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SCIENCE TEACHERS' PERCEPTIONS ON USING MOBILE-BASED FORMATIVE ASSESSMENT FOR INQUIRY-BASED TEACHING: BENEFITS AND CONSTRAINTS

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Abstract

The proliferation and use of mobile technologies in and outside the classroom has contributed to the rapid extensive implementation of mobile-based teaching and learning practices across the globe. In the 21st century, using mobile devices for assessment purposes has become the new and important phenomenon for researchers and teachers. This paper reports the findings of a qualitative case study of four science teachers' perceptions on the use of mobile-based formative assessment for inquiry-based teaching within their classrooms. Participant teachers were purposively selected from schools around the Gauteng Province, South Africa. Data was gathered through baseline questionnaire, classroom observations and stimulated-recall discussions. The findings from the baseline questionnaire indicated that all four participating teachers have adequate knowledge and understanding on using inquiry-based teaching, formative assessment, and technology. Challenges such as inadequate teaching and learning time, inadequate resources, no-cell phone school policy, unstable network connectivity and teachers' inadequate knowledge and skills were established from classroom observations and stimulated-recall discussions as common barriers to effective enactment of mobile-based formative assessment for inquiry-based teaching from all the four teachers. The four science teachers indicated benefits of implementing mobile-based formative assessment for learners such as enhanced learner engagement, participation, motivation, and learners having fun while they comprehend scientific concepts during the learning process. Although the use of mobile-based formative assessment was reported to be beneficial in the teaching and learning experience, science teachers also mentioned that the curriculum must be flexible in terms of time allocated, for mobile-based formative assessment to be effectively implemented during inquiry-based teaching.

Keywords: *Formative assessment, inquiry-based teaching, mobile-based formative assessment, mobile technologies.*

1. Introduction

The shift from traditional teaching and learning approaches towards inquiry-based teaching approaches has led to a critical consideration of technological tools that have great potentials of effectively supporting and promoting formative assessment practices in an inquiry-based science classroom. Trending technologies such as mobile technologies are developed and rapidly integrated in educational contexts to offer adequate support to teachers for effective enactment of formative assessment practices (Woolf, 2010). 21st century learners are regarded as technology-savvy generation that are eager to experiment and enjoy learning and assessments through educational applications such as kahoot!, Socrative and quizizz on their mobile devices as an approach to support and enhance learning and assessment process (Anamalai & Yatim, 2019). Research reveals that game-based formative assessment tools such as Socrative and Kahoot! have a positive impact on the learners' learning experiences, enhances learners' motivation and active engagement towards science learning (Ismali & Mohammad, 2017). It is accordingly important for science teachers to adopt and use mobile technologies to support effective formative assessment practices in an inquiry-based teaching and learning environment. Although mobile-based formative assessment is still at an emerging area in the mobile learning research context, mobile technologies have a great potential in facilitating formative assessment practices in an inquiry-based context (Nikou & Economides, 2018). Formative assessment is an important component in the teaching and learning process which supports learners in acquiring skills, knowledge and expertise that will help them to be critical and competent learners in the 21st century era (Nikou & Economides, 2018). There are numerous benefits associated with the effective use of mobile technologies for formative

assessment practices. To point out few benefits, firstly, mobile technologies enable easier administration of formative assessment activities (Bacca-Acosta & Avilla-Garzon, 2019). Secondly, formative assessment conducted through mobile technologies has a potential of enhancing learners' motivation and achieve the stipulated learning goals (Nikou & Economides, 2018). Thirdly, mobile technologies can further support wide variety of assessment practices such as formative assessment and game-based assessment (Sung et al, 2016). Fourthly, the effective use of mobile technologies can help teachers to successfully assess their pedagogical practices as well as the learners' competences related to 21st century knowledge and skills such as critical thinking, collaboration, creativity and problem-solving (Nikou & Economides, 2018). Fifthly, mobile technologies can be used to capture learners' performance and analyze the captured data to inform the next teaching and learning steps while providing appropriate support to learners according to their needs based on their formative assessment prior performance (Sung et al, 2016). Empirical research (Oyelere et al, 2016; Sung et al, 2016) have reported that mobile devices play a vital role in learners' academic achievement, providing adequate support to foster meaningful teaching and learning experiences, and improve engagement with the learning material, collaboration, enjoyment and interest in a science subject, promoting continuous interactions and can also facilitate innovative pedagogical strategies that will equip learners with higher-order thinking skills. Despite the numerous affordances associated with mobile-based formative assessment practices in the 21st century era, science teachers are experiencing numerous challenges that hinders successful enactment of formative assessment using mobile technologies. Lack of appropriate teaching and learning resources, adequate technical and management support, teachers' adequate knowledge and experience, and teachers' positive attitudes and believes towards mobile-based formative assessment are the main challenges that hinders the teachers from implementing mobile-based formative assessment (Nikou & Economides, 2018). It is noticeable that teachers receive arguably little or no guidance to select and implement mobile technologies for formative assessment when following an inquiry-based pedagogical approach. Grob et al. (2017) argues that teachers' lack of formative assessment literacy has been reported and professional development is suggested as an approach to develop teachers' formative assessment literacy.

