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Teachers' Beliefs and Technology: Calculator Use in Mathematics Instruction in Junior Secondary Schools in Botswana

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Lesson starts are transitional events which may cause management problems for teachers. This study sought junior secondary school mathematics teachers' beliefs about calculator use in mathematics instruction in Botswana and was descriptive in nature adopting a survey design. The sample of seventeen (17) mathematics teachers from four (4) junior secondary schools in the Tutume Sub-district in Central Educational Region was selected through a purposive random sampling procedure. A questionnaire comprising both closed and open ended questions was designed to collect data then the analysis of results was carried out using descriptive and inferential statistics. As an illustration, a t-test was used to test for differences in teachers' beliefs by gender while a one-way ANOVA was used to test for difference in their beliefs by experience. The study revealed that most of the teachers expressed their lack of confidence and were incompetent with the use of a calculator in their teaching with female teachers feeling less confident to explain different functions of a calculator than their male counterparts. In addition, the study showed that most of the teachers believed that a calculator was a technological tool that could be useful to the students in the future. On the contrary, most teachers felt that the overuse of calculators by the students could hamper the development of basic computational skills. Therefore, it was recommended that school based training on calculator use should be provided so as to empower teachers with the necessary technological skills for effective classroom instruction. The study findings have implications to research and practice as it provides unique and comprehensive data that will lead to insight for curriculum designers, policy implementers and instructional leaders on effective calculator use in math instruction.

Key Words: Secondary education, teachers' beliefs, mathematics instruction, calculators, technology.

Introduction

Calculators are a common tool in many learning of mathematics classrooms and work environments and are viewed as tools that develop computational skills in its users. According to Suydam (1976) values of calculators have been listed as "to aid algorithmic instruction; facilitate concept development; reduce the demand for memorization; enlarge the scope of problem solving; provide motivation; and encourage discovery, exploration, and creativity'' (p. 12). This therefore explains why it is imperative for students to be accorded the opportunity to explore and utilise a calculator during mathematics learn-

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ing processes as a way of developing an appreciation of technology and the acquisition of basic skills in handling tools and materials (Revised National Policy on Education, [RNPE,1994]) and also to develop the ability to use calculators (Botswana Junior Certificate Mathematics Syllabus, 2010). ,

For the past thirty-five years or so, there have been spectacular advances in personal computational technology. The appearance of hand held electronic calculators in the early 1970s brought calculating devices into popular awareness and the mainstream of economic and technical activity (Kilpatrick, Clements, Bishop & Keitel, 1996). Improvements in this technology and its availability in schools have changed the focus of mathematics education with students being expected to learn how to use calculators efficiently and when it is appropriate to use them.

In the United States of America, the National Council of Teachers of Mathematics (NCTM, 1974) issued a far – reaching statement recommending that calculators be used in all schools. In 1980 NCTM further published an agenda for action recommending that (i) problem solving be the focus of school mathematics (ii) basic skills in mathematics is defined to encompass more than computational facility (iii) Mathematics program take full advantage of the power of calculators and computers at all grade levels (p. 3). This put NCTM at odds with solid majorities of both the general-public and teachers as not all educators applauded the NCTM position warning that the use of such devices would displace attention to paper-and –pencil skills.

Also in Britain, the Cockcroft's (1982) report indicated that there was a widespread public concern over the use of calculators by children who had not mastered the traditional paper- and – pencil methods of computation. Likewise, Ruthven's (1992) study found that various members of the society had strong reservations about the educational use of calculators, often reflecting their own experience of learning mathematics without access to technology. Despite these concerns, Cockcroft reported that the weight of evidence from studies on the use of calculators strongly indicated that calculators did not produce any adverse effect on basic computational ability.

In Botswana, hand – held calculators were introduced in Junior Secondary Schools in 1996 following recommendation No. 31 of the Revised National Policy on Education report (RNPE, 1994) whose major goals were to develop in all children: (i) The capacity to use computational skills for practical purposes, (ii) An appreciation of technology and the acquisition of basic skills in handling tools and materials (p. 33). The use of calculators in Botswana also had the support of the three year J.C. syllabus 1996 whose goals are to develop in all children appreciation of technology and technological skills requiring knowledge of mathematics and ability to use calculators.

