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Online Assessment in the Subject of Applied Mathematics as one of the Instruments during the Formative Assessment

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Abstract: Taking assessments these days doesn't have to be stressful as technology has revolutionized the entire education system. Assessments are the most important part of the applied mathematics course, as they give students an accurate background of where they stand. It acts as a catalyst and positive reinforcer for students encouraging them to perform better. Most importantly, teaching and assessing students are two actions that should not be confined within the walls of a classroom but can be done anytime, anywhere with the help of technology. Therefore, in this study we have tried to analyze an assessment process developed through online tests in the subject of applied mathematics, as one of the instruments of formative assessment. To formalize this study, it was decided to use quantitative research methodology as a research strategy. The sample number was 110 students and it was a purposive sample. The empirical data collected during this research study involved a variety of data collection techniques. The methods used consist of questionnaires. The results from this research are important because online assessment is a formative assessment tool for students. The conclusion from this study is that students enjoyed taking online tests in the subject of applied mathematics. Therefore, the online assessment had a great positive impact on the formative assessment process in this subject. This paper has shown that online assessment as one of the instruments used in the formative assessment process affects the appearance of special assessment strategies in the subject of applied mathematics.

Keywords: Applied mathematics, Assessment, Formative, Online, Students

1. Introduction

In applied mathematics, teachers need to observe how their students approach problems, how much mathematical knowledge they have, and at what level students use when solving problems. That is, knowing how students think in learning or solving problems enables teachers to help their students overcome conceptual difficulties and, in turn, improve learning. In this sense, assessment is diagnostic. To implement assessment in the classroom, a teacher must ensure that every student participates in the learning process by expressing their ideas and that there is a reliable environment in which students can give each other feedback or the teacher gives students comments and instructions according to the needs of the students.

Through assessment, students receive information about what they will have to learn. How much they will learn and how they will learn largely depends on the assessment being applied. Assessment encourages the student to learn and gives him instructions on how to learn to improve his

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achievements in and outside of learning. The evaluation not only proves how much the student has managed to learn. Evaluation is an ongoing process (Kadriu, et al., 2011).

The assessment is based on the use of several different methods. The types of assessment based on their function in the teaching and learning process distinguish Formative Assessment and Summative Assessment.

Teachers should consider the selection criteria of assessment methods and instruments before the lesson, during the lesson, and after the lesson. A variety of methods and instruments should accommodate different learning needs and styles. Using multiple instruments to assess an (expected) learning outcome makes it possible for a larger group of students to show their true achievement. Teachers should identify, develop and use different assessment instruments so that all students can fully express their achievements.

How teachers orchestrate their classroom activities and lessons can be improved by using connected technologies in the classroom. With the use of technology, the formative assessment process allows for the rapid collection, analysis and use of student data. It provides teachers with the data they need to inform their teaching. The shift to online assessment is a natural result of the increasing use of information and communication technologies to enhance learning. As more students demand flexibility in their lessons, it seems inevitable that there will be increasing expectations for flexible assessment as well. When implementing online and computer-based instruction, it is recommended that a structured framework or model be used to guide assessment (Shirley & Irving, 2015).

Online assessments can take many forms, including but not limited to teacher-created online assessments via course management systems and quiz/test creation websites, classroom response systems, math practices on the internet, games/applets, online practice tests, online portfolios, online surveys, and so on. Students can take assessments online with a laptop, tablet, or smartphone (Ross, 2017).

For this study, we have based on online evaluation through the use of online tests created with Google Forms with closed answers with options and with open answers without options. Students from the online test will be assessed 10% of the overall formative assessment. Below we present a model of formative assessment instruments for the subject of applied mathematics.

No.	Name and Surname	Homeworks (10 %)	Classroom activities (20 %)	Seminar Paper (10%)	Online exam (10 %)	Test (50 %)	Total points	Final grade
(0-40)% "**1**"; (41-60)% "**2**"; (61-80)% "**3**"; (81-90)% "**4**"; (91-100)% "**5**";								

Figure 1. Formative assessment model in the subject of applied mathematics

These tests are distributed through Google Classroom to all students at the same time, but with a change of questions and options for each student individually. Once students take their tests, they are automatically graded, and students have instant access to review scores and correct and incorrect answers.

