemikiran matematis mereka melalui umpan balik yang dihasilkan oleh sistem. Temuan ini merekomendasikan integrasi teknologi evaluasi otomatis sebagai bagian dari strategi pembelajaran untuk meningkatkan efektivitas dan efisiensi dalam pengajaran Kalkulus Diferensial di tingkat pendidikan tinggi.

Kata kunci: penilaian otomatis, umpan balik, kalkulus diferensial, pendidikan matematika, teknologi pembelajaran

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BACKGROUND

Automated assessment and feedback tools are gaining interest because they can speed up the evaluation process while encouraging students' independent learning. Students can review their work and receive instant feedback through automated assessment tools. This supports them in becoming more responsible for their learning. Developing this sense of independence is essential to help them get used to solving problems independently and build the habit of studying without relying on others (Acuña, R & Bansal, A., 2024). One thing that really stands out about automated feedback is how fast it is. Students don't have to wait to see their results, and that quick turnaround often gets them more interested and helps them understand the lessons better (Hahn et al., 2021).

Lecturers' views are increasingly being considered as an important element in assessing how effective the use of artificial intelligence-based assessment tools in higher education is, especially in shaping their implementation, beliefs, and influence on students' learning processes. Understanding this perspective is crucial, as it can provide direction in creating more effective methods and improving the performance of artificial intelligence in education, which in turn will improve student learning outcomes (Mutanga et al., 2024). In line with this, the findings indicate that addressing lecturers' concerns and misconceptions about AI can facilitate its more efficient use, contributing to more impactful teaching and enhanced student achievement (Lam et al., 2023).

Previous research is limited in exploring the long-term impact of using automated assessment tools on students' self-directed learning motivation. While many studies focus on cognitive resources and motivational factors, they frequently fail to consider how these elements interact and evolve (Barkela, Schmitt, & Leuchter, 2023). Existing findings indicate that, although students perceive automated feedback systems (AFS) positively and can use them to support their development and identify areas for improvement, the extent to which these tools influence sustained motivation for independent learning remains insufficiently explored (Li & Kim, 2024).

There's increasing interest in using automated assessment and feedback tools to make the evaluation process more efficient while keeping quality high. These tools provide quick, personalized feedback that can really help students sharpen both their understanding and their ability to think about their own learning. This article also explains how automated assessment tools can help reduce bias and keep evaluations consistent (Hahn et al., 2021). These factors are important for making sure assessments stay reliable and high-quality, which supports the case for paying more attention to these tools (Zhao, 2025)

Automated assessment and feedback tools are based on adaptive learning, which adapts the educational experience to the learner's needs and seeks to personalize educational experiences to meet individual learners' needs. Building on this foundation, these tools offer timely and specific feedback that supports self-regulated learning (SRL) and facilitates continuous monitoring of student progress. This allows educators to deliver tailored support that responds to cognitive performance and motivational and emotional factors (Mejeh, Sarbach, & Hascher, 2024). A literature review suggests that these tools aim to enhance learning outcomes. By continuously adapting to individual learner profiles, automated systems contribute to equitable and compelling learning experiences—an outcome that represents the core value of adaptive learning environments (Messer et al., 2023).

PROBLEM FORMULATION

This study looks into how well automated assessment and feedback tools work in math teaching, focusing especially on how they can replace or support traditional methods in Differential Calculus classes. Using digital tools like online quizzes or worksheets offers a promising way to track students' progress more effectively. This tool is capable of providing immediate feedback, which plays a crucial role in supporting students to understand and remember the key ideas of Differential Calculus (Hasibuan, 2023). A good feedback system is essential in teaching mathematics. Automated tools that provide instant responses allow students to quickly identify and correct misunderstandings, thereby supporting the development of stronger problem-solving skills and deeper conceptual understanding (Fonseca et al., 2024).

RESEARCH OBJECTIVES

This study takes a closer look at how generative digital tools are being used in student assessment,

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particularly their impact on learning outcomes, student participation, and the practical challenges teachers face when adopting them in real classrooms. In doing so, it also attempts to address some of the gaps in existing research about how these technologies shape educational practices. Understanding how these tools actually fit into the day-to-day realities of assessment is essential for seeing their broader effects on both students and educators (Ahmed et al., 2024). One key finding points to the ability of generative AI to reduce the burden on teachers by handling repetitive tasks like grading and giving feedback. With these time-consuming jobs off their plate, teachers can focus more on deeper aspects of instruction—something that could eventually lead to a shift in how assessment is approached in higher education (Lee & Moore, 2024).

