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In-Service Student Teachers' Perceptions and Calculator Technology: Feasibility of Calculator Use in mathematics instruction in Botswana Primary Schools

End Salani
Lecturer, Department of Primary Education, University of Botswana, Botswana

Abstract:
Classroom effectiveness in this technological driven environment compels teachers to engage in instructional practices that effectively integrates technological tools. This study sought in-service student teachers' perceptions about calculator use in mathematics instruction in Botswana primary schools and was descriptive in nature adopting a survey design. The sample comprised of seventy-five (75) year four University of Botswana B.Ed.(primary) in-service student teachers who had specialised in math and science at Diploma level. The sample was selected through a purposive non-random sampling procedure while a questionnaire comprising both closed and open ended questions was designed to collect data. The analysis of results was carried out using descriptive and inferential statistics. The study revealed that most of the in-service student teachers expressed their lack of confidence and were incompetent with the use of a calculator with more experienced in-service student teachers disapproving the use of calculators in primary school than the less experienced ones. In addition, the study showed that majority of the in-service student teachers believed that a calculator could enhance problem solving, cooperative skills and students' motivation and participation levels. On the contrary, some in-service student teachers felt that calculators could promote laziness and dependence on it, thus hindering development of basic arithmetic skills. Therefore, it was recommended that use of calculators be adopted for mathematics instruction at Botswana primary education level by refining the curriculum to incorporate calculator use at primary school level. School managers should facilitate school based workshops on calculator use so as to empower teachers with the necessary technological skills for effective classroom instruction. The study findings have implications on research and practice as it provides unique and comprehensive data that would inform teacher preparation institutions to design specific courses intended to equip student teachers with the mathematical application of different functions of a calculator and its integration into the primary school curriculum.

Keywords: *primary education, in-service student teachers' perceptions, mathematics instruction, calculators, technology*

1. Introduction

The use of calculators in the primary or elementary mathematics classroom level had been over the years a bone of contention among global educators, curriculum designers and policy makers. In 1974, the National Council of Teachers of Mathematics advocated for the introduction of calculators across all grades. Six years along the line NCTM recommended that Mathematics programs take full advantage of the power of calculators and computers at all grade levels (NCTM, 1980). It is undoubtedly given that not all stakeholders of the education system agreed with this position as research has shown that some teachers, parents, educators, policy makers cautioned that the use of calculators at early grades might negatively affect learners' basic computational skills leading into calculator dependence (Johnson, 2008; Ng Wee Leng, 2013).

Research has shown that calculators use was introduced in different countries in the early nineties. For example, in Australia, it was recommended in 1990 to have calculators used at all grade levels as both an instructional aid and as a learning tool (Australian Education Council, 1991). Willoughby (1990) noted that rapid developments in technology ought to change the way mathematics is taught as they provide new tools with which mathematics goals can be better achieved. Technology is here to stay and definitely continually becoming more effective and user-friendly. On the other hand, Willoughby (1990) stressed that students should regularly use calculators in school, with appropriate instruction, so that they will learn to integrate their various skills to solve mathematical problems efficiently.

However, the Japanese education system disapproves the use of calculators prior to grade 4 and it was found in a study by Tarr, Mittag, Uekawa and Lennex(2000) that Japanese students were not using calculators at grade 8. In Singapore calculators were introduced in primary schools in 2008 (Ng Wee Leng, 2013). In Africa, for example, in Kenya calculators were introduced into the secondary mathematics education in 2002 (Ochanda & Indoshi, 2011) and in Botswana calculators were introduced in junior secondary education in 2008 (Botswana, 2008; Salani, 2013). This clearly attest to the belief that calculators were appropriate for higher levels of education as there is no documented research indicating effective use of calculators at primary school level in Africa.

In Botswana, very few researches had been conducted in Botswana schools at secondary education level with findings indicating that teachers were given inadequate in-service training to the detriment of effective use of calculators for improved teaching and learning processes (Ponoesele, 1999; Salani, 2013). Furthermore, research on calculator use in Botswana has shown that students did not realize the benefits of using a calculator in mathematics learning and despite that most students were accessible to calculators, they were not accessible to calculator technology (Kaino & Salani, 2004). The Ministry of Education and Skills Development (MoESD) in its pursuit to align the education system to the evolving technological practices provided an objective that required primary school learners to develop numeracy and literacy skills compatible with technological and scientific developments (Botswana, 2010). Despite this objective, very little or nothing has been done to provide learners at primary school level with calculator skills to explore and enhance their problem solving skills. In many instances primary school teachers mainly use calculators to compute marks when compiling learners' academic progress reports or converting raw marks into percentages.

It has to be underscored that the use of technology such as calculators in the school curriculum is undoubtedly a valuable tool in this technologically advanced era. For example, the National Council of Teachers of Mathematics outlined the following reasons why technology is used in teaching of mathematics:

- technology could support investigation by students in every area of mathematics
- students have a greater chance of diverting their attention to decision making, reflection, reasoning and problem solving
- Access to technology allows students to work productively and reflectively when doing exploratory work (NCTM, 2000, pp.3&24).

This clearly supports the assertion that technology plays a pivotal role in the modern society let alone the school curriculum. The question now is whether or not student teachers approve the introduction of calculator use in primary schools or not given that both the pre- and in-service training programmes do not offer deliberate courses intended to equip future teachers with relevant calculator skills. It has to be emphasized that unavailability of calculators in primary schools and lack failure to provide continual professional development of teachers in this dynamic technological world are in contravention of recommendation 42(f) and 32(c) of the Revised National Policy on Education, RNPE (1994) and Botswana Vision 2016's pillar of an educated and informed nation which stresses that "Botswana would have sought and acquired the best available information technology…" (p. 5).