2. Aims and Objectives

Despite global empirical research (Sung et al, 2016; Grob et al, 2017; Lee et al, 2011) that has reported the significant role of implementing mobile-learning technologies in an inquiry-based pedagogy, the teachers' experiences, and challenges on the use of mobile-based formative assessment, not many studies in science education have reported on the teachers' experienced benefits and constraints with the use of mobile-based formative assessment in a South African context. Thus, for this study, the overall aim was to investigate South African science teachers' experienced benefits and constraints with the use of mobile-based formative assessment for inquiry-based teaching. The following research question was posed to drive the inquiry;

What are science teachers' experiences benefits and constraints with the use of mobile-based formative assessment for inquiry-based teaching?

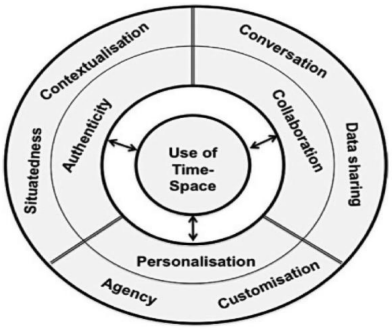
In answering the posed research question, we purposively and conveniently selected four science teachers from around the Gauteng province schools, which presumably had the resources for enacting mobile-based formative assessment and inquiry-based teaching to participate in this study. The objectives included to;

- *investigate science teachers' experienced benefits with the use of mobile-based formative assessment for inquiry-based teaching.*
- *explore science teachers' experienced constrains in the use of mobile-based formative assessment for inquiry-based teaching?*

3. Theoretical framework

The mobile learning pedagogical framework proposed by Kearney et al (2012) and constructivism by Vygotsky (1978) were adopted and deemed suitable to theoretically guide this study. Constructivism has two categories, namely social constructivism (Vygotsky, 1978) and the cognitive constructivism (Piaget, 1967) which both shapes the nature of inquiry-based pedagogy and provide explanations on how individual learners adapt and refine knowledge through active and collaborative participation. Aligning to constructivism learning theory, empirical research Ozdamli (2012) pointed out that the constructivist learning theory is the most significant learning theory for describing, guiding, and underpinning learning facilitated through mobile technologies. The mobile learning pedagogical framework proposed by Kearney et al (2012) shown in figure 1 below illustrates the effective pedagogical use of mobile technologies for constructive meaningful learning.

Figure 1. Pedagogical framework for mobile learning (adopted from Kearney et al., 2012.



As seen in figure 1 above, the key three features of mobile learning are surrounding the 'time ad space' concept, followed by a further breakdown of the three distinctive features into two sub-scale categories per each feature. The use of time-space feature considers the 'organization of the temporal and spatial aspects of mobile-learning environments (Kearney & Mahar, 2012). This implies that the teachers need to clearly identify the learning environment, either virtual or physical, and synchronous or asynchronous incorporation of mobile technologies to enhance the teaching and learning process. Personalization feature takes into consideration the learners' ownership, agency and autonomous learning that is specifically customized, tailored and appropriately designed mobile-learning experiences (Kearney et al., 2012). The authenticity feature comprises of the contextualization and situatedness as the sub-themes that emphasizes the significance of rich and contextual learning activities facilitated through mobile technologies (Kearney et al, 2012). Lastly, learning through collaborative socio-cultural perspective implies that learning takes place through social interaction, two-way conversations, and classroom dialogues whereby learners are actively engaging with their fellow peers to construct knowledge and enhance conceptual understanding (Kearney et al., 2012).

4. Research methodology

Creswell and Creswell (2018) define qualitative research methodology as an approach that gives the researcher the room to be descriptive and consider the social phenomena. Taking into consideration this definition, the qualitative research methodology was adopted and deemed suitable for gathering data that will help us answer the research question of this study. A case study design was adopted as it a design that allowed the researcher to follow participant science teachers over an extended period.

5. Data collection and analysis

Participants of this study included four science teachers' pseudonyms as T_A, T_B, T_C and T_D from three different South African schools in Gauteng province. Three teachers had a 5 – 6 years' experience of teaching science subjects such as Life Sciences and Physical Sciences, and the fourth teacher had a three-year experience of teaching Life Sciences. Data was collected in three stages namely, Stage 1 – open-ended questionnaires: Stage 2- classroom observations, and Stage 3- stimulated-recall discussions. Open-ended questionnaire data collected in stage 1 was collected with the aim of identifying participants' perceptions on enacting mobile-based formative assessment for inquiry-based teaching. In Stage 2 of data collection, classroom observations were video-recorded with the aim of understanding the actual practices of the participating science teachers in terms of how they enact mobile-based formative assessment in inquiry-based teaching within a natural setting of their classrooms. The video-recorded lessons were approximately 45 – 60 minutes long per lesson. All open-ended questionnaire responses from stage 1 and video-recorded stage 2 data were transcribed and analyzed using thematic and deductive coding, in order to identify the correlation and differences between the science teachers' perceptions and actual pedagogical practices of mobile-based formative assessment for inquiry-based teaching. Thereafter, the findings from the first two stages guided the formulation and administration of the questions for the stimulated-recall discussions for stage 3 of the data collection.

