

THE INFLUENCE OF ONLINE FORMATIVE ASSESSMENT IN EUCLIDEAN GEOMETRY ON THE ATTITUDES OF GRADE 11 LEARNERS

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Abstract

Formative assessment (FA) can potentially provide valuable insights into learners' conceptual knowledge of Euclidean geometry and contribute to the development of appropriate assessment activities which focus on developing a conceptual understanding of Euclidean geometry. Research indicates that geometry is an abstract yet crucial topic in the school Mathematics curriculum because it helps learners to develop logical thinking, problem-solving skills, deductive reasoning, and analytical reasoning. Due to the Covid-19 pandemic, teachers were forced to integrate technology to continue with teaching, learning, and assessing Mathematics. Following this, the purpose of this study was to determine the influence of online FA in Euclidean geometry on the attitudes of Grade 11 learners in a public school in South Africa. Learner attitudes contribute to performance in Mathematics. Attitudes are formed by the past experiences, observations, and imitations of learners who enter the mathematics classroom with their pre- and misconceptions. Assessing mathematics concepts anywhere facilitates individual assessment, and supports differentiated instruction of Mathematics, which ultimately can lead to an increase in using pedagogical approaches that are learner-centred. Therefore, technology in assessment plays a pivotal role in mathematics teaching and learning. This study was conducted using mixed research methods utilizing semi-structured interviews and a questionnaire to collect data. The participants that were purposively sampled in this study were 104 Grade 11 learners. This study was underpinned by Bandura's Self-efficacy theory derived from the Social Learning Theory. The main findings of this study revealed that learners enjoy online FA, they find it meaningful, it motivates them, and contributes to their self-confidence. The theoretical and practical implications of the findings are discussed in this research study.

Keywords: *Online formative assessment, Euclidean geometry, online quizzes, learner attitudes.*

1. Introduction

The use of online formative assessment (FA) may assist Mathematics teachers with useful information regarding conceptual understanding of Mathematics (Martin et al., 2015). The flexibility in online assessment allows for FA to be conveniently completed provided that learners adhere to the submission dates (Ogange et al., 2018). Additionally, online FA makes provision for multiple attempts in one assessment which can be used until a desired mark is attained. The multiple attempt option also furnishes learners with an opportunity to use the feedback on the previous FA, evaluate their own learning and ultimately improve on the content. Many opportunities through FA are created for learners to receive automated grading, and the ability to complete assessment anywhere and at any time (Padayachee et al., 2018). According to Wang and Tahir (2020), learners' attention and the level of their engagement can be improved, and enjoyment and motivation increased, because of FA.

However, sometimes learners perform poorly on FAs, and there are many factors that contribute to this poor performance. Sa'ad et al., (2014) argue that poor performance in FA taken for Mathematics can be influenced by anxiety, fear, and a negative attitude towards Mathematics. Hence, helpful ways to improve the performance is by developing a positive attitude towards Mathematics, through increased motivation, learner-centered approaches to teaching and assessing, and the integration of technology (Sa'ad et al., 2014).

The implementation of online assessment resources in Mathematics for FA are not void of problems, specifically in the topic of Euclidean geometry among Grade 11 learners. It is not uncommon that performance in Euclidean geometry has been poor across countries. In Turkey, Kutluca (2013) investigated Grade 11 learners' attitudes on this topic and concluded that learners have been estranged to Euclidean geometry and often failed. The same is true in the South African context because of conventional assessment of Euclidean geometry using outdated methods such as fostering memorisation and recall of

theorems and proofs that learners need to present on paper which do not often aid in understanding (De Villiers & Heideman, 2014). Thus, this study explored the influence of online formative assessment in Euclidean Geometry on the attitudes of Grade 11 learners at a public school in South Africa.