For this reason it goes without saying that strategic moves to have calculators introduced in primary schools would be in accordance with global education technological benefits of a computer use in instruction which among others includes provision of an interactive learning environment. Moreover, the National Council of Teachers of Mathematics (NCTM, 1989) highlights that the use of calculators along with traditional paper-and-pencil instruction enhances the learning of basic skills. This study therefore intends to establish the feasibility of introducing calculator use in Botswana primary school math instruction, with the view of promoting good technological practices geared towards improving the quality of math teaching in terms of promoting problem solving and critical thinking skills among learners.

An awareness of teachers' perception on the use of calculators in primary school math instruction may provide some insights into their perceptions of and concerns about calculator use in schools, thus helping the in-service unit of MoESD to adopt appropriate strategies and approaches to improve teachers' receptivity to change and to implement the change successfully. The purpose of this study was thus intended to examine B.Ed. (primary) student teachers' perceptions of the use of calculators in the mathematics instruction. Conducting such a study is also timely and relevant, as the effects of using calculators remain an area of great interest to researchers and policy-makers around the world. Therefore, the following research questions guided this study:

1. What type of professional support did in-service student teachers receive to effectively integrate calculators in math instruction?
2. Do student teachers support the use of calculators at primary school level?
3. What are in-service student teachers' views about the value of calculators' in math instruction?

2. Literature Review

Research has shown that calculators allows students to explore mathematical concepts, hence the need for recommendation by NCTM and other researchers to avail calculators for use by students at every grade level from kindergarten into college (NCTM, 1991;NCTM, 2014; Australian Education Council, 1991). Furthermore, NCTM's *Principles to Actions* (2014) identified calculators in the elementary grades, as one of the classroom tools that could aid students in making sense of mathematics and reasoning mathematically. However, NCTM (2015) advocates for selective and strategic use of calculators in the mathematics classroom with attention to how such a tool will support and advance learning. In support, Reys and Arbaugh (2001) pointed out that when calculators are implemented strategically in ways that support the development of problem solving skills. He further emphasized that students will be afforded the chance to engage with cognitively rich problems that allows for exploration of mathematical patterns and relationships. Moreover, NCTM(2014), stressed that the Strategic use of calculators in the elementary grades could support students in communicating mathematically and making necessary connections across mathematics concepts and procedures and in real-world situations.

Despite several findings indicating the value of calculator use in schools in terms of reducing computational time (Salani, 2013), students gain a higher level of mathematical power and understanding (Pomerantz, 1997), we still have research showing teachers' and other ministry of education officials' fears that calculators at primary education level will inhibit students' development of mathematical computational skills and promote laziness and dependence on it (McNamara & Alice Healy, 1995;Adabor, 2008; Johnson, 2008; Howard, 1992; Yi-Ching & Yuan, 2007). It has to be pointed out that proponents of use of effective use of calculators in classroom are not saying they should replace paper and pencil and mental methods (Ellington, 2003). What Ellington (2003) and other researchers (Mbugua, Muthomi& Okere', 2011; Ng Lee Weng, 2013; NCTM, 2015) are saying is that if calculators are used strategically, an effective learning environment strengthening a positive view of mathematics could be supported. In support of the preceding argument, NCTM (2000) also cautioned that technology should be used to foster mathematical understandings and intuitions and not as a replacement for those.

Use of calculators at elementary or primary school level has been viewed with mixed reactions across the global research experts. For example, in 1995, McNamara and Alice Healy's study observed that allowing elementary school children to use calculators to solve addition and multiplication problems before basic skills were acquired would be detrimental to the learning process. In support of this, Johnson (2008)'s experimental study in a university in the United States of America on Pre-service Elementary-school Teachers' Beliefs Related to Technology Use in Mathematics Classes found that many pre-service teachers opposed the use of calculators during mathematics instruction. This is detrimental to the improvement of quality of math instruction in primary schools as such beliefs are transferred to real class room teaching upon completion of teacher training. It is reported that the Results indicate that teachers report that this belief is related to their own elementary-school experiences and to their own computational abilities.

Other teachers believe that calculators and computers can be used as teaching tools but caution that they should not be over used (Johnson, 2008). An introductory methods course positively affected the beliefs of pre-service teachers. This suggests that Botswana teacher preparation institutions have a harmful effect as they do not provide specific calculator courses. In this manner future teachers graduate without adequate calculator skills and it is given that such teachers are highly probable not to support its use in math instruction as they themselves would be limited on applicable activities.

They seem to be resonance among research on that calculators at primary school level should be cautiously introduced as suggested by the following research: Howard (1992) conducted a study on 147 primary teachers undertaking their fourth year of study for B.Ed. (primary) in 3 universities in Australia to examine their attitudes toward the student use of calculators in primary (Kindergarten-Year 6) mathematics classes. The results of the study showed that few teachers were using calculators for teaching stating that the non-use was either due to their unavailability, there was no school policy on their use and/or they were not considered relevant for the class being taught. It was further found that teachers who supported the primary student use of calculators believed that calculators were a technological tool for use in mathematics that they increase children's confidence, they take the focus off computation in doing problems and that children use them outside the classroom. In Taoyuan, Yi- Ching and Yuan's (2007) investigated fourteen primary schools to establish how they felt about incorporating calculators into the math curriculum. It was revealed that teachers tended to oppose calculator use in math education and believed that the calculator cannot enhance students' understanding of math concepts. Worse than that the surveyed teachers felt that in the process of using the calculator, the students will develop a dependency on the calculator, and the use of the calculator itself will become an impediment to learning. This is clearly indicative that primary teachers across the globe are not grounded on the potential benefits of calculator use as opposed to their perceived damage to students' mathematical background.

In Australia a recommendation by The National Statement of Mathematics for Australian Schools (Australian Education Council, 1991), that calculators should be used at all levels (k-12) as both instructional aids and as learning tools. Following this recommendation, a four year project on The Calculators in Primary Mathematics was conducted to investigate the effects of the introduction of calculators on the learning and teaching of primary mathematics in six Melbourne schools. According to Groves (1997), the findings of the project revealed that classroom observations confirmed that the use of calculators provided a rich mathematical environment for children to explore and promoted the development of number sense. Contrary to fears displayed by some parents there was no evidence that children became reliant on calculators at the expense of their ability to use other forms of computation. Groves (1997) further decried failure by elementary teachers to use calculators in their classrooms despite convincing support for its use at early grades. This situation clearly denies young children an opportunity to experiment with numbers and develop cognitive thing that could be derived through exploring and construction of new knowledge.