Ponoesele (1993) and Mosimaneotsile (1999) conducted two independent studies on the use of calculators in Botswana. Ponoesele's study investigated the impact of calculators in senior secondary school mathematics classroom and found that calculators were extensively used in classrooms with students showing lot of interest in using calculators frequently. Mosimaneotsile's (1999) study revealed that majority of teachers were aware of the role calculators played in a position to effectively incorporate confidence in using calculators to teach.

Similarly, calculator revolution in Botswana never took place as anticipated mainly because teachers' classroom instructional beliefs are a barrier. Haynes (1991) and Koehler and Grouws (1992) in Boris (2004) believe that teachers are more comfortable to implement educational reforms, in this case technology, provided there is a match between their instructional beliefs and the original goals of the innovation at hand. It is therefore reasonable to assume that teachers play a pivotal role for the smooth integration of calculator use in the classroom instruction. Hence, teachers need to employ progressive methods of teaching that support the constructivist approaches in math education with profound reference to strategies that incorporate technology in the classroom, so that effective change in the teaching and learning of mathematics could be realised.

By the same token, beliefs have a determinant role in teachers' efficacy (Viera, Christian, Roch & Gaspar, 2013). In Borris's (2004) words "teachers' instructional beliefs reflect personal theories of knowledge and knowing. Such nature has been seen as influencing teachers' curriculum decisions". There are several studies showing that calculators when used in the teaching and learning of mathematics yields positive effects on students' cognitive and attitudinal domains (Kaino & Salani, 2004; NCTM Principles & Standards for School Mathematics, 2000; NCTM Position Paper, October 2003).

Therefore on the basis of the preceding findings, beliefs held by teachers in their pursuit to effectively integrate calculators in teaching needed to be explored. In this study the researcher intended to find out whether Botswana Junior Secondary School teachers viewed calculators as a tool that could develop in the users, an appreciation of technology in computational and problem solving skills. Also teachers' competences and confidence in the use of calculators during their teaching needed to be established. As a result beliefs held by teachers as they integrate calculators during mathematics instruction should be understood as an educational instrument for providing relevant integration in the curriculum. The purpose of this study was, therefore, to examine the Botswana junior secondary school teachers' beliefs about the integration of calculators in the three-year junior secondary school mathematics curriculum. The study was further intended to find out teachers' competence levels and confidence on the use of calculators in the teaching and learning of mathematics, and their beliefs about the use of calculators in developing computational and problem solving skills.

Research Questions

For the purpose of this study, the following research questions are raised:

1. To what extent do teachers perceive technology as a tool that could develop students' computational skills and inquiry skills in problem solving?
2. To what extent are teachers competent and confident in the use of calculators in mathematics instruction?

Literature Review

Research studies on the use of hand-held calculators in the classroom seem to indicate, to date, that calculators have changed the nature of the problems that are important in mathematics and have opened the door for new methods of investigating those problems. Mason (2010) analysed secondary mathematics teachers' experiences, attitudes, beliefs, and practices in teaching and learning mathematics using the calculator and found that some teachers believed that the calculator can contribute to lack of mathematical understanding and threaten basic skill development. Nevertheless, Cockcroft's (1982) report argued strongly for the importance of developing calculator use in schools and stressed that all secondary school pupils should use calculators as part of their mathematics course.

The results of most studies suggest that introduction of calculators as early as pre- school does not harm computational ability, that appropriate use of calculators enhances young children's ability to learn basic facts and that students who use calculators frequently exhibit more advanced concept development and problem solving skills than those who do not use calculators (Cockcroft, 1982**;** Hembree & Dessart, 1992; Howson, 1991; Suydam, 1982).