2. Literature review

There is a plethora of dynamic geometry software such as GeoGebra which is an interactive online software designed to stimulate learners by presenting instant dynamic visuals on the behaviour of graphs such as the transformation of trigonometric functions (Naidoo & Govender, 2014). Using dynamic software in teaching, learning, and assessment in Euclidean geometry may improve learners' geometric reasoning (Bayaga et al., 2019). Kahoot! boasts in its functionality to allow teachers the freedom to design online questions learners can answer with the use of smart digital devices and obtain feedback immediately (Prieto et al., 2019). Moodle is another platform which can be used as a FA platform and it is enacted, and students can engage with material by downloading or uploading work (Padayachee et al., 2018). All these existing online tools can be effectively used to generate online tests and quizzes, whether formative or summative. However, as stated on the aforementioned paragraphs, the availability of online tools to conduct FA and the learners' ability to use these online tools to take the given FA, as well as their performance on these Mathematics FA should not be understood separately from their attitudes and behaviour towards Mathematics.

Learner attitudes towards Mathematics are considered as a crucial element in describing how Mathematics is learned which is characterised by the emotions of learners and consider what they value including their prior experiences (Fuqoha et al., 2018). Cerbito (2020) defined attitude as an action, behaviour, and the individual's level of thinking. Learner attitudes can influence behaviour that contributes to the learners' reaction towards teachers, peers, and Mathematics learning material. Moreover, self-confidence is one of the factors that can positively influence learner attitudes, and contribute to persistence and a successful completion of Mathematics problems (Cerbito, 2020). A positive attitude toward Mathematics may be affected by consistently experiencing success in Mathematics performance. On the other hand, constant failure or poor performance in Mathematics discourages and negatively influences learners' self-confidence because learners might not want to engage with complex Mathematics problems (Cerbito, 2020).

According to Fuqoha et al. (2018), motivation involves learners' personal interest, hence, directly impacts learner performance in Mathematics. Some are self-motivated (intrinsic motivation) and others are externally driven by others (external motivation) (Fuqoha et al., 2018). Therefore, motivation, whether intrinsic or external, is essential for learners' learning process. Fuqoha et al. (2018) postulate that using online FA tools (e.g., Kahoot!) impacts class motivation and learner performance. Additionally, as online FA can improve attention, concentration, motivation and engagement, the level of confidence and self-efficacy are likely to increase (Wang & Tahir, 2020). It is therefore safe to say that a variety of factors need to be considered since they can have either a positive or negative effect.

3. Theoretical framework

The Self-efficacy theory derived from Bandura's (1977) Social Learning Theory (SLT) was used to underpin this study. Bandura (1977) argued that learning is modeled through observation and intrinsic reinforcement. According to Bandura and Adams (1977), self-efficacy affects the choices of tasks, behavioral settings, and learners' persistence when faced with difficulties. Essential to the self-efficacy theory is the four main sources which involve learners' achievements, considering their prior experiences. Secondly, it is influenced by vicarious experiences which are concerned with the observation of others and their successful experiences through their effort. Thirdly, verbal persuasion which is influenced by encouragement and positive feedback from others. Lastly, Bandura talks about the physiological or emotional arousal which also impacts the level of anxiety and how learners are able to maintain or control that (Bandura & Adams, 1977). More specifically, self-efficacy in Mathematics focuses on the perceptions of learners regarding their ability and successful learning in Mathematics Education (Damrongpanit, 2019).

4. Research methodology

The study adopted a mixed method research to understand the influence of online FA in Euclidean geometry on the attitudes of Grade 11 learners. A mixed method study is one in which the research employs at least one quantitative method and one qualitative method to gather, analyse, and report data in a single study (Creswell, 1999).

4.1. Selection of the participants

This study purposively selected 104 Grade 11 learners from a public school in South Africa to collect data. The study consisted of both male (43) and female (61) learners with more than 80% of learners classified as black and they all specialised in Grade 11 Mathematics.