In Japan, the education system disapproves the use of calculators prior to grade 4 and this resonates Japanese primary school teachers who agree that it is inappropriate for use in grades 1 to 3 (McCauliff, n.d). On the contrary Tarr et al.'s (2000) on trends in calculator use among 13 year olds in Japan, United States and Portugal, it was found that calculator use in eighth-grade classrooms varies substantially across nations especially in Japan where it was revealed that calculators were not used in eighth grade mathematics classrooms. This clearly shows that even technologically advanced nations could still be holding to those beliefs that calculators hamper the development of basic computational skills. In Tarr et al. study it was revealed that less than 0.5% of Japanese students used calculators during mathematics compared to about 43% of the USA students.

Moreover, a survey by Ng Wee Leng (2013) on 32 primary mathematics teachers in a primary school in Singapore that employed use of questionnaires and interviews explored teachers' perceptions toward the use of calculators in primary mathematics classes. The findings revealed that majority of teachers supported the use of calculators in the primary mathematics classrooms and indicated that the calculator was a technological tool that reduces time spent in tedious computational work and in turn increases students' motivation in mathematics. However, few teachers expressed their reservation on use of calculators in school as they expressed concern that they reduced the need for children to learn basic mathematical facts and might prevent children from acquiring paper-and-pencil computational skills. The findings further emphasized on the need to provide teachers with intensive start-up training, regular follow-up activities ensure the sustainability of such training. This therefore, calls for progressive and continuous courses to accommodate those teachers who might need refresher or practical solutions when they experience calculator related challenge in their instructional practices.

Another exploratory survey in Singapore by Yeo (2008) investigated Singapore's 43 primary schools heads of mathematics departments' beliefs and practices toward the use of calculator in mathematics instruction. The findings revealed that HoD recognized that use of calculator led to better understanding, generated interest and enhanced student performance. This therefore calls for a strategic move to proffer professional development to teachers where they could nurture their calculator knowledge through sensitizing them on research available about successful calculator use in the mathematics classroom, as one of the world's technology innovations.

Quite interestingly, in Singapore, from 2009, the use of calculators were allowed in the mathematics examination in the Primary School Leaving Examination, a national examination taken by all students near the end of their sixth year in primary schools. Accordingly, since 2008, calculators were introduced to primary 5 pupils in Singapore. As Hermans, Tondeur, van Braak, and Valcke (2008) have noted, one of the factors affecting the implementation of educational change is teachers' perceptions of the efficacy of that change. Indeed, in every new initiative introduced, one of the factors determining success is the teachers' mindset and attitudes toward it. In implementing this major change in the Singapore Primary mathematics curriculum in which the use of calculators in examinations is expected, the teacher is thus the key to exploiting the potential of calculators in teaching and learning of mathematics. This calls for teachers to be vigilant in technology use to demystify the notion that the potential of the calculator in primary schools is largely unrealized as viewed by Rousham and Rowland(1996) as cited in McCauliff (n.d.). Further, in 1997, Houssart interviewed 26 teachers form England primary schools, the results revealed that only one teacher was positive about calculator use and it was evident that teachers were not aware of the teaching and learning opportunities availed by calculators. Research has in the past pointed out that teachers were mainly concerned about how calculators will affect students' computational skills (Reys et al., 2001). As a remedy to the preceding argument Vannatta & Hutton (1980) cited in McCauliff (n.d.)stressed that a successful calculator program should include effective teaching materials correlated with the on-going mathematical program. This suggests the need for extensive in-service program for Botswana primary schools teachers to develop and improve competences in the use of calculators. In support of the preceding statement researchers have over the years proposed training programs targeted at equipping elementary teachers with computer skills to help students use calculators to effectively learn mathematics concepts (Williams, 1987; Porter, 1991).

In Africa, a study by Adabor (2008) sought to compare the attitudes of teachers of elementary school and high school mathematics teachers in Ghana and determine the school level it was relatively feasible to consider the integration of calculators into instruction and learning of mathematics. It was found that high school teachers had a more positive attitude towards using calculators in class than elementary teachers. However, in Nigeria, Ogunkunle and Charles-Ogan's (2013) Ex post facto design study investigated dependence of students on calculators for acquisition of basic skills in junior secondary school mathematics. They found that students over depended on the use of calculators in solving problems in mathematics. Consequently, the researchers recommended that students should be introduced to the use of calculators but not to the detriment of mastering basic skills. This clearly suggests that both primary and secondary teachers view mastering basic skills as fundamental before one could think of introducing calculators to students, though secondary school teachers tend to show desirable views on calculator use by students.

Research where use of calculators by students was fairly supported by teachers was on secondary school teachers. For example, Mbugua, Muthomi and Okere's (2011) descriptive survey research design study that investigated the influence of using scientific calculators in teaching and learning mathematics on form 3 students' attitude towards mathematics in secondary schools in Embu District of Kenya, found that use of calculators influenced student attitude towards mathematics. It was further found that teachers felt calculators motivated students and that calculators did not make students confused but encouraged them to think. Moreover, teachers indicated that when students use calculators they finish the work faster and also it makes mathematics easy. The findings of Mbugua et al.(2011)'s study revealed that students believed that not all problems required use of calculator. However, calculators helped them to perform better in mathematics and work out more problems and they believed mathematics was very interesting and enjoyable with calculators. It can be concluded from these findings that the use of calculators lead to improved students' attitude and thus enhances students' mathematics self-concept which raises and maintains their motivation to learn. The findings of this study are useful to teacher educators and curriculum developers, and the calculators should be maintained in the mathematics class.