In addition, Dunham (1995) found that research did not only prove that the use of calculators resulted in more positive feelings and better attitudes about mathematics for both students and teachers but it also confirmed that calculators improved performance in a variety of areas including problem solving. Evidence for in support of this position, can be found in results from previous studies which suggest that when calculators are incorporated into the learning process, achievement in problem solving increases, counting, computation, estimation and other mathematical skills develops and it makes teaching less onerous thus improving attitudes towards mathematics (Calculator Information Center, 1977; Suydam, 1982; Suydam, 1985; Szetela, 1979). Although the integration of all types of technology into the classroom is viewed as an effective instructional strategy for improving the students, many teachers often do not have favourable attitudes towards the effectiveness of technology as previous studies, indicated that one problem with the growth of technology as an instructional tool was the influence of teachers' attitudes towards technologies and their ability to use them successfully (Huan, Compley, Williams, & Waxman, 1992; Padron, 1992; Planov, Baunder, Carr, & Sarrar, 1993). These studies have also shown that many teachers were struggling to make efficient and effective use of today's technologies and those teachers' attitudes toward technology could also influence students' attitudes toward technology utilisation. This point is also sustained by the work of Brown, Karp, Petrosko, Jones and Beswick (2007), who in their survey established that high school teachers were significantly higher in their perception of calculator use as a catalyst in mathematics instruction than teachers from lower bands. However, Brown et al. (2007) found that teachers across bands believed that students can learn mathematics through calculator use and using calculators in instruction led to better student understanding and making mathematics more interesting.

An equally significant aspect of teachers' attitudes and perceptions on the use of technology was investigated by Akbaba and Kurubacak (1998), and the findings are listed as: technology takes more time; doing task efficiently; experts' opinions and students' interests are important for teachers to use into classroom or integrate into curriculum; teachers and In- service training and seminars about technology as an instructional tool; teachers need the support in terms of availability of equipment and searching of information about technology. Findings from earlier studies (Fleener, 1994a, 1994b) suggested conceptual mastery before calculators are used for mathematics instruction. Follow up studies (Fleener, 1994c; Fleener, 1994d) revealed that there was an interaction between experience and philosophical orientation suggesting conceptual mastery before calculators are used for mathematics instruction. Further Critics of calculators believed they might impede learning, especially when used by students who haven't memorised basic facts. Worse yet, it is believed that young children may never acquire a deep understanding of how numbers work if, on first exposure to mathematical operations, they merely push buttons to arrive at answers (Clayton, 2000).

Powers and Blubough (2005) argue "future teachers need to be well vested on the issues and applications of technology" (p.254). Nevertheless, many teachers still lack the knowledge necessary to effectively integrate calculator technologies into their lessons despite the abundance of these technologies available in schools (Davis, 2002 cited in Hartsell, Herron, Fang & Rathod, 2009). This assertion suggests a paradigm shift and a drastic change by teachers to embrace the modern technologies. For this reason, it could be interpreted to mean that teachers who are not proficient with modern technologies will most likely employ methods that encourage rote memorisation of facts rather than learner centred approaches intended to provide students with learning of mathematics through relational understanding.

Similarly, there was also a general consensus that in-service training support for teachers on the effective use of calculators was minimal. In view of the aforementioned one could allude that calculators have not been effectively integrated into the Botswana mathematics classroom instruction (Kaino & Salani, 1994; Ponoesele, 1993; Mosimaneotsile, 1999). Additionally, the National Council of Teachers of Mathematics (2000) observed that integration of technologies into classroom was left solely the responsibility of math teachers. This situation has an adverse effect on effective use of technology as math teachers have to learn how to use the calculators and at the same time try to teach students to use it appropriately. The sentiment expressed by NCTM (2000), embodies the view that teachers should be proffered continual support and guidance in view of technology use if its integration has to be effective. In the words of Howard (1992, p.7), "despite the fact that NCTM (1980) recommended that mathematics programs should take full advantage of the power of calculators and computer levels, we still had teachers who were not using calculators primarily because there were none available and /or there was no school policy on the use".

Whilst the discussion in the preceding paragraph focusses on in-service teachers, it could also be said that, studies on use of calculators during teaching of pre-service teachers have revealed positive change in philosophies and attitudes towards the use of calculators in pedagogy (Kastberg & Leatham, 2005). Research findings have similarly revealed that technology acceptance was related to perceived ease of use of technology, the perceived usefulness of technology and the attitudes towards the use of technology (Keraz & Ozdemir, 2006). Researchers on technology use have also indicated that teachers' instructional beliefs are a reflection of the students' cognition and attitudinal outcomes which can impact positively or negatively on students' understanding of mathematics concepts through use of technology. Likewise, Handal, Bobs & Grimison, 2001 argued that mathematics teachers' instructional beliefs were important in the education system of any country because these beliefs strongly impacted on teaching and learning. An equally significant aspect of teachers' instructional beliefs has been conceptualised to be a set of assumptions that teachers hold on various educational processes such as curriculum, schools, students, teaching and learning and knowledge (Lovat & Smith, 1995). The aforementioned views imply that positive attitudes towards use of calculators may be developed through teachers' desirable and positively driven attitudes as they view calculators to be tools that enhance effectiveness in the teaching and learning of mathematical concepts.