METHOD

DESIGN

Quantitative research design utilizes questionnaires to regularly and standardize the collection of numerical information from respondents. Quantitative research centers on the collection and analysis of numerical data to answer specific research questions. Among the various tools used in this method, questionnaires are particularly effective for gathering structured information that supports hypothesis testing (Branaghan et al., 2021). This underscores the important role that quantitative approaches especially the use of questionnaires play in studies that rely on empirical validation. Unlike qualitative research, which often focuses on exploring ideas and generating new hypotheses, quantitative methods are designed to confirm or refute existing theories through measurable evidence. (*Quantitative Research*, 2023).

PARTICIPANT

This study involved 30 students of the Mathematics Education program who were taking the Differential Calculus course. Given calculus's complexity and cognitive demands, this research focuses on understanding the relationship between cognitive load and brain activity during learning (Oktaviyanthi & Agus, 2024). By examining students who are actively enrolled in the Differential Calculus course, the study also seeks to assess their comprehension of the material and their level of self-efficacy, thereby offering insights into the challenges and dynamics of their learning experiences (Jasmi et al., 2024)

RESEARCH INSTRUMENT

The study used questionnaires to gather quantitative data efficiently and accurately. The study used questionnaires to gather quantitative data efficiently and accurately. Questionnaires are practical tools for reaching a large audience quickly, making them highly suitable for quantitative research (Bihu, R.2021). To support this effectiveness, the questionnaire used in the study must have high validity and reliability so that the results are not biased. This emphasizes the importance of designing the right questionnaire to ensure the accuracy of the data obtained (Nursalam & Djaha, 2023).

DATA COLLECTION PROCEDURE

The data collection process begins with identifying participants, followed by the distribution of a carefully designed questionnaire. This part outlines several methods most notably, survey questionnaires used to obtain more in-depth insights from respondents (Klingebiel et al., 2024). The use of structured questionnaires fits within a broader methodological framework designed to ensure the reliability and validity of the data collected. Such rigor is essential to produce credible research results that inform practice or policy(Strandhagen, 2022).

DATA ANALYSIS

The collected data was analyzed using a preliminary testing method to assess how effective the automated assessment tool was. The results showed that the increased technological capabilities, facilitated by the automated assessment tool, were able to produce better hiring outcomes and increase productivity in the accounting field, while considering the value of data analysis to assess the impact of the tool (Sarsa et al., 2022). Moreover, the proposed evaluation approach, which utilizes data collected

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from an introductory programming course, demonstrates that grounding the analysis in real-world applications is essential for accurately assessing the effectiveness of such tools (Coyne et al., 2024).

DATA TRIANGULATION

When conducting this study, triangulation was used by gathering input from a variety of participants and combining different methods to look at the data from several viewpoints. Instead of depending on one source or technique, the approach was to cross-verify the findings to see if they remained consistent across various angles. This way, the research could minimize bias and build stronger confidence in the results. This includes data triangulation, which involves comparing information from multiple respondents or sources, and methodological triangulation, which entails using more than one data collection method (Marlina et al., 2024). Furthermore, triangulation serves as a foundation for deepening knowledge and understanding, particularly in mixed-method research designs, as it offers a more comprehensive perspective on the research questions and enhances the precision of the results (Meydan & Akkaş, 2024)