Similarly, in an emailed Australian state-wide survey of 92 secondary teachers of Victorian secondary schools on Mathematics with Technology Perceptions was carried out by Pierce& Ball (2009). The findings showed that teachers had a positive perception that use of technology can allow students to engage in more real world problems, make mathematics more enjoyable and make students more motivated. On the other hand there was evidence that those teachers who perceived that students must learn mathematics by-hand (pen and paper) first may see teaching students to use technology as an extra, time-consuming task.

In Ghana, a descriptive survey by Amanyi, Sigme and Asiedu-Owuba (2016) investigated teachers' perceptions towards the use of calculators in mathematics instruction in JHS. Teachers were found to be having positive perceptions towards the use of calculators for mathematics learning. This finding is helpful to Botswana curriculum developers and policy makers as they could argue their case to implement the use of calculators in the teaching and learning of mathematics at primary school level.

3. Theoretical Framework

In this study the researcher used constructivist theory to understand how technology provides new opportunities such as learning styles, student-centered instruction and promotion of higher-order thinking, the student teacher's perceptions on the use of calculator technology into the classroom instructional practices. It is without doubt that constructivism is a philosophical position which holds that any so-called reality is the mental construction of those who believe they have discovered and investigated it (Saunders, 1992) and from this perspective, learning is understood to be a self-regulated process of resolving inner conflicts that become apparent through concrete experience, discussion, and reflection (Brooks & Brooks, 1993).

Constructivists believe that knowledge must be constructed by the learner and Holzer (1994) asserts that it cannot be supplied by the teacher. For example, if one considers the likes of constructivists such as Piaget, who defines knowledge as an interaction between subject and object it is imperative that learning can be nurtured. The concept of constructivism emphasises knowledge as a perpetual construction made by exchanges between thought and its object. It is not a copy of reality by the concepts of the subject that approaches the object without ever attaining it in itself. Consequently, the construction of knowledge is a dynamic process that requires the active engagement of the learners who will be responsible for ones' learning while the teacher only creates an effective learning environment, thus taking the role of a facilitator.

Darling-Hammond, and Falk (1997), indicated that when applying constructivism it is noteworthy to consider teacher quality as a determinant of student performance. Stressing the preceding argument, Brooks & Brooks (1993), pointed out that the teacher’s knowledge, beliefs, and actions all affect the success of the learner and that the most valuable quality of a teacher applying pedagogy based on constructivism is the "instantaneous and intuitive vision of the pupil’s mind as it gropes and fumbles to grasp a new idea. It is imperative that the teacher as a facilitator should bridge the learner’s knowledge gap by guiding the knowledge a learner constructs. In other words this call for teachers to direct the learners to provide experiences that can question or expand upon their previous learning. Consequently teachers will promote the development of powerful and effective constructions (Confrey, 1990; Ernest, 1994). It is also upon the teachers’ shoulders to ensure that they give learners assurance that they are doing things appropriately and that they can think logically and all their mistakes can be corrected. Noddings (1990) emphasize that students’ thinking has power and their errors are corrigible. It is with no doubt that constructivism advocates that teachers should allow learners to choose technology based activities, ask learners to explain answers, and prompt all learners to be involved (Mikusa & Lewellen, 1999).

The researcher employed the constructivist approach to catechize the feasibility of introducing calculator technology in primary school math instruction with the view of addressing objectives that promotes critical and problem solving skills supported by technology enhanced learning environment. Bachelor of Education (Primary) in-service student teachers’ perceptions about calculator use at primary school was analysed. It is imperative that student teachers’ willingness to embrace change as a major requirement for successful calculator technology integration has a bearing on their choice of classroom instructional practices. Similarly, technology is continuously, and rapidly, evolving, hence requires continual learning and support in terms of providing opportunities for effective technology integration. It goes without saying that teacher support in terms of availing different forms of technology, providing students with more access to technology, could reduce the likelihood of a teacher centric learning environment whereby calculator use revolves around teacher needs, not necessarily learner needs.

According to the National Educational Technology Standards for Students, International Society for Technology in Education (NETSS, ISTE 2007), effective classroom use of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information, and present it professionally. This is to say that technology should become an integral part of how the classroom functions in terms of accessibility like any other classroom learning tools. This clearly tells us that technology has become a major component of our educational system. Supporters of technology argue that technology is often touted as the saviour of education (Collins & Haverson, 2009).

Constructivists further argue that there is a close relationship between technology and constructivism, the implementation of each one benefiting the other and it is no longer a luxury. Gilakjani, Leong and Ishmail (2013) view constructivism as learning that takes place in contexts, while technology refers to the designs and environments that engage learners and those recent efforts to integrate technology in the classroom have been within the context of a constructivist framework. Parpert (1999) stressed that if education is to be pertinent, productive, progressive and proficient then the fever of technology can no longer be starved, but must be fed, embraced and embodied within our institutions; making every attempt to fuel it rather than cool it. In view of this, constructivists see an opportunity for practice and drill where learners require opportunities to assimilate new information in repetitive and multiple ways. Similarly, the use of calculators can enhance cognitive powers of learners during thinking, problem solving and learning and imperatively overwhelmed with technology pervading every aspect of our lives. However, Yet within educational institutions, the amount, quality and expertise in technology is grossly insufficient (Jonassen, 1996).

It is on the basis of the above that constructivism becomes an instrumental tool for the investigation of the University of Botswana B.Ed. (Primary) in-service student teachers’ perceptions about the feasibility of using calculator technology in the teaching and learning of mathematics at primary school level. The researcher used constructivists in view of the fact that learners’ academic challenges are rooted in inappropriate teaching and learning strategies which tend to be teacher dominated, as opposed to learning environments that support multiple perspectives or interpretations of reality, knowledge construction, and context-rich, experience-based activities. This approach is similar to the position of the RNPE (1994), which puts emphasis on learner centered approaches. As such the apt development of increasingly powerful calculator and communication systems has great implications for the constructivist approach to education. It offers a tremendous tools for creativity and development, and various environments and forums for communication. Within a learner-centered curriculum based on learner performance, new technology tools provide many opportunities for leaners and teachers to build knowledge in an engaged setting.