Research Methodology

The research design for this study falls within the quantitative approach (Cresswell, 1994) which employed a descriptive survey method intended to provide a numeric description of the teachers' sample (Fowler, 1988 in Creswell, 1994). The design was also a cross sectional survey as data was collected at one point in time (Creswell, 1994; Babbie, 1973). Moreover, the study was descriptive in that a questionnaire comprising both closed and open ended questions was employed to collect data and it was meant to describe the "what" of a situation, and not determine cause and effect (Hale, 2011). According to Gay and Airasian (1996), the advantages of using a questionnaire are that it is less expensive, takes less time, can be confidential, easy to score most items, has standardized items and procedures and can be administered to a larger population. In this study they were 17 participants in total, which means it could have been time consuming to use an interview as the participants were widely spaced. An interview data collection method needs some training and also scoring of unstructured items is complex (Gay & Airasian, 1996, p.283). The researcher hence opted for a questionnaire because of time constraints and limited funds for the research study.

Sample

The sample included all mathematics teachers in four Botswana junior secondary schools in the Tutume sub district which administratively falls under the Central Regional Education Office. Botswana Junior secondary schools are divided into clusters or sub-districts/ districts, whereby they conduct workshops and do a common scheme of work as a way of sharing ideas intended to enhance the learning of mathematics within the cohort. The researcher stratified the schools (Cohen & Manion, 1994) into the respective clusters and chose the Tutume sub-district cluster to generate a sample for the study. The sub – district was selected through convenient sampling procedures (Cohen & Manion, 1994) and this was so because of accessibility to the researcher. From the Tutume sub-district cluster the researcher randomly selected four schools to generate the study sample. All mathematics teachers in these four Tutume sub-district cluster schools were used as a representative sample. This constituted 17 teachers (those who volunteered to respond to questionnaires) as a representative sample of junior secondary school mathematics teachers in the sub-district. Among these 17 teachers 2 were female while 15 were males. It has to be noted that this gender disproportion in the study sample may adversely affect the generalisability of the study. Teachers who participated in the study represented a breath of teaching experience ranging from 1-15 years. Participation of schools and teachers depended on the agreement with the school heads and teachers. Teachers who were willing to devote some of their time to the study were used in the study. They had to fill up the research questionnaire and respond to open ended questions. These made the number of teachers participating per school varying from school to school as it depended on their willingness.

Research Instrument and Procedures

Information was collected though a closed and open ended teacher questionnaire in which the researcher designed 2 scales and adapted 2 from Murphy, Coover, and Owen (1989) and Kyeleve and Williams (1995). The four scales used were: use of technology (4 items were constructed to get information on how teachers feel about calculators to develop inquiry skills); Confidence in the use of a calculator (4 items about the teacher's confidence with the use of a calculator were also constructed by the researcher); Computational skills (4 items were constructed to find out teachers' views on calculators with respect to computational skills); Competence (4 items were developed to find out the extent to which teachers can use calculators in their teaching). Altogether there were 21 items representing these scales, and the responses were rated in a 4-point Likert scale with answers ranging from strongly agree to strongly disagree. The researcher avoided a "neutral" option to eliminate indecisive data. On the other hand, open ended items consisted of probing questions which enabled teachers to express their unrestricted views on their beliefs about use of technology (calculator) in mathematics instruction.

Twenty (20) teacher questionnaires were distributed to the involved schools on different dates and each respondent was given an opportunity to fill up the questionnaire within a day before the researcher collected the questionnaires back. Data collection lasted for a period of one week with a response rate of 85% (willing participants).