2. Literature Review

Mathematics has a learning gap, and with this rapid change in methodology, something that was previously difficult for students has become an even greater challenge. Students have difficulty using their mathematical reasoning skills to solve problems because, in the learning process, they are given procedural learning that results differ from the development of their thinking and reasoning skills. These reasoning and processing skills are relatively unique to mathematics, which is why teaching and assessing methods tend to differ from other subjects. (Novianda, Darhim, & Prabawanto, 2021; Barut & Retnawati, 2020). Assessment is essential in teaching and learning mathematics at all levels. One of the most important challenges facing mathematics educators is to design and successfully implement new assessment strategies for use in the 21st-century classroom (Niss, 1993; Kilpatrick, 1993).

Evaluations are referred to as the process of obtaining information that is used to draw conclusions and decisions about students, curriculum achievements, program implementation results, and educational policies for any institution that organizes learning activities (Adri, Suwarjono, Sesrita, & Sudjani, 2021). The purpose of the evaluation is twofold, i.e., Formative and Summative. Formative assessment, also referred to as assessment for learning, is an inherent part of the teaching and learning process. Summative assessment administration usually occurs after a topic or a range of related topics in mathematics. The results of summative assessments are recorded and used for progression and promotion purposes (Damon, 2017). Interaction, collaboration, cooperation, dialogue, and discourse are key concepts that are facilitated by formative assessment for the effectiveness of learning activities. As such, collaborative group learning fosters meaningful learning and the construction of new knowledge (Mutodi & Chigonga, 2016).

On the other hand, an online assessment in mathematics is defined as a mathematics assessment administered in an online learning environment. In contrast to traditional assessments, online assessment is done using computer network technologies, where the teacher creates online assessments, the computer captures student responses, marks them, and provides immediate feedback to students (Damon, 2017). Online assessments will not be as effective if those who use and implement them do not believe in their validity or believe they are necessary. Students must be convinced of the utility of switching to online assessment before willingly embracing it (Khan & Khan, 2018). Online assessments can be any means of assessing student achievement, providing feedback, or channelling students forward in their learning process fully online. Assessments can be formative or designed to monitor student progress in a relaxed environment, or summative, designed to assess students against criteria. Such commonly used online assessment tools include Google Form-based quizzes, Kahoot!, Quizizz, Socrative, Near Pod, Educanon, etc. (Bardhan, Mohanty, & Dey, 2020).

In the research by Bayazit and Aşkar (2011), no significant difference was found between the students' results in the online and paper-pencil tests at the end of the study. This is something that may shock the most, but it has very important implications. This means that student scores remain the same across different testing environments. This gives teachers a reason to possibly invest their time in researching online assessments (Bayazit & Aşkar, 2011). Hewson's (2012) findings have contributed evidence to support the validity of online assessment methods by showing that the performance of students who take an online or offline assessment does not differ depending on whether they are asked to use their preferred mode or not preferred. These findings help encourage students to fully embrace a switch to online assessment, especially if the data shows that it does not affect their overall performance (Hewson, 2012). As mentioned, Vonderwell et al. (2007) showed

that online formative assessment can improve equitable education through different assessment activities that provide alternative means and multiple indicators for students to demonstrate their skills (Vonderwell, Liang, & Alderman, 2007).

3. Methodology

To formalize this study, it was decided to use quantitative research methodology as a research strategy, which for this research served as a systematic investigation of phenomena by collecting quantitative data and performing statistical techniques from the participants. This quantitative research collected information from participating students by distributing an online questionnaire. Our goal in conducting the quantitative research study is to determine the relationship between online assessment as one of the assessment instruments in the subject of applied mathematics and its use in formative assessment within the selected sample.

3.1. Purpose of research

Student learning and achievement should be assessed continuously using the most appropriate methods and instruments. In order to ensure this, teachers must implement Assessment for Learning and develop instruments that are suitable for this purpose. Formative assessment is such an essential part of the learning process and student success in applied mathematics, and many electronic tools can help support this process. Therefore, in this study, we have tried to analyze an assessment process developed using online tests. Additionally, perhaps due to another commitment during the COVID-19 pandemic when we moved to online learning, this led us to continue to integrate online assessment as part of continuous assessment. The online tests were prepared through Google Forms, where students completed their assessments with open options and answers. Therefore, the purpose of this study is to reflect students' opinions about the use of online assessment in the subject of applied mathematics as one of the instruments of formative assessment.

3.2. Sampling

The study was conducted in two high schools in the city of Prizren in the Republic of Kosovo. The first school was the music high school "Lorenc Antoni" with the participation of a sample of 2 10th grades with a total of 28 students and 3 11th grades with a total of 28 students. Meanwhile, the other school was the gymnasium "Remzi Ademaj" high school with the participation of a sample of 2 10th classes with a total of 28 students and 2 11th classes with a total of 26 students. Therefore, the number of the sample was 110 students and it was a purposive sample since the study was conducted with these students that I, as a teacher of the subject of applied mathematics, practice online assessment.