4. Methodology

4.1. Research Design

In order to explore in-service student teachers' perception about calculator use at primary school level, a descriptive survey design was carried out. The reason for choosing a survey is that it allowed for a large amount of data to be collected. As the research was concerned with what student teachers' perceptions are and not why, this research design is thus considered the most appropriate. Despite the data collection instrument being a questionnaire, the focus was on collecting rich qualitative data in the form of in-service student teachers' perceptions about calculator use in primary schools through the use of both closed and open-ended questions.

4.2. Sampling Design

Target population and sample size

The actual sample size used in the study was 75 in-service student teachers from 86 math and science specialization cohort of the B.Ed. (primary) programme that was purposively selected. Moreover these in-service student teachers had specialised in mathematics and science at diploma level. Ideally these included all year 4 student teachers taking mathematics as one of their core subjects in B.Ed. (primary) degree programme.

4.3. Study Site

The study sample was drawn from the University of Botswana (Department of Primary Education) year four students. All in-service student teachers taking mathematics and science as their area of specialization served as the study population and were all taught both the content and method courses by the researcher.

4.4. Sampling Procedure

Non-probability sampling method was employed to select the area of specialization in B.Ed. (Primary) programme where the in-service student teacher participants were drawn from. This is a method of selection in which elements or participants are not chosen by chance procedures and the success depends on knowledge, expertise and judgment of the researcher. The area of specialization was chosen on the basis of convenience and economical advantage as the student teachers were taught by the researcher (both math content and pedagogy), hence were within the researcher's proximity. Similarly, the University of Botswana was chosen on the basis that it is the only institution in Botswana offering in-service training to primary school teachers, with a specialization in mathematics and science on full time basis. As a result students in this area of specialization were selected as the study sample.

4.5. Data Collection

4.5.1. Instrument for Data Collection

The instrument used was both a closed and an open ended questionnaire for in-service student teachers. The instrument was piloted with the University of Botswana 3rd year B.Ed.(primary) math and science specialization in-service student teachers before the actual data collection to ascertain the reliability of the instrument.

4.5.2. Data Collection Procedure

Data was collected from the in-service student teachers who were in their fourth year of the B.Ed.(primary) specializing in mathematics and science. An in-service student teacher Perception Questionnaire was administered by the researcher over a 50 minutes period. The closed ended component of the instrument was intended to provide quantitative data while the open ended part provided in-service learners with an opportunity to provide insights of perceptions about calculator use in their own words.

4.5.3. Reliability of Instruments

The reliability of student teacher perception questionnaire was tested using Cronbach's correlation coefficient Alpha formula, which was considered appropriate where the items are of varying point values or attitude scales and also determines reliability of an instrument by a single administration. The degree of internal consistency as estimated by Cronbach Alpha value obtained was 0.904 for Perception Questionnaire for student teachers and was considered reliable.

4.6. Analyzing of Data

Data analysis was done both quantitatively and qualitatively, with the results tabulated and summarized in graphs and tables. Furthermore, inferential statistics, One way ANOVA was used in data analysis as multiple comparisons of student students' teaching experiences against their perceptions about calculators use was conducted using Scheffe test.

5. Findings / Results

This section presents the research findings in line with the research questions that guided this study. A total of 75 year four University of Botswana B.Ed. (Primary) math and science specialization students responded to the calculator perception questionnaire. Out of these 48% were females while 52% were males. The purpose of the study was to find out year four B.Ed. (primary) in-service student teachers' perceptions about the feasibility of introducing calculators at primary school level. All the 82 year four B.Ed. (primary) in-service student teachers filled the questionnaire with 75 returning the filled questionnaire making a response rate of 91%. The responses given were used by the researcher to obtain information on in-service student teachers' perception about use of calculators at primary school level. The responses were categorized into various themes based on perceptions about feasibility of use of calculators to support primary school mathematics classroom instruction, their perceived value of calculators as a technological tool in math instruction and their competency and confidence on the use of calculators to support math instruction, in-service student teachers' views about their proficiency on use of calculators and calculator in-service support to promote math instructional processes.

5.1. Results from the B.Ed. (primary) in-service student teachers' Survey

Tables 1(a), (b), (c), (d) and 2, figures 1 and 2 below present the results from the in-service student teachers' survey which speaks to their perceptions about the feasibility of use of calculators to support primary school mathematics classroom instruction, their perceived value of calculators as a technological tool and their proficiency on the use of calculators to support math instruction.

- Research question 1: What type of professional support did in-service student teachers receive to effectively integrate calculators in math instruction?

In-service Training for In-service Student Teachers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	42	56	56	56
	1	28	37.3	37.3	93.3
	2	1	1.3	1.3	94.7
	3 and above	4	5.3	5.3	100.0
	Total	75	100	100	

Table 1(a): In-service training for student teachers

I have never been given calculator in-service support to help me integrate it effectively in my teaching					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SA	22	29.3	29.3	29.3
	A	38	50.7	50.7	80.0
	D	8	10.7	10.7	90.7
	SD	7	9.3	9.3	100.0
	Total	75	100	100	

Table 1(b): In-service support on calculator use

Calculator Proficiency of In-service Teachers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Elementary	36	48	48	48
	Intermediate	29	38.7	38.7	86.7
	Advanced	10	13.3	13.3	100.0
	Total	75	100	100	

Table 1(c): In-service students' Proficiency levels on calculator use

I was not trained in the use of calculators in teaching at my previous college(s)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SA	15	20.0	20.0	20.0
	A	34	45.3	45.3	65.3
	D	13	17.3	17.3	82.7
	SD	13	17.3	17.3	100.0
	Total	75	100.0	100.0	