Testing Construct Reliability and Validity of Instruments

To check for validity of the questionnaire, University of Botswana Bachelor of Education (Secondary) students were used in the trial testing of the questionnaire to try and provide information on the suitability of the instrument and also for modifications on the instrument. Some unclear questions were modified based on the feedback submitted. The teachers' questionnaire was pilot tested in the Boteti Sub-district schools. The items from the adapted scales were modified because they were used in a different context, thus making them valid for this study. The reliability of the Likert scale questionnaire items was examined using the Cronbach's alpha. All items in this instrument measuring each scale were found to be reasonably reliable as they all scored an alpha coefficient of 0.6 and above (Confidence scale= 0.6723; Competence scale = 0.7988; Use of technology scale = 0.7233 and Computational Skills scale = 0.6867). The Cronbach's alpha estimated internal consistency reliability by determining how all items on the questionnaires related to all other items and to the whole questionnaire. According to Gay and Airasian (1996), if numbers are used to represent choices, analysis for internal consistency can be accomplished by using Cronbach's alpha.

Data Analysis

The researcher used both qualitative and quantitative methods to analyse the data. For quantitative data processes (closed ended questions), Statistical Package for the Social Sciences (SPSS) was used for data entry and analysis of the results. Tables of frequencies and descriptive statistics (mean, mode, standard deviation and variance) were used in the analysis. Inferential statistics i.e. a paired sample t-test and a one-way ANOVA were also used in the analysis. Open-ended responses were analysed using qualitative methods. According to Bogoan and Biklen (1998), qualitative methods are descriptive. In this study the open-ended responses were analysed in the form of words rather than numbers. The written results of the research contained notations from the data to illustrate and substantiate the presentation and the data was analysed with all the richness as closely as possible to the form in which the respondents presented them.

An independent sample t-test was used in the analysis in order to check whether the mean difference between males and females could have occurred far too easily by chance for us to generalise it to the whole population or it reflected a pattern that existed in the whole population. According to Bryman and Cramer (1997), a t-test for two independent means is used to determine if two means of unrelated samples differ. It does this by comparing the standard error of the difference in the means of different samples. An estimation of standard errors of the difference in means of a given population in the study is given by Levene's test for equality of variances. Levene's test is a one-way analysis of variance on the absolute (ignoring minus sign) deviation of scores of the groups where the group mean is subtracted from each of the individual scores within that group (Bryman & Cramer, 1997, p.144). The significance or probability value was set at less than or equal to 0.05.

A one way analysis of variance (ANOVA) was also used in this study to compare the means of 4 unrelated samples i.e. teachers' mean responses on the 4 scales (Confidence, Competence, Use of technology, and Computational skill) against the 4 different experiences (1-3years, 4-7years, 8-11years, and above 11years). A post hoc analysis using Scheffe' test was used to test for significance difference between the groups (Bryman & Cramer, 1997).

Limitations of the Study

The study had limitations. The sample comprised only four (4) schools out of fourteen (14) schools which was a small fraction of schools from one of the ten (10) Regions that make junior schools in Botswana. This therefore had some limitations, one of which is that of generalising the results to the rest of the teacher population in Botswana. The sample in one fraction of a region cannot thus be taken as a representative for the entire teacher population. Furthermore filling in of questionnaires by participants in respective schools was not done centrally or supervised but individually at participants' own suitable times. This arrangement might have given participants the latitude to consult one another and possibly respond to certain questions in a particular way, thus influencing the findings of the results to be biased in a particular way.

Findings and Discussions

This section presents research findings of the analysed survey data with a focus on the following research questions:

Research question 1: To what extent do teachers perceive technology as a tool that could develop students' computational skills and inquiry skills in problem solving?

The average mean response for teachers' beliefs about technology as a useful tool that could develop students' inquiry skills in problem solving was 3.40, while their belief about technology as a tool that could develop computational skills was 1.92 (negative statements). This shows that most teachers believed that calculators were a useful technological tool that could aid students to develop inquiry skills and experience problem solving and investigative skills. The teachers' beliefs supported recommendation no. 31 of the RNPE (1994), which states that critical thinking, problem solving ability, individual initiative and interpersonal skills should be developed in all children during the learning and teaching process. Other researchers (Hemberee & Dessart, 1986; Campbell & Stewart, 1993; Dunham, 1996; Smith, 1997; Suydam, 1987 cited in Tarr et al., 2000) have also found that calculator use improved higher order thinking skills and conceptual understanding and fosters independent exploration. There is also, however, a further point to be considered with regard to responses from open ended questions which revealed that some teachers felt calculators were useful technological tools. As one of the teachers said "a calculator gives exposure to computerisation." Some teachers felt calculators were useful in that they prepare students for the modern technology and this is corroborated by one teacher who said, "a calculator is advantageous in that it equips pupils with basic skills to modern technology equipment." It is therefore reasonable to assume that teachers in this study had the right attitudes to effectively integrate calculators in the mathematics instruction and help students enhance their problem solving and inquiry skills.