6. Results

Regarding formative assessment, findings from the open-ended questionnaire analyses revealed that the science teachers do practise formative assessment in a similar way, where they engage learners in traditional question-and-answer, short activities, and spot tests with the aim of testing learners' understanding of the taught concept, identify any knowledge gaps and help learners prepare for summative assessment. Participant science teachers have experienced that learners are more engaged and have deeper knowledge understanding when formative assessment was incorporated in their learning. They also indicated that they are not 100% competent and they experience certain challenges such as insufficient classroom time, limited knowledge on various forms of formative assessment and mobile technology integration to effectively enact formative assessment everyday throughout the lesson. From the classroom observation data, findings indicated that only 50% of the participating science teachers have experienced and know how to use mobile-based formative assessment platforms such as socrative and kahoot!, while the other 50% of teachers have no experience and knowledge on such platforms for conducting formative assessment. following the nature of this study, this 50% of the participating science teachers were provided with guidance on how to conduct formative assessment using platforms such as kahoot! On mobile technologies. Thereafter, they were given an opportunity to implement the kahoot! Platform for mobile-based formative assessment. During the observations of these lessons, it was revealed that the inadequate knowledge and skills has impact on how teachers enact mobile-based formative assessment for inquiry. As it was clearly visible that these teachers do not understand the key significance of using formative assessment, instead to them it is just another approach for engaging learners, keep them active during the lesson. Overall, it was observed that all four participating science teachers could not complete their lessons within stipulated lesson time, they could not analyze, interpret and use learners' performances from the kahoot! And Socrative to inform the next teaching and learning step. Wi-Fi connectivity issues were observed and coherent teaching and learning process was affected. Accordingly, these findings were fully explained by the participating science teachers during the stimulated-recall discussions, where they indicated that school context and certain socio-economic factors contributes towards how teaching and learning takes place. For instance, in two schools learners do not normally bring mobile devices at schools for learning purposes and some learners cannot afford such devices, which hinders' full learner participation during mobile technology-enhanced teaching and learning. Secondly, the time allocated per lesson, which is ranging between 30 to 60 minutes is insufficient for teachers to effectively engage learners, ensure meaningful and constructive learning, as a results exploration, elaboration and even assessment time is very limited and thereafter, teachers tend to bend towards traditional, teacher-dominant teaching. Thirdly, there were noticeable differences between the teachers' use of game-based formative assessment, as one out four used Socrative while the other three used the Khaoot! Platform. Only 2 out of 4 participating teachers managed to use learners' responses to stimulate classroom discussions, ask follow-up questions with the aim of identifying knowledge gaps and enhance learners understanding before moving to the next quiz questions. Whereas, the other two teachers only administered the kahoot and Socrative at the end of the lesson with little to no interpretation and use of learners' responses to inform the next teaching and learning step.

7. Discussion

The findings from this study reveal that although the science teachers recognize the importance of incorporating mobile technologies and have adequate knowledge to effectively enact mobile-based formative assessment for inquiry-based teaching, their mobile-based formative assessment practices still require extensive guidance and development. These findings concur with research findings such as (Cochrane, 2014; Lee et al, 2011; Sung, Chang & Liu, 2016; Grob et al, 2017) that attests that mobile technologies can be successfully implemented and be more effective with pedagogies such as inquiry-based teaching and formative assessment, however, teachers are experiencing difficulties in implementing mobile technologies for inquiry-based teaching and formative assessment due to lack of adequate knowledge and skills, inadequate teaching and learning resources, large class sizes, insufficient teaching time. South African curriculum structure does not give teachers opportunities to be flexible and teach according to their classroom context as they must rush to complete the prescribed syllabus content on time, as a result the use of mobile-based formative assessment for inquiry-based teaching is not possible as this pedagogical approach requires time for preparing, administering and discussing learners' input during the learning process.

8. Conclusions and recommendations

Based on the findings of this study, it can be concluded that the enactment of mobile-based formative assessment can improve learners' interest and engagement in science classrooms. However, the effective enactment of mobile technology-enhanced formative assessment is still a challenge for South African science teachers. Taking into consideration the 21st century technology-savvy learners we have in science classrooms, the traditional use of formative assessment practices and non-inquiry-based pedagogies are no longer relevant and effective for teaching and learning. As a result, there is still a need for a meaningful development of in-service teachers in equipping them with adequate knowledge and skills to enact 21st century pedagogy like the mobile-based formative assessment. Based on these conclusions, we recommend that the science education fraternity including, department of education authorities, researchers and teacher educators provide intervention programmes for in-service teachers on the effective enactment of mobile-based formative assessment for inquiry-based teaching. Studies of this nature could help inform higher institutions and teacher-training programs about the gaps and the type of guidance and support required to equip teacher with adequate knowledge and skills to effectively enact mobile-based formative assessment for inquiry-based teaching.

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