Table 1(d): In-service teachers' acquisition of calculator skills during teacher training

The questionnaire sought to establish in-service student teachers' views about their proficiency on use of calculators and calculator in-service support to promote math instructional processes by asking questions on the following:

I. In-service workshops support on calculator use
II. Proficiency level on calculator use
III. Acquisition of calculator skills during teacher training

The results show that the majority of the respondents agree that they have never been given an in-service calculator support to help in the teaching of mathematics concepts. This is shown in table 1(a) where 72% of in-service teachers agreed with the statement. In support of the preceding finding, 93.3% of the respondents indicated that they have attended either zero or one workshop on calculator use. This could imply that some teachers might have attended a workshop on calculators but no strategic moves have been made to provide continuous support intended to help teachers effectively incorporate the calculators in math instruction. Table 1(c) further shows that 86.7% of the respondents were either at elementary or intermediate proficiency level on the use of calculator in math instruction. Similarly, results from table 1(d) reveal that 65.3% of in-service students had not acquired calculator skills from their teacher preparation institutions. It has to be noted that even at the University of Botswana, under the B.Ed.(primary) programme, there is an optional course on mathematical applications for primary schools, which equips students with skills on how to use a calculator effectively to explore and enhance problem solving skills (University of Botswana, 2016). However, this course is an option, implying that very few students take it while majority opt for courses which are not mathematics oriented. For this reason, failure by the mathematics and science specializationin-service student teachers to pick the course limits access to exposure to this technological gadget. The findings of this study corroborates those of other researches, as it revealed that there was need for continual provision of calculator in-service training to foster effective use of the technology in math instruction (Ng Weng Leng, 2013). This clearly suggests that lack of calculator skills by teachers influence their support on the use of calculator instructional practices. In this manner, these findings are in contrary to what research has proposed in the past, where extensive in-service calculator program is to be provided to support calculator use (Reys et al., 2001, Hermans et. al., 2008).

- Research Question 2: Do student teachers support the use of calculators at primary school level?

The questionnaire further wanted to establish the in-service teachers' competence and confidence on use of calculators by asking questions on:

I. Difficulty of calculator use in math instruction
II. Competencies on the use of calculators in math instruction
III. Confidence in calculator use as a teaching aid (see figure 2 below)

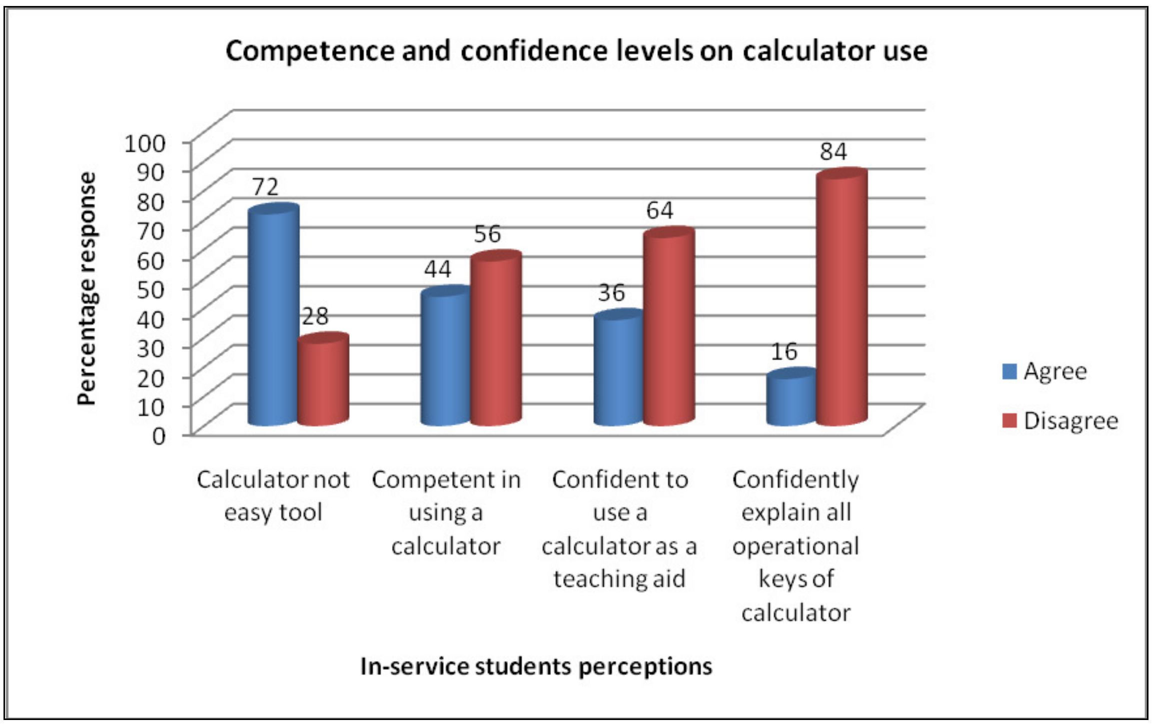

Figure1: In-service students' levels of competence and confidence on calculator use

The results as shown in figure 1 above indicate that the majority of the respondents revealed a positive response on all items. The percentage response ranged from 56% to 84% indicating that in-service student teachers were neither competent nor confident with the use of calculators in the teaching of mathematics in their classrooms. These negative responses are indicative that teachers were not employing a variety of teaching approaches which are supposed to be drawn from drill and practice to discovery methods of teaching. The findings support findings from previous research where it was found that teachers tended to oppose the use of calculators at primary school level due to their limited computational abilities in calculator use (Johnson, 2008; Groves, 1997; Yi-Ching & Yuan, 2007). It is quite evident that failure to empower student teachers with relevant and appropriate calculator skills, the effective use of calculators at primary school level will be a self-fulfilling prophecy that it will not be feasible. These findings, therefore, send a clear signal of the need to introduce courses that infuse calculators in the teaching of mathematics as a way of increasing varied learning strategies to students in math and science, thus contributing to realization of quality education as enshrined in ETSSP (2015-2020) (Republic of Botswana, 2015).