On the other hand, majority of teachers believed calculators hindered students' computational skills. This finding is consistent with Farkas and Johnson's, 1997; Lin and Yuan's, 2009; Mason's, 2010 studies who found that majority of teachers want students to memorise the multiplication tables and learn pencil and paper arithmetic before using calculators. They found that teachers believed that calculators should be restricted to mathematics that do not require basic computations and that a calculator was ideal for checking mathematics solutions to avoid its interference with students' computational skills. Some teachers also felt calculators should be restricted to high ability students. Teachers' responses to open – ended questions for this scale revealed that majority of teachers agreed that calculators inhibited students' basic computational skills as 64.7% of the teachers felt calculators made students to be calculator dependent while 70.6% of the teachers felt calculators inhibited the development of computational skills. Statements such as the following could be picked from some members of the researched group's responses to open ended questions:

> "The use of calculators cultivates laziness in students and may also hamper the development of basic computational skills in students. As a result, the use of calculators in school does not make students to think broadly at all. It is better not to be used in schools at all."

Despite a global technological advancement, some teachers still feel negatively on the use of calculators by students. This is what one teacher said about the use of calculators by students.

> " … Students should be given many exercises were basic computational skills are needed and they should not use a calculator at all."

This study provided some evidence on teachers' attitudes towards students' use of calculators as dependent on their beliefs about its computational effects on students' mathematics learning. Ruthven (1992) indicated that concerns on calculators use were characteristic: that children may become calculator dependent on the calculator; that use of the calculator may encourage laziness; that availability of the calculator may inhibit the acquisition of number facts; that mental and calculator computation does not give rise to extensive written records; and that all these factors may handicap children when they come to public examinations. It is therefore possible that teachers would prefer paper and pencil methods over calculator use because themselves they lacked the advanced skills to make a calculator interesting and useful in the mathematics instruction.

The teachers' beliefs about a calculator as a useful technological tool were further disaggregated by gender and the average mean response was 3.402 for male teachers and 3.400 for female teachers, indicating that both sexes believed a calculator was a useful technological tool for developing inquiry skills. Levine's test from Table 1 showed no significant difference in variables under Q12, Q4, Q15 and Q16, while for variable under Q13, Levene's test was significant implying that the variances are unequal. In addition, the t-value based on unequal variances, was found to be significant with a two-tailed p-value of 0.001, indicating the belief that a calculator was a technological tool which should be used to develop students' basic computational skills was more inclined towards female teachers than male teachers.

As stated earlier on, Levine's test for variables under Q12, Q14, Q15 and Q16 was non-significant as the variances are equal. Furthermore, the t-value based on equal variances, showed that the average mean scores for variables Q12, Q15 and Q16 were non-significant. For variable 14, the t-value based on equal variance was significant indicating that majority of female teachers did not believe that calculators could develop inquiry skills through students engaging in problem solving activities.

Table 1. Summary of t-test for male and female teachers' average mean responses about their beliefs in the use of technology in developing students' inquiry skills

	Levene's test for equality of variances				
	F	Sig.	T	DF	Sig(2-tailed)
Q12 Var.[1]	0.008	0.930	-0.083	15	0.935
Var.[2]			-0.064	1.640	0.539
Q13 Var.[1]	395.294	0.000	-1.420	15	0.176
Var.[2]			-4.000	14.000	0.001
Q14 Var.[1]	0.022	0.884	2.291	15	0.037
Var.[2]			2.091	1.224	0.246
Q15 Var.[1]	0.399	0.537	-0.430	15	0.673
Var.[2]			-0.540	1.522	0.658
Q16 Var.[1]	0.231	0.638	-0.355	15	0.728
Var.[2]			-0.425	1.455	0.725

Var.[1] Assumed equal variances
Var.[2] Not assumed equal variances
Q12, 13, 14, 15, 16 are variables on teachers' beliefs about technology use in developing inquiry skills in problem solving

For the variable on computational skills, the average mean response for male teachers was 3.03 and 2.75 for female teachers, which indicated that the belief that calculators hindered students' basic computational skills affected female teachers than their counterparts. However, Levene's test showed no significant differences in all the computational skills variables under Q17, Q18, Q19, Q20 and Q21 (Table 2) between male and female teachers. As a result there was no significant gender difference in teachers' mean belief on the use of calculators by students to develop computational skills.