3.3. Research questions

To fulfil the purpose of our research, we are posing the following research questions, which we see as a starting point for the initial study presented in this study:

1. What is the effectiveness of online assessment as one of the formative assessment instruments in applied mathematics?
2. What are the students' attitudes on online assessment as one of the formative assessment instruments in applied mathematics?

3. What are the implications of online assessment in the subject of applied mathematics?
4. Is there a link between online assessment as one of the measuring instruments in the subject of applied mathematics with formative assessment?

3.4. Hypothesis

H_1: Online assessment had a high efficiency as one of the instruments used during formative assessment in applied mathematics

H_2: Students have affirmative attitudes on online assessment as one of the formative assessment instruments in applied mathematics.

H_3: Online assessment in applied mathematics has significant implications for formative assessment.

H_4: There is a statistically significant positive correlation between online assessment as one of the measuring instruments in the subject of applied mathematics with formative assessment.

3.5. Data collection and analysis

This research study was quantitative research and therefore quantitative data analysis methods were used. The empirical data collected during this research study involved a variety of data collection techniques. The methods used consist of questionnaires. The closed questions of the questionnaire were compiled according to the objective of the research. However, the answer options are compiled based on the Likert scale. These questions help in collecting quantitative data and hence are widely used in quantitative research. The questionnaire was used to assess students' attitudes on the use of online assessment as one of the formative assessment instruments in the subject of applied mathematics. Data collection was carried out online, distributing the questionnaire to students compiled with Google Forms. Data collected from the online questionnaire will be kept confidential and anonymous, and student participation was voluntary. The data collected from the questionnaire were analyzed through the statistical program for social sciences SPSS.

4. Results

Regarding the expectations and purpose of the research, we can present the results of the study, showing the importance of using online assessment as a formative assessment instrument in the subject of applied mathematics. Below we provide the analysis of the results of the questionnaire responses from the participants of this study.

The results of the study show that 110 students participated in this study, of which 63.6% were female and 36.4% male. In technological knowledge of these participants, 18.2% of students had a basic knowledge of technology use, 66.4% average knowledge, and 15.5% advanced knowledge of information technology. From the results of the study, we can see that 85.5% of students like applied mathematics, 10.9% do not have an opinion on this statement, only 1.8% do not like this subject, and 1.8% did not answer this question.

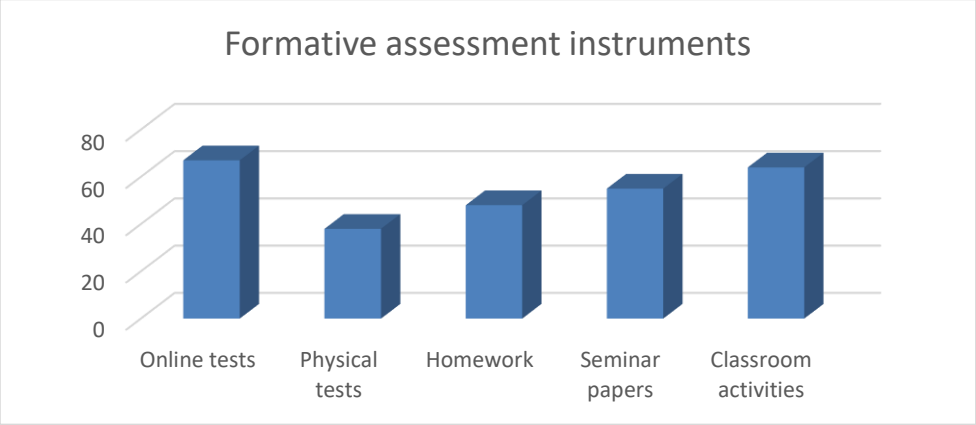

Diagram 1. Results from formative assessment instruments

As we can see from Diagram 1, the results of the study show that students want a variety of assessment instruments to be used during the formative assessment. Of them, 67 participants state that online tests are necessary, while 43 do not like them. Only 38 students prefer the physical test, while 72 students do not prefer this type of examination. Homework assessment as a formative assessment instrument is preferred by 48 students, while 62 do not prefer it. Seminar papers are liked as an instrument by half of the students, while the other half do not like that their papers are evaluated. And finally, the assessment of student activities in the classroom is preferred by 64 students, while 46 students do not prefer that their engagement in lessons be evaluated. As can be seen from the results, we notice that the participating students mostly prefer the use of online tests in the subject of applied mathematics as one of the formative assessment instruments.