➢ Research Question 3: What are in-service student teachers' views about the value of calculators' in math instruction?

Finally, the questionnaire further wanted to establish how teachers valued the use of calculators in the teaching of mathematics and the possibility of introducing calculator use in primary schools by asking questions on:

i. Calculator dependence and laziness
ii. Development of cooperative learning, problem solving, basic arithmetic and computational skills
iii. enhanced students' motivation and participation levels
iv. Integration of calculators in math instruction
v. Reduced computational time spent in math

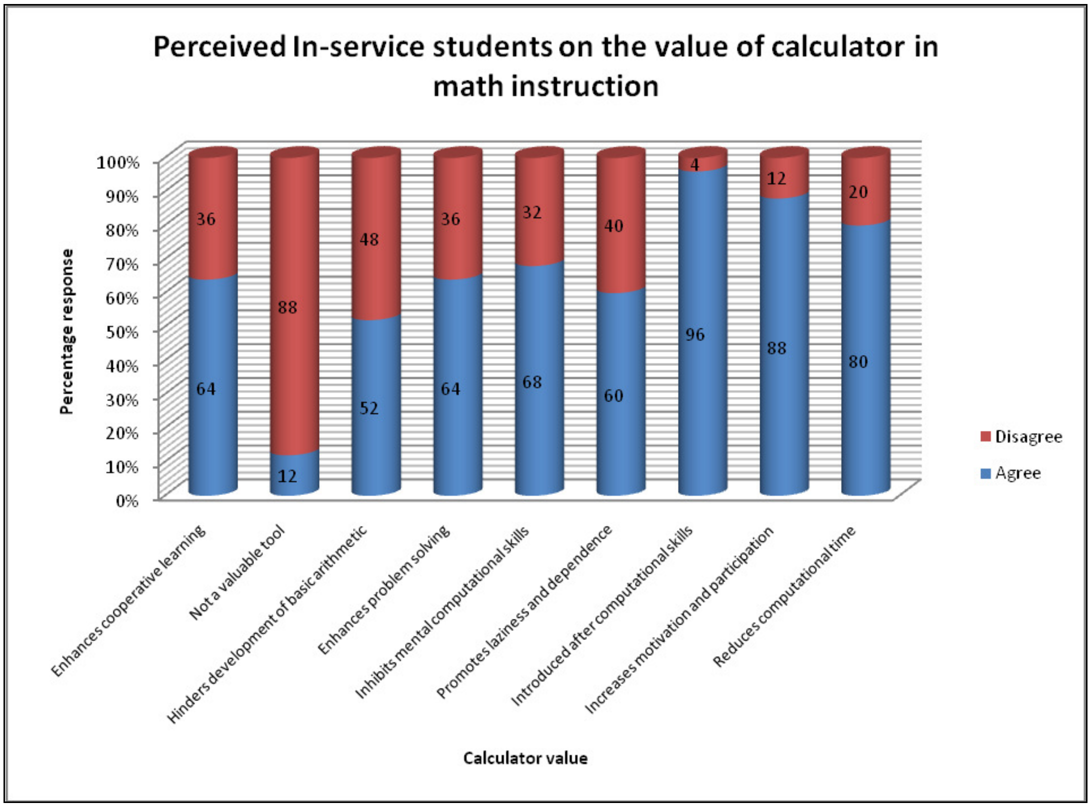

Figure 2: The value of calculator use in math instruction

The results from figure 2 above show that the majority of the respondents revealed their agreement with that a calculator could enhance problem solving and cooperative learning skills, reduces computational time, a valuable instructional tool and that it could increase students' motivation and participation levels. However, the in-service student teachers felt a calculator should be introduced after students have mastered basic computational skills, thus supporting a finding by Salani (2013). They also felt calculators could hinder the development of basic arithmetic and could promote laziness among students and over dependence on it. It is quite evident from the findings that in-service students highly regard a calculator as a valuable tool but disapprove its use at in the primary school mathematics. The disapproval could be attributed to in-service student teachers' lack of calculator skills as evidenced by one of the students who said that "teachers need to be taught how to use calculators before integrating calculators in primary schools." In-service student teachers further reiterated the need for government to provide calculators to all primary schools and come up with academic strategies on its effective classroom use. There is therefore, an urgent need for teacher preparation institutions to develop courses that vigorously equip student teachers with necessary calculator skills to empower future teachers for effective integration in the math instruction. Furthermore, policy makers, regional education officers and school authorities should support schools with calculators and in-service support to workshop teachers on effective use of calculators without hampering mental developments among primary school pupils. This would gradually remove teachers' fears regarding use of calculators at primary school level. One of the in-service student teachers stated that "No, it is not good to use calculators at primary school because pupils needs to solve more problems or be familiar with different methods and formulas without using calculators. They should use their memories to calculate since primary mathematics deals with simple problems." This clearly shows that in-service are not well versed with the different types of activities where calculators can be utilised, hence the need to workshop teachers on the effective use of calculators to support math instruction in primary schools. In view of the above, research done elsewhere support this finding in that calculators will make students develop dependency on them, thus impeding learning and denying them to develop paper-and- pencil computational skills (Yi- Ching & Yuan, 2007; Ng Wee Leng, 2013).

Dependent Variable	(I) Teaching Experience of the teacher	(J) Teaching Experience of the teacher	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Calculator not a valuable and instructional tool	5 - 10 years	10 - 15 years	-.091	.114	.731	-.39	.21
		Above 20 years	-.667*	.174	.004	-1.12	-.21
	10 - 15 years	5 - 10 years	.091	.114	.731	-.21	.39
		Above 20 years	-.576*	.174	.012	-1.03	-.12
	Above 20 years	5 - 10 years	.667*	.174	.004	.21	1.12
		10 - 15 years	.576*	.174	.012	.12	1.03
Calculator not easy tool to use in teaching math concepts	5 - 10 years	10 - 15 years	-.364	.145	.063	-.74	.02
		Above 20 years	-1.000*	.222	.001	-1.58	-.42
	10 - 15 years	5 - 10 years	.364	.145	.063	-.02	.74
		Above 20 years	-.636*	.222	.030	-1.22	-.05
	Above 20 years	5 - 10 years	1.000*	.222	.001	.42	1.58
		10 - 15 years	.636*	.222	.030	.05	1.22
*. The mean difference is significant at the 0.05 level.							