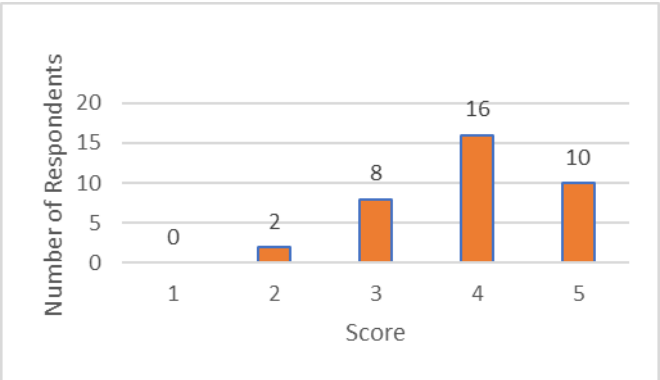
RESULT AND DISSCUSION

Data from the instrument questionnaire

The data collected from the questionnaire indicate positive student perceptions regarding using Automated Assessment and Feedback Tools in Differential Calculus. This study collected data from ±30 Faculty of Islamic Education and Teacher Training students at Syarif Hidayatullah State Islamic University to evaluate the implementation of Automated Assessment and Feedback in the Differential Calculus course within the Department of Mathematics Education. For this study, the participants were students currently enrolled in the course who agreed to take part in using the digital assessment system. To learn about their experiences and opinions regarding the automated system, a carefully prepared questionnaire was used. This allowed the researchers to gather honest feedback about how the system was received. In addition, a literature review was conducted, analyzing findings from previous journals that discussed similar implementations of automated assessment in mathematics education to support the results and provide a comparative framework. Through this approach, the study not only assessed the impact of the system on students' conceptual understanding but also examined the relevance and benefits of such technology in the context of higher education mathematics instruction.

Diagram 1. Research Results Diagram on Improving Teaching Techniques Using Automated Assessment Tools

The results of this study indicate that the use of automated assessment tools has a positive impact on improving teaching techniques. Data were obtained from 36 respondents who had used automated assessment tools in the mathematics learning process, especially in teaching differential calculus. Respondents were asked to assess the tool's effectiveness using a scale of 1 to 5, where one indicates "very ineffective" and five indicates "very effective."



The distribution of respondents' scores shows that most gave a high assessment. No respondents gave a score of 1, and only two people (5.6%) scored 2. Eight respondents (22.2%) scored 3, indicating a neutral view of the tool's effectiveness. A score of 4 was given by 16 respondents (44.4%), while 10

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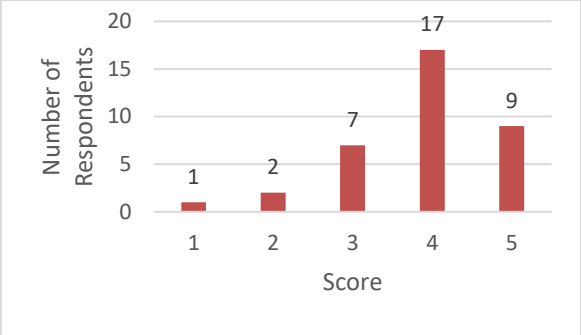
respondents (27.8%) showed a score of 5. Thus, as many as 72.2% of respondents gave an upbeat assessment (scores 4 and 5), indicating high satisfaction with this tool.

These results generally indicate that most respondents consider automated assessment tools adequate. This tool can increase the speed of providing student feedback, accelerate the assessment process, and help teachers identify students' understanding of mathematical concepts more precisely and efficiently. Fast feedback allows teachers to immediately intervene in learning, while students can immediately discover their mistakes and correct them directly.

In addition, the use of automated assessment tools is also considered to contribute to improving student learning outcomes. This happens because the efficient assessment process allows learning to take place in a more focused and targeted manner. Teachers can allocate more time for active and reflective learning instead of spending time on manual correction processes. Based on these findings, automated assessment tools have great potential to support more effective and adaptive teaching to students' needs.

Diagram 2. Research Results Diagram on Implementing Effective Mathematics Teaching Using Automated Assessment Tools



The results of this study indicate that most respondents responded positively to the use of automated assessment tools in implementing effective mathematics teaching. Of the 36 respondents involved, 17 (47.2%) scored 4, and 9 (25%) scored 5. This shows that most respondents consider this approach practical or very effective. As many as seven respondents (19.4%) gave a score of 3, indicating a neutral perception, while only two respondents (5.6%) gave a score of 2, and 1 respondent (2.8%) gave a score of 1.

This score distribution reflects that using automated assessment tools has positively impacted the mathematics teaching process. Most respondents felt this tool could help implement more targeted teaching strategies based on accurate assessment results. This tool allows teachers to better understand how students learn mathematics and the difficulties they experience. With assessment data available directly, teachers can identify areas of concepts that students have not mastered and adjust teaching approaches to better suit the learning needs in the classroom.