Below we give the summary table of students' attitudes about the use of online assessment as one of the formative assessment instruments in the subject of applied mathematics:

Table 1. Students' attitudes toward online assessment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Negative	1	,9	1,0	1,0
	Neutral	3	2,7	2,9	3,8
	Positive	100	90,9	96,2	100,0
	Total	104	94,5	100,0	
Missing	System	6	5,5		
Total		110	100,0		

From these results of Table 1, it is proven that 90.9% of students have positive attitudes about using online assessment in the subject of applied mathematics as one of the formative assessment instruments, 2.7% of students are neutral and .9% have negative attitudes about this assessment. Therefore, from this evidence, we can say that online assessment was a useful instrument in formative assessment, and has its effectiveness and efficiency in measuring specific learning outcomes in applied mathematics. In other words, the promise of an online assessment was motivation to prompt students' reflections on how to promote the expectations and value of learning in this subject.

In the question that the online assessment can be used as one of the measuring instruments during the formative assessment in the subject of mathematics, an average of 2.86 with a standard deviation of .443. In the next question, the online assessment in the subject of mathematics has helped me gain experience in my preparation for other online assessments, where the results show a mean of 2.86

with a standard deviation of .421. Also, a high mean of 2.88 with a low standard deviation of .402 students expressed that the online assessment results from the subject of mathematics helped them reflect on their knowledge and skills while learning. Meanwhile, for the question of how much online assessment statistics in the subject of mathematics give you detailed information on the units and tasks, where they were successful or unsuccessful, the results show that the average of positive attitudes was 2.83 with a standard deviation of .468. Likewise, the mean scores were 2.91 with a standard deviation of .373 for the question that the online test in the subject of applied mathematics helps students prepare and orient themselves better for the physical test in the classroom. On the other hand, we are noticing that about 73.6% of students think that the online assessment in the subject of applied mathematics created less anxiety and stress compared to other formative assessment instruments, 5.5% of them do not have any attitude, and only 14.5% think that the online assessment in the subject of mathematics created anxiety and stress compared to other formative assessment instruments.

In comparison, 6.4% of the participants did not respond to this statement. About 90.0% of students indicated that the online assessment in applied mathematics had a positive effect and is being shown as a new form of knowledge assessment. .9 % have no opinion, 2.7% think the opposite, and the rest did not answer for this question. Also, 86.4% of students think that online assessment as one of the assessment instruments should also be applied in other teaching subjects, 2.7% do not have any opinion, and 4.5% emphasize that online assessment as one of the assessment instruments should not be applied in other subjects. In comparison, 6.4% of the participants did not answer this statement.

Below, using the t-test at a confidence level of 95%, we are analyzing the results of student attitudes and online assessment as one of the instruments of formative assessment in the subject of applied mathematics:

Table 2. One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Attitudes	117,511	103	,000	2,95192	2,9021	3,0017

T-tests were used to examine whether the online assessment instrument satisfied students' preferences in the subject of applied mathematics. As we can see from table 2, from the results of the t-test, it is clear that students have positive attitudes regarding the use of online assessment as one of the formative assessment instruments. So, the results of the t-test show significant significance with .000 and a mean of 2.902, which shows that the students have positive attitudes to continue with this assessment. The results of the t-test are showing that the difference observed in the average values of the online evaluation indicators is statistically significant ($p < .05$) in the subject of applied mathematics. This was a success in the subject of applied mathematics because almost all students were motivated to complete these online assessments.

Below, by using Pearson Correlation, we are analyzing the results of the online assessment as one of the assessment instruments with that of formative assessment in general:

Table 3. Correlations between online assessment and formative assessment

		Formative assessment	Online assessment
Formative assessment	Pearson Correlation	1	,622**
	Sig. (2-tailed)		,000
	N	104	103
Online assessment	Pearson Correlation	,622**	1
	Sig. (2-tailed)	,000	
	N	103	103

**. Correlation is significant at the 0.01 level (2-tailed).

As we can see from table 3, there is a significant relationship between online assessment as one of the instruments and formative assessment in general. This correlation is .622, indicating a positive and moderate correlation. This shows that if students are successful in online assessments, at the same time, better results will be achieved in the formative assessment in the subject of applied mathematics.