4.2. Data collection and analysis

Quantitative data was accumulated using a standardised questionnaire that consisted of 40 items adopted from Tapia and Marsh's (2004) Attitude of Mathematics Inventory questionnaire. The questionnaire was divided into two sections. Section A considering the graphical information of 104 learners, and Section B considering 96 learners' views about online FA in Euclidean geometry on their attitudes. This study reports on the data accumulated from Section B. Additionally, six learners were purposively selected to conduct semi-structured interviews to collect qualitative data. The interviews were transcribed and coded using four themes suggested by Tapia and March (2004) namely (1) enjoyment; (2) motivation; (3) self-confidence; and (4) value.

5. Findings

Key findings emanating from the study are categorised according to four broad themes, namely: Enjoyment, Motivation, Self-confidence, and Value.

Theme 1: Enjoyment

Part of the aim of the study was to establish how the Grade 11 learners felt being assessed through online FA in Euclidean geometry. Evidently, working with peers to complete online FA on this topic proved to be more fun and entertaining for the learners. The following excerpt illustrates.

"I enjoyed the online assessment and the group I was in; we were all participating you know..." (Participant 2, Interview 2, Aug).

"I mostly enjoyed like socialising it was a nice experience overall". (Participant 3, interview 3, Aug).

This suggests that learners enjoy working on online FA tasks with their peers which benefits their learning of Euclidean geometry in Grade 11. Some learners also mentioned that Kahoot! To be specific was the most fun online tool for the FA. The participants found the assessment to be a *"nice experience overall"*. As a result of enjoying the online FA, majority 34 (35,42%) of learners strongly agreed that they would prefer to do an assignment or any assessment in mathematics online rather than to do a written test/examination. 23 (23,96%) Of the learners strongly disagreed, whereas 16 (16,67%) have neutral views, 9 (9,38%) disagreed and 14 (14,58%) agreed. 7 (7,29%) Learners strongly agreed that they have usually enjoyed being assessed online in mathematics in schools; 18 (18,75%) strongly disagreed; 15 (15,63%) agreed as well as disagreed, but majority of the learners 41 (42,71%) had neutral views. Also, 20 (20,83%) strongly disagreed that online assessment in mathematics is dull and boring (item 25). Whereas 42 (43,75%) held neutral views; and 9(9,38%) strongly agreed.

Theme 2: Motivation

Motivation is an imperative aspect of learning. The data pointed to the importance of internal motivation which challenges the learners to think and move to the higher order level of cognitive level where they can solve equations efficiently. The work became bearable for some students when they were doing online FA within groups and it can be safely posited that this encouraged the students to complete the online FA. The learners sentiments are captured in the following excerpts.

"...makes you think more but then I tried to answer them as best as I could...for me to be able to solve uhh...equation quicker then...I think I can". (Participant 1, Interview 1, Aug).

"I think it was easier doing things as a group although I don't like eh...group work". (Participant 3, Interview 3, Aug).

Seemingly, internal and external forces of motivation are important in completing online FA on Euclidean geometry for Grade 11 learners. As a result of the expressed above sentiments, about 22 (22,92%) of the learners agreed that they were willing to do more online assessments than prescribed by the teacher, with a few 13 (13,54%) learners who strongly agreed that they are willing to do more online assessments than the teacher prescribes. However, few learners 12 (12,4%) admitted that they are not willing to do more online assessments in mathematics than the required number of assessments prescribed by the teacher. Those who have strongly disagreed were 21 (21,88%) among the 28 (29,17%) who held neutral views.

Theme 3: Self-Confidence

Based on the findings, 22 (22,92%) Strongly agreed, 20 (20,83%) disagreed, and 34 (35,42%) of the learners had neutral responses that online mathematics assessments are difficult. This suggest that the 20 (20,83%) learners that agreed had self-confidence regarding online mathematics FA while the other 22 (22,92%) did not have comparable confidence. The majority 34 (35,42%) chose to remain neutral instead

so it cannot be deduced whether or not there were self-confidence or a lack thereof. Nonetheless, the element of self-confidence is reflected in the excerpts below:

“It was very easy. However, considering the network we have...it might be a little challenge.” (Participant 4, interview 6, Aug).