In addition, the results of this study also show that using automated assessment tools helps teachers implement responsive incorporating data-informed instruction allows teachers to identify how students are progressing with specific concepts and adjust their teaching strategies accordingly, either by reinforcing challenging areas or extending learning opportunities ultimately fostering a more personalized and impactful educational experience. These data indicate that automated assessment tools are essential in supporting more effective mathematics teaching implementation. Although a few respondents gave low ratings, most believed that implementing this tool supports the achievement of learning objectives and improves the quality of learning interactions in the classroom.

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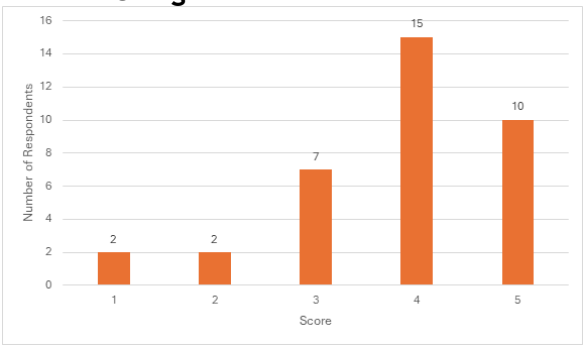
Diagram 3. Research Results Diagram on Enhancing Understanding in Differential Calculus Teaching to Address Student Learning Disabilities Using Automated Assessment Tools



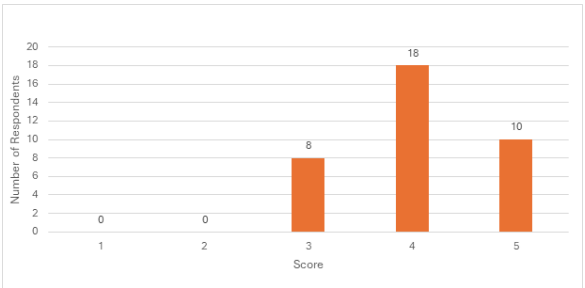
The study results showed that the use of automated assessment tools in teaching differential calculus to overcome students' learning difficulties received a very positive response from most respondents. Of the total 36 respondents, 15 people (41.7%) gave a score of 4, and 10 (27.8%) scored 5, reflecting that most participants felt that this tool was effective in helping a more inclusive differential learning process. A total of 7 respondents (19.4%) gave a score of 3, indicating a neutral view. Meanwhile, only two respondents (5.6%) scored 2, and 2 other respondents (5.6%) scored 1, indicating a slight doubt about the effectiveness of using this tool.

The distribution of the data shows that automated assessment tools can support students' understanding of differential calculus concepts in a more focused manner, especially for students who experience learning difficulties. Through automatic analysis of student work results, teachers can obtain clear information about areas of concepts that have not been understood and the types of errors or misconceptions that commonly occur. Thus, this tool allows teachers to develop more targeted learning strategies to respond to students' needs.

This tool also strengthens the adaptive and data-driven learning process, where teachers not only rely on final assessments but can provide timely interventions based on measurable progress indicators. In the context of differential calculus, which is known to be complex, monitoring student progress continuously becomes very important to prevent the accumulation of learning difficulties. Technology-based approaches such as automated assessments can strengthen teaching effectiveness and provide additional support for students who need it.

In general, the findings of this study indicate that the use of automated assessment tools in teaching differential calculus has a great potential to improve student understanding, detect learning difficulties early, and offer learning assistance that is more tailored to individual needs. Although a few respondents expressed doubts, the dominance of high scores reflects a good level of acceptance and belief that this tool can contribute significantly to addressing the challenges of complex mathematics learning.

Diagram 4. Research Results Diagram on Readiness and Confidence in Facing the Challenges of Teaching Mathematics Using Automated Assessment Tools



The results of this study indicate that most respondents felt ready and confident in facing the challenges of teaching mathematics after using the automated assessment tool. Of the 36 respondents, none scored 1 or 2, meaning all participants positively assessed this tool's influence on their readiness and confidence. A total of 18 respondents (50%) gave a score of 4, indicating that half of the participants felt quite ready and confident. In addition, 10 respondents (27.8%) scored 5, indicating high readiness and confidence. Meanwhile, eight respondents (22.2%) scored 3, reflecting a neutral assessment but still in the positive category.