5. Discussion

Online assessment in the course of applied mathematics was a critical component, which was presented with a significant impact on the structure of formative assessment. The online assessment in this study served as a systematic process of its use during the assessment of students' abilities and their knowledge based on the subject of applied mathematics. Our study results show that this assessment instrument can help teachers align learning outcomes with teaching methodology to encourage a more effective learning process.

In this study, we have tried to analyze an assessment process developed through an online assessment. Moreover, the purpose of this study was to reflect the students' attitudes about using online assessment in the subject of applied mathematics as one of the formative assessment instruments. We will discuss our analyzed findings from the data collection process to achieve this goal.

The results of this study support the effectiveness of online assessment as one of the instruments used during formative assessment in the subject of applied mathematics. This research was able to highlight the main aspects needed in the effective use of online assessments. It was able to show how it can affect the level of students' motivation toward mathematics. These findings confirm that online assessments can provide teachers with support in implementing technology most effectively. Also, the study by Özden, Ertürk, and Sanli (2004) shows that the participants reported the effectiveness of the online evaluation system (Özden, Ertürk, & Sanli, 2004). Therefore, from these findings, we can also answer the research question that online assessment is an effective tool for formative assessment in applied mathematics. All this was in line with expectations. These results, especially those related to the overall positive effects of the strategy of using online assessment as one of the instruments used during formative assessment in the subject of applied mathematics. Findings indicate that online assessments may provide an additional benefit to the student by allowing them to complete the test conveniently without the environmental distractions that are common during physical classroom tests. The results also show that online assessment in the subject of applied mathematics helps you solve problems more efficiently and creatively. About 90.0% of students indicated that online assessment had a positive effect and is being shown as a new form of knowledge assessment. Also, according to Malguri (2021), the benefits of online assessment justify the purpose of assessing, analyzing, and documenting readiness for work, training needs, learning progress, and

the acquisition of skills of testers (Malguri, 2021). Therefore, from these results, we can also support our research hypothesis that online assessment had a high efficiency as one of the instruments used during formative assessment in applied mathematics.

In addition, it was shown that students have a positive attitude toward online assessment because it is playing an important role in ensuring that students have factual knowledge, technical skills, communication, and higher-level cognitive skills. According to our results, the online assessment was the most popular instrument of formative assessment, and that students express the desire that, in addition to the subject of mathematics, it should be integrated into other subjects as well. The results of the Valdez and Maderal (2021) study showed that students have a high level of motivation toward the subject of mathematics and have a positive perception of online assessments (Valdez & Maderal, 2021). However, our findings are contrary to the explanations of authors Cassady and Gridley (2005) who indicate that there is an additional concern often raised by instructors considering online summative assessment is that online testing will cause high levels of test anxiety, leading to performance levels that underestimate true ability (Cassady & Gridley, 2005). However, our findings show that students were less stressed when taking an online test on the subject of applied mathematics, compared to the stress they had in classroom tests. Therefore, we can answer the research question that students have a positive attitude toward online assessment as one of the instruments of formative assessment in applied mathematics. Also, according to our findings from the analysis of the results of the t-test show that the significant significance is .000 and a mean of 2.902, in favor of positive attitudes regarding the use of online assessment as among the formative assessment instruments in the subject of applied mathematics Also, the study of Christine, Valdez, and Maderal (2021) gives similar results to our study, as they emphasize that students have a positive attitude of the use of online assessment. They agreed that integrating technology into the way they receive their assessments is a good innovation that allows them to get immediate feedback (Valdez & Maderal, 2021). Therefore, the results obtained based on the study and research of the authors mentioned above support the hypothesis that students have positive attitudes toward online assessment as one of the instruments of formative assessment in applied mathematics, which shows that the use of online assessment will strongly influence formative assessment in the subject of mathematics. Thus, we can conclude that this hypothesis is supported that students have more positive attitudes about online assessment.