Table 2: Multiple comparisons of In-service students' teaching experiences with their perceptions about calculators use using Scheffe test

The data was further disaggregated by experience to establish whether teaching experiences of in-service student teachers affected their perception about use of calculators in primary schools or not. Univariate analysis of variance was used to study the effect of in-service student teachers' in-service teaching experience in the overall perception towards calculator use in primary school mathematics instruction. Specifically, multiple comparisons of a one way ANOVA using the Scheffe's test showed that in-service student teachers with teaching experience of 5-15 years differed significantly with those with experience above 20 years as the mean values were significant at the 0.05 level. For the statement which want to find out how in-service student teachers felt about a calculator not being a valuable and instructional tool, the mean difference for teaching experience 5-10 years and above 20 years was -0.667 with a significance value of 0.004. On the other hand, the mean difference for teaching experience 10-15 years and above 20 years was -0.576 with a significance value of 0.012. Both these values were less than the critical value of 0.05. In-service students' response to the statement that intended to find out whether they felt calculator were not easy tools to use in teaching math concepts or not revealed that there was a significant difference in the mean difference for those with teaching experience between 5-10 years and above 20 years. The mean difference for this group was -1.000 with a significance value of 0.001, less than the critical value of 0.05. Similarly, the mean difference for in-service student teachers with teaching experiences between 10-15 years and above 20 years was -0.636 with a significance value of 0.030, which was significant at the 0.05 level. The mean differences in both statements imply that the in-service student teachers who had taught for many years tended to disapprove the use of calculators in math instruction compared to teachers who are in their early or middle career years. This could be attributed to that older teachers could be still holding to old schools of thoughts which believed that calculators inhibited students' development of computational skills and should not be used unless students have fully mastered their basic computational skills(Willoughby, 1990; Salani, 2013; Kaino & Salani, 2004). On the contrary younger teachers are likely to have had relatively more exposure to calculators in secondary education and teacher preparation institutions compared to older teachers (more experienced ones). There is need for teacher preparation institution to take advantage of the digital native generation (learners) to design courses that would empower future teachers with modern technologies. It is hoped that if teachers are well grounded with calculator technologies and other tools, they would be in a better position to explore and design interactive lessons that allows learners to explore technologies during lessons.

6. Conclusion and Recommendations

6.1. Conclusions

The findings provide some indications on in-service student teachers' perceptions about calculator use in Botswana primary school mathematics instructional practices. This study has shown that the majority of in-service student teachers have attended minimal workshops that addressed use of calculators in mathematics instruction and there was no deliberate in-service calculator support to help them in the teaching of mathematics concepts. This clearly shows that the limited skills that in-service student teachers had was never developed as it was clear that no strategic continual support intended to help teachers effectively incorporate the calculators in math instruction had been made by the school authorities or Teacher In-service unit of the MoESD.

The findings have likewise revealed that the in-service student teachers were neither competent nor confident with the use of calculators in the teaching of mathematics in their classrooms. These leave one to conclude that classroom instructional practices do not promote the technological tools which have been found to enhance discovery, cooperative and problem solving skills among learners. This situation defeats the MoESD and Vision 2016's goals of having all learners employing critical thinking and modern technologies in their learning. Similarly, varying of teaching techniques is comprised as these technological tools have been found elsewhere to increase learners' participation levels and at the same time motivating them to explore concepts leading to relational form of understanding (Skemp, 2006).

It has also been shown in this study that in-service student teachers felt calculators could enhance problem solving and cooperative learning skills, reduce computational time, were a valuable instructional tool that enhanced learners' motivation and participation levels. However, they were some in-service student teachers who felt a calculator should be introduced after students have mastered basic computational skills as it could hinder the development of basic arithmetic and could promote laziness among students and over dependence on it. It has been quite evident from the findings that in-service students highly regarded a calculator as a valuable tool but disapproved its use at in the primary school mathematics mainly because they lacked calculator skills from their teacher training at diploma level.

The most experienced in-service student teachers tended to disapprove the use of calculators in math instruction at primary school level compared to teachers who are in their early or middle career years. This is an indication that most experienced and probably older teachers might be holding to the belief that calculators can only be introduced after learners have mastered paper and pencil skills while the younger teachers falls within the digital native generation and are more exposed to modern technologies than their counterparts.

6.2. Recommendations

Based on the findings made in this study, it is recommended that use of calculator be adopted for mathematics instruction at Botswana primary education level by refining the curriculum to incorporate calculator use at primary school level. This is due to the positive perceptions held by in-service student teachers who felt calculators were valuable and could enhance problem solving and cooperative skills among students, a trait that could promote learner centered teaching, thus ensuring quality of instruction (RNPE, 1994; Botswana, 2015).

There is also a need for reformation on teacher preparation institutions training primary school teachers to make use of these research results that document teacher's lack of skills, perceptions about usefulness of calculators at primary school level as an important tool to promote effective teaching and learning of mathematics. It is anticipated that these findings would inform them to design specific courses intended to equip student teachers with the mathematical application of different functions of a calculator and its integration into the primary school curriculum.

The Teacher Support Unit should develop a committee tasked with designing and production of calculator technology materials to be accessed by learners in specialised rooms such as mathematics labs. The Unit should also see to it that adequate materials on calculator technology are supplied to all primary schools as teaching and learning aids, to accommodate mixed ability teaching and other progressive methods of teaching.

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