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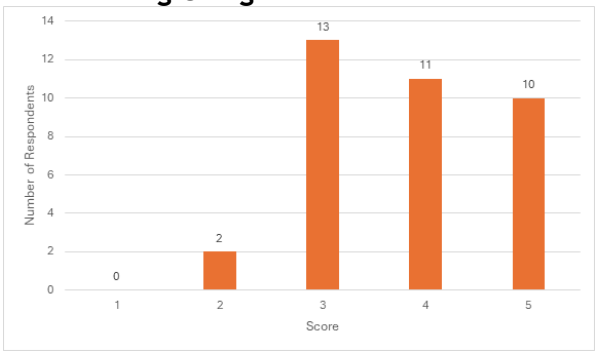
Automated tools seem to make a noticeable difference in how ready teachers feel when teaching math. Many educators also report feeling more confident handling problems in class. These tools make it easier to follow how students are doing and help teachers plan lessons that fit what learners actually need. With clear and structured learning outcome data, teachers feel more confident in making teaching decisions and are better prepared to handle the diversity of student abilities in the classroom.

The absence of respondents who gave low scores (1 or 2) also indicates no significant resistance to using this tool, and in general, the respondents' perceptions were very positive. From what we found, automated assessment tools don't just help with the technical side of teaching. They also seem to make teachers feel more ready and confident in handling their work. This is especially important in math classes, where teaching often needs to be flexible and quick to adjust. Overall, these tools help teachers face real classroom challenges with more assurance. The majority of respondents rated their experiences as positive, indicating the great potential of this technology in strengthening teacher professionalism and improving the quality of the learning process.

Diagram 5. Research Results Diagram on The Role of Efficient Assessment and Quick Feedback in Improving Differential Calculus Learning Using Automated Assessment Tools



The study results indicate that applying automated assessment tools in differential calculus significantly improves students' learning process, primarily through assessment efficiency and feedback acceleration. Of the total 36 respondents, most gave positive responses: 13 respondents (36.1%) gave a score of 3, 11 respondents (30.6%) gave a score of 4, and 10 respondents (27.8%) gave a score of 5. Meanwhile, only two respondents (5.6%) gave a score of 2, and no respondents gave a score of 1, indicating no rejection of using this tool.

One of the main impacts of using automated assessment tools is time efficiency, both from the lecturer's and student's perspectives. Students do not have to wait long to find out the results of their work; feedback can be obtained directly after submitting assignments or exercises. This allows students to immediately understand the mistakes they make, improve their understanding of the concept, and avoid repeating similar errors for a long time. The learning process also becomes more effective because students can adjust their learning strategies based on fast and specific information from the system.

In addition, this efficiency also reduces students' dependence on lecturers for further explanations because they automatically receive clear assessments and accurate feedback from the system. This is very helpful in managing self-study time, especially in courses such as differential calculus that require in-depth understanding and continuous practice. Students can use their time to focus more on topics that are still weak or not fully understood.

Based on the results, using automated assessment tools seems to make teaching better by giving faster feedback. This also helps students manage their study time more efficiently. Because of that, learning becomes more focused and students can understand tough topics in differential calculus quicker. Plus, these tools encourage students to think about their own progress right away and fix mistakes on their own.

Discussion

The research findings show that using automated assessment and feedback in Differential Calculus learning significantly improves the overall quality of education. One of the main contributions is its ability to provide instant and specific feedback, which is very important in helping students recognize and correct mistakes immediately. According to the "quick response time of automated feedback boosts motivation and understanding," indicating that the speed of feedback is an essential factor in effective learning.

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(Hahn et al. 2021).

From the perspective of constructivist learning theory, feedback is not just an evaluation tool but part of the knowledge construction process (Mejeh et al., 2024). Students are not only told right or wrong but are guided to understand why their answers are wrong and how to improve them (Li & Kim, 2024). From this point of view, feedback isn't just about giving grades or corrections it's more like a conversation that helps students think about their own ideas and change how they understand things. When students find mistakes, it challenges them to dig deeper and learn more. This fits with the idea that we build knowledge by interacting with what's around us and adjusting our mental picture. Automated feedback tools can help with this by guiding students to think about their thinking and take charge of their own learning.