Table 2. Summary of t-test for male and female teachers' average mean responses on their beliefs about technology in developing students' computational skills

	Levene's test for equality of variances				
	F	Sig.	T	DF	Sig(2-tailed)
Q17 Var.[1]	0.002	0.961	1.136	15	0.274
Var.[2]			1.183	1.314	0.408
Q18 Var.[1]	0.638	0.437	-1.153	15	0.267
Var.[2]			-1.488	1.565	0.307
Q19 Var.[1]	0.737	0.404	-0.095	15	0.925
Var.[2]			-0.065	1.107	0.958
Q20 Var.[1]	2.452	0.138	1.169	15	0.261
Var.[2]			3.292	14.000	0.005
Q21 Var.[1]	1.201	0.290	-1.877	15	0.080
Var.[2]			-2.244	1.455	0.200

Var.[1] Assumed equal variances
Var.[2] Not assumed equal variances
Q17, 18, 19, 20, 21are variables on teachers' beliefs about technology as a tool that develops students' computational skills.

Research question 2: To what extent are teachers competent and confident in the use of calculators in mathematics instruction?

An average mean response of the extent to which teachers felt competent and confident with use of calculators during math instruction was 3.00 and 2.78 as obtained from the confidence and competence scales respectively. This showed that for confidence scale few teachers felt somewhat confident with the use of calculators during mathematics instruction. Responses from open ended questions support this finding as it was revealed that some teachers expressed their lack of confidence in the use of calculators during teaching and this is what one of the teachers remarked, “No! …because I was not trained to use a calculator but I only depend on the calculator user guide.”

For competence scale, majority of teachers felt incompetent with the use of calculators during mathematics teaching. The findings on competence scale are consistent with Mergendoller, 1994; Walmsley, 2003; Hartesell, 2009 who found that many teachers lacked knowledge necessary to effectively integrate those technologies in their lessons. The above findings provides one with the basis to sensible assume that teachers’ apparent negative beliefs about effects of calculator use in the math instruction could emanate from their incompetency on its effective instructional use. This is further supported by Mason (2010) who demonstrated that integrating the calculator in the secondary mathematics classroom was a complicated and deliberated task that required maximal teacher support and knowledge for effective integration.

Moreover, the findings further indicate that most teachers felt that they experienced difficulties when using calculators during their mathematics lessons. Whilst the discussions in the preceding statement suggest that majority of teachers felt incompetent in the use of calculators during teaching, open-ended responses revealed that there were some teachers who felt competent in the use of calculators during teaching. This is what one teacher said regarding his competence in the use of a calculator.

> “…Even though most of the pupils can’t read manuals on their own, a calculator is an attractive learning aid to learners. When they are asked to take out their calculators they seem to enjoy it and they easily follow instructions provided by the teacher.”

It is possible that some teachers had favourable attitudes towards calculator use and were able to explore the calculator with the view of mastering it in order to make students appreciate its computational use.

Considering gender differences, it was obtained from the confidence and competence scales average mean responses of 3.03 for males; 2.75 for females and 2.826 for males; 2.400 for females respectively. This revealed that most female teachers felt unconfident while both gender felt incompetent with the use of calculators during teaching, with most female teachers being affected.

The Levene’s test on variables under Q1, Q2, Q3, Q4, and Q6 from Table 3, showed no significant differences in teachers’ extent of confidence in using calculators in their mathematics instruction. There were significant differences between male and female teachers on variable under Q5 (alpha: 0.000) on teachers feeling confident explaining different functions of a calculator. However, the t-value based on unequal variances showed no significant differences in mean responses of teachers to Q5 (Table 3) between males and females. The difference is very small, hence it could have occurred far too easily by chance for us to generalise to the entire teacher population.

For competence scale the average mean response was 2.826 for male and 2.400 for female teachers. Even though both gender felt incompetent in the use of calculators during their teaching, most female teachers were affected. Levene’s test was found to be significant for variables under Q9 and Q10 (Table 3) indicating that the variances were equal. However, the t-values based on equal variances revealed that the differences in teachers’ mean responses were not significant between males and females.