“You should make longer...”. (Participant 5, interview 6, Aug).

Although the learners pointed to issues such as network issues and the duration of the online FA, stating that it should be longer, the data indicate that learners were confident. The self-confidence evident in learner’s responses could suggest that perhaps learners need to be taught with similar online tools to be confident in the Euclidean geometry content. This is mainly because the data had also shown that the learners guessed the correct answers. Thus, even though there is a level of self-confidence in using the online FA tool, the conceptual understanding of the participant does not seem to suggest that the learner can confidently solve geometry questions using a traditional pen-and-paper based assessment involving the topic.

Theme 4: Value

The value of online FA in Euclidean geometry was associated with a number of benefits by the learners. When asked if online assessments in mathematics were worthwhile and necessary, 15 (15,63%) learners strongly agreed; 18 (18,75%) agreed; and 12 (12,5%) strongly disagreed. Their views are captured on the excerpts below.

“...it helps with the group work...it could help the ones who didn’t understand...helping me especially when it comes to exams...” (Participant 1, Interview 1. Aug).

“The colours of ya’ll put for the options...ja that was actually really helpful instead of the A, B, C kind of thing because then I tend to forget that I was there at C...”. (Participant 6, Interview 6, Aug).

“I would recommend that it should be more accessible to for everybody. So, a lot of people can actually learn how to do Math or something...”. (Participant 3, Interview 3, Aug).

Participants seem to propose that online FA supports learning that is socially constructed and helps solve mathematical questions easily, thus preparing them for formal examinations and they also valued the colourful presentation of the assessment tool. Lastly, the recommendation of the use of online FA in improving learning of Euclidean geometry suggest that learners value online FA in learning this topic.

6. Discussions

According to Barana et al. (2019), the immediate interactive feedback provided by online FA tools can help learners develop and identify problem-solving strategies as they engage with mathematical tasks. In their study, the same writers (Barana et al., 2019), found that online FA increased the level of engagement in learners who had demonstrated little interest toward Mathematics prior to the online FA. In other words, the attention of learners increased because of the interactive feedback which they found to be useful. Similarly, in this research study, majority of the learners showed more interest in the online assessment than the traditional (paper-based) assessment. Furthermore, Barana et al. (2019) contended that the content knowledge and procedural understanding of learners can be improved when utilising online FA. This research study, however, indicates that although learners value and enjoy online mathematics assessment, the procedural understanding of learners did not necessarily improve immediately. In fact, there was a group of learners who were still guessing responses which pointed to their lack of conceptual understanding of the content. However, an interesting trend on the data also pointed to the enforcement of critical thinking while taking the online FA which is crucial in Euclidean geometry. Critical thinking is particularly important in developing self-efficacy as learners may either have high levels of self-efficacy that motivates them to put effort into their learning, or low levels of self-efficacy where they might not be as motivated to solve challenging questions.

7. Conclusion

The use of online FA in Euclidean geometry during teaching and learning is stimulating and engaging to most Grade 11 mathematics learners in this study. These online FA tasks are especially enjoyable for learners when they work in groups, thus highlighting the significance of collaboration when working with Euclidean geometry and online assessment tools. Furthermore, learners' positive attitudes towards the usefulness of online FA show that using Kahoot! allows them to overcome prevalent knowledge gaps, stimulates them, and enhances their confidence. The data showed that continued usage of the online FA in assessing Euclidean geometry could lead to increased learning because these activities have been proven to be beneficial and essential for the learners' higher cognitive development. Therefore, it is vital to take advantage of the pedagogical benefits of online tools for FA like Kahoot! to enhance learners' academic experience in basic education and ensure greater access to the conceptual understanding of Euclidean

geometry. Online FA will probably assist learners who have trouble learning the fundamental concepts in Euclidean geometry. Moreover, the consistent use of online FA in Mathematics is critical for the learners' preparation of the summative evaluation, which is often the most difficult assessment for learners, according to research.

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