Using this automated tool also helps improve formative assessment practices. According to Barkela et al. (2023), giving structured, automated feedback can boost students' ability to monitor their own learning and stay engaged mentally. Because of this, formative assessment can happen continuously throughout the course. This ongoing process helps both students and teachers spot learning gaps as they happen and deal with them quickly. Instead of waiting for final tests at the end, students get timely feedback that helps them change how they study early on. Meanwhile, teachers can adjust their teaching to better suit what students need. This back-and-forth creates a learning environment that is flexible and supports growth, showing that learning is a continuous process.

This study shows that lecturers who use live data from automated assessments can create more flexible and evidence-based lessons, which is key for effective AI-supported teaching. Mutanga et al. (2024) stress how important it is for lecturers to feel ready and have a positive attitude toward digital tools to get the best results. It's clear that the success of AI in education doesn't just depend on the technology. The success of AI in education depends largely on teachers' attitudes and how they integrate the technology into their teaching. Lecturers comfortable with using real-time data tend to make more informed decisions, customize learning activities to suit student needs, and quickly address challenges as they arise. When educators feel confident and skilled with digital tools, the potential benefits of AI become much clearer. For this reason, continuous training and fostering a positive mindset toward technology are essential for sustainable implementation.

Adaptive learning systems change how students learn by adjusting to their personal needs. For example, if a student struggles with concepts like derivatives or integrals, they can get immediate support without waiting for in-person help (Messer et al., 2023). This kind of tailored assistance is one of the biggest advantages of adaptive learning because it recognizes that every student moves at their own pace and faces different obstacles. By automatically spotting misunderstandings, the system can provide feedback or extra materials suited to what the student currently understands. This way, students avoid falling behind and are encouraged to take charge of their own progress. Overall, adaptive learning makes education more fair and responsive, which is especially helpful in challenging topics like differential calculus.

In addition, in the context of future teacher education, this tool also increases the self-confidence of prospective mathematics teachers. According to lecturers' and students' readiness for AI technology reflects professionalism in facing the challenges of modern teaching. (Lam et al., 2023). This study also supports the results of (Acuña & Bansal, 2024), which state that "automated assessment promotes self-directed learning and improves students independence." These results are evident from the students' perception scores on their ability to reflect independently and the clarity of feedback.

Time efficiency improves with automated assessment, as it allows both lecturers and students to better allocate their time—focusing more on refining materials or engaging in deeper discussions instead of spending time manually grading assignments (Coyne et al. 2024). Simplifying the usual assessment routines gives everyone more time for meaningful learning activities. Teachers don't have to spend as much time grading the same kind of work over and over, so they can focus on planning better lessons, supporting students more, and trying different teaching approaches. Students, on the other hand, get quick feedback that helps clear up confusion sooner and lets them use their study time smarter. Moving away from paperwork to focus on real teaching makes the whole learning experience richer and more effective.

Automated assessment helps make grading fairer by cutting down bias. Zhao (2025) says these tools "improve reliability and reduce subjectivity," which is really important for fairness in schools. Since the

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system uses clear and consistent rules, it avoids mistakes and personal opinions that can sneak in when teachers grade by hand. This matters a lot in big classes or important exams, where things like who the student is or how neat their handwriting is might accidentally affect scores. Using automated grading also makes the process clearer and more trustworthy for students. So, adopting this kind of technology supports fair chances for all learners.

Learning design emphasized the importance of evaluation data to design learning activities on students' actual achievements. This is in line with the results of this study, which show that the system helps with more accurate instructional planning. (Klingebiel et al. 2024). Several studies also emphasize that digital feedback provides emotional support because students feel accompanied. Stated that students even consider the feedback system as a study buddy, strengthening their attachment to the material. (Li & Kim 2024).

The results of this study also support the findings of (Jasmi et al., 2024) on the relationship between self-efficacy and conceptual understanding. Instant feedback builds students' confidence in their mathematical abilities. Even in learning data analysis, automated feedback makes it easier for lecturers to track error patterns and cognitive development (Sarsa et al., 2022). This supports the use of learning analytics in modern teaching. The results of this study also support the findings of (Jasmi et al., 2024) on the relationship between self-efficacy and conceptual understanding. Instant feedback builds students' confidence in their mathematical abilities. Even in learning data analysis, automated feedback makes it easier for lecturers to track error patterns and cognitive development (Sarsa et al., 2022). This supports the use of learning analytics in modern teaching.