The study results provide answers to the posed research question, which is the implications of online assessment in applied mathematics. In these implications, we can list many of the factors that we accepted from the research participants, such as that gaining experience in preparing students for other assessments with a score of 2.86. Also, another implication was that online assessment helped students reflect on their knowledge and skills while learning. It is worth noting that the online assessment statistics in the subject of applied mathematics give you detailed information on the units and tasks where the students were successful or unsuccessful. The results show that another implication of online assessment was that it could be applied to other teaching subjects as one of the instruments of formative assessment. Also, our findings are consistent with the findings of various studies by Chung et al. (2006), Koh, (2008), Pachler et al. (2010) and Wang et al. (2008), which show that the effective use of online assessment can engage students and teachers in meaningful educational experiences as it provides opportunities for them to identify learning needs and strategize how to meet them collaboratively. The need. This is through providing enhanced opportunities to document, monitor, and assess student progress and achievement, which informs the desired formative feedback. In these ways, online assessment can play a crucial role in improving learning by creating enhanced learning environments that motivate students to engage and actively regulate

their studies [20-23]. Based on the findings we can prove our hypothesis that if the online assessment is used in the subject of applied mathematics and online assessment is one of the important measuring instruments of formative assessment, then we can say that if the online assessment is applied in the subject of mathematics applied, it has a significant impact on formative assessment.

The results of the research suggest that the improvement in the achievement of the goals required during the formative assessment can be influenced by the appropriate formative assessment instruments, which in turn, are stimulated by the online assessment. Also, another result worth highlighting is that 81.9% of students had above-average knowledge of technology use. This could probably positively affect the reflection of students' attitudes. These findings confirm that similar assessments obtained from physical tests are also valid in the context of online knowledge assessment within the subject of applied mathematics. Also, the findings of the study by Gikandi, Morrow, and Davis (2011) show a relationship that online assessment has as a systematic and rigorous approach to achieve useful findings that can inform effective practices (Gikandi, Morrow, & Davis, 2011). Also, from the results of the research, we are noticing that this was a success in the subject of applied mathematics because almost all students were motivated to perform these online assessments as one of the instruments used during the formative assessment in applied mathematics. Therefore, we can also answer the last question of the research that there is a connection between online assessment as one of the measuring instruments in applied mathematics and formative assessment.

On the other hand, from the correlation analysis, we discovered that the attitudes toward online assessments are significantly related to the formative assessment in all its aspects. Pearson's correlation analysis from table 3 shows that the relationship between online assessment and formative assessment in the subject of applied mathematics in our study is .622, which indicates a positive and moderate correlation. All this, we can also support the last hypothesis of the research that there is a statistically significant positive relationship between online assessment as one of the measuring instruments in the subject of applied mathematics with formative assessment.

6. Conclusions

The results analysis and discussion section highlight the findings useful for this research study. This research was important because online assessment is a formative assessment instrument for students. One of the key elements of the 21st century applied mathematics curriculum is an emphasis on learning skills, which includes the ability to use technology in the learning process. Based on the results of the study, this research confirmed that the online assessment instrument has a positive efficiency in the subject of applied mathematics during formative assessment.

Many times, teachers overlook the modifications needed to move an assessment from its paper form to an online environment. From the findings of the study, we can say that in the effective use of online assessments, students can be influenced by their level of motivation toward the subject of applied mathematics. In other words, we can conclude that online assessment is one of the effective tools for formative assessment in applied mathematics. In addition, our study findings show that students have positive attitudes toward online assessment because it plays an important role in ensuring that they have a higher level of factual knowledge, technical skills, communication, and cognitive skills. Also, our findings show that students were less stressed when taking an online test in applied mathematics, compared to the stress they had in classroom tests.

Another important finding within this research study was the use of meaningful feedback from online assessments. In other words, students using the online assessment were correcting their

mistakes from the immediate feedback of the results, and they were being guided for the physical test in the classroom where they were stuck.

When looking back at the research questions and our findings, the conclusion from this study is that students enjoy taking online tests in applied mathematics. Therefore, the online assessment had a great positive impact on the formative assessment process in this subject. This paper has shown that the online assessment used in the formative assessment process affects the emergence of special assessment strategies in the subject of applied mathematics. Among other things, the findings show that there is also a relationship between online assessment as one of the measuring instruments in the subject of applied mathematics with formative assessment. This positive relationship is statistically significant between online assessment as one of the measuring instruments in the subject of applied mathematics with formative assessment.

According to the findings, this will probably encourage mathematics teachers to use online assessment in the future as one of the formative assessment instruments to help assess and further assist students in all assessments. As we look to the future of education, it is becoming increasingly clear that technology will be key to the assessment process.

Implications from this study may indicate that teachers can use data from online assessments to improve their formative assessment methods, while students use online test achievement to gain teacher attention. Also, this study helps support the transition to online assessment as part of formative assessment instruments in applied mathematics but does not deny the real impact some students have when assessed online. The results of this research can be generalized to a wider population to take appropriate action for improvement.

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Conflicts of Interest

The authors declare no conflict of interest.

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