This study also confirms the importance of assessment instruments' validity and reliability, as Djaha emphasized. 2023) so that the assessment results truly reflect student learning achievements. From the perspective of implementation in higher education (Strandhagen. 2022) states that consistent and structured system integration is critical in determining the success of using technology in learning. In teacher training, (Branaghan et al., 2021) stated that using technology-based questionnaires can improve quantitative reasoning skills, which are essential for mathematics teachers—equitable learning quality for all students.

FINDING

Based on the five research results and discussions that have been explained, several main findings show the positive impact of using automated assessment tools in mathematics learning, especially in differential calculus courses. The first finding shows that automated assessment tools significantly improve teaching technique quality. The feedback provided quickly and objectively allows lecturers and prospective teachers to evaluate the methods' effectiveness and immediately adjust learning strategies. This makes the teaching process more adaptive to the responses and needs of students in the classroom and encourages teachers to be more reflective in developing more appropriate teaching approaches.

The second finding relates to increasing effectiveness in planning and implementing learning. Evaluation data obtained automatically allows lecturers to prepare more focused learning plans based on real results from student learning achievements. The implementation of learning becomes more responsive because lecturers can immediately adjust learning activities based on student development. his way of working really supports learning that's based on data and helps teachers make smarter decisions. The third point shows that students understand differential calculus concepts better. Because they get quick and clear feedback on each exercise or task, students can spot their mistakes right away and fix them or review the material on their own.

This is very important for students who have learning difficulties, because the process becomes more personal and repetitive, so they can deepen their understanding without having to wait for intervention from the lecturer

The fourth finding shows that using automated assessment tools increases students' readiness and confidence in facing teaching challenges, especially for prospective mathematics teacher students. They feel more confident in designing and implementing data-based teaching by getting used to evaluating learning using automated tools. This confidence also arises from their ability to provide objective assessments and prepare follow-up steps based on the assessment results, which are essential skills in education.

One big advantage from this tool is saving time, especially for students. Because feedback comes

instantly, they don't need to wait to see how they did. This lets them quickly think about their mistakes and fix them right away. This efficiency makes their learning time more focused and effective. In addition, this tool also lightens the burden on lecturers in the correction process so that the time usually used for assessment can be diverted to more interactive learning activities or personalized instruction.

To sum up, these results suggest that automated assessment tools do more than just evaluate—they help improve learning quality overall. They make teaching more flexible, efficient, and centered on what students actually need. Because of this, using automated assessments is highly recommended to modernize math education in our digital world.

CONCLUSION

This study concludes that integrating automated assessment tools in teaching and learning mathematics particularly differential calculus significantly enhances higher education pedagogical practices and student learning outcomes. The results make it clear that these tools genuinely help improve how teaching is done. They support more focused and effective lesson planning, and they're especially useful in helping students who struggle, as they encourage a stronger grasp of key concepts. Teachers benefit from automated assessment because it helps them react faster in the classroom. Since the system gives clear feedback quickly, they can see right away if students are confused or making the same mistake. That means they don't have to wait until the end of a unit to change how they teach. Instead, they can make adjustments as they go, which makes lessons more useful. It also helps teachers use assessments in smaller, everyday ways not just at the end of a chapter.

For students, the biggest help is that they don't have to wait to know how they're doing. Feedback comes right after they finish a task, so they can fix things while the topic is still fresh. If they're stuck, they can try again or focus more on the parts they don't get. This kind of setup builds habits like thinking for themselves and learning independently. It also helps them feel more confident especially students who are preparing to become teachers themselves.

The study shows that even though automated assessment tools can really help improve teaching, their actual use in the classroom depends on more than just having the tools. Things like clear support from the institution, working technology, and training for teachers all play a big role. These tools only work well when they fit with good teaching practices and are adjusted to match the real needs of the students and the learning setting.

In conclusion, automated assessment tools represent a powerful innovation in mathematics education. When used thoughtfully and strategically, they can transform the educational experience into more efficient, personalized, and effective for instructors and students. To realize this potential fully, a collaborative effort involving technology developers, educators, and institutions is essential to ensure that these tools are pedagogically meaningful, contextually appropriate, and sustainably integrated into teaching and learning practices.

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