Table 3. Summary of t-test for male and female teachers' average mean responses on their confidence and competence on the use of calculators in mathematics instruction

Levene's test for equality of variances					
	F	Sig.	T	DF	Sig(2-tailed)
Q1 Var.[1]	0.245	0.628	-0.568	15	0.579
Var.[2]			-0.765	1.640	0.539
Q2 Var.[1]	0.219	0.647	-0.539	15	0.579
Var.[2]			-0.663	1.492	0.539
Q3 Var.[1]	0.148	0.706	0.355	15	0.579
Var.[2]			0.425	1.455	0.539
Q4 Var.[1]	0.074	0.790	1.009	15	0.579
Var.[2]			0.947	1.240	0.539
Q5 Var.[1]	26.114	0.000	1.555	15	0.579
Var.[2]			0.641	1.024	0.539
Q6 Var.[1]	0.788	0.389	1.169	15	0.579
Var.[2]			0.781	1.101	0.539
Q7 Var.[1]	0.112	0.742	-0.273	15	0.788
Var.[2]			-0.307	1.384	0.799
Q8 Var.[1]	0.834	0.376	1.169	15	0.261
Var.[2]			0.781	1.101	0.568
Q9 Var.[1]	5.852	0.029	1.862	15	0.082
Var.[2]			0.859	1.036	0.544
Q10 Var.[1]	8.897	0.009	0.794	15	0.440
Var.[2]			0.331	1.026	0.795
Q11 Var.[1]	2.128	0.165	0.220	15	0.829
Var.[2]			0.619	14.000	0.546

Var.[1] Assumed equal variances
Var.[2] Not assumed equal variances
Q1, Q2, Q3, Q4, Q5, Q6 are variables on teachers' confidence on the use of calculators in math instruction.
Q7, Q8, Q9, Q10, Q11 are variables on teachers' competence on the use of calculators in math instruction.

The teachers' beliefs about technology use in mathematics instruction were further disaggregated by experience across the three main variables (competence, confidence, technology use) It was revealed that there was no significance difference between teachers' beliefs about their competence and confidence in using technology and usefulness of technology among the four groups of teachers' experience as a post hoc analysis using Scheffe test showed no significance differences between any of the two groups, taken at a time (F > 0.05 for all the variables).

Summary

The findings from this study revealed that most of the teachers expressed their lack of confidence with the use of a calculator in their teaching. These findings support what other studies have found (Mosimaneotsile, 1999; Ponoesele, 1993), which revealed that teachers' responses clearly showed that they were unable to use calculators in the mathematics classrooms. Findings from this study further suggest that both male and female teachers expressed their lack of confidence in the use of calculators during teaching with more females feeling less confident to explain different functions of a calculator. Analysis of a t-test showed that the t-value was non-significant for most variables under the confidence scale indicating that there was no significant difference between male teachers and female teachers who expressed lack of confidence in the use of calculators during teaching.

Findings of the study further suggest that teacher qualification seemed not to determine teachers' confidence on the use of a calculator. This could be the case because during teachers' professional training, they are not taught how to use calculators in an effective way, and therefore they apply what they think is the best way to teach using calculators. A one- way analysis of variance (ANOVA) performed on the experience of teachers using all the items in the 4 scales revealed that experience did not affect teachers' confidence on the use of calculators during teaching. It is also revealed that teachers felt they were incompetent in the use of calculators in their teaching. Under the scale of competence, gender and experience seemed not to play a major role in determining teachers' competence. Consequently, one could conclude that most of the 17 teachers in the sampled Tutume sub-district schools were highly incompetent and not confident in the use of calculators during teaching and learning process.

In view of teachers' beliefs about technology use in mathematics instruction, most of the teachers believed calculators inhibited students' basic computational skills. These findings support a study by Farkas and Johnson (1997), which showed that 73% of teachers who were researched on wanted students to memorise the multiplication tables and learn pencil-and- paper arithmetic before using calculators because they could hamper the learning of basic facts. However, teachers believed calculators were useful for students to improve their critical thinking through problem solving. The findings confirms other studies which found that students could investigate their own approaches to problem solving, making their own conjectures and testing them out on the calculator to quickly see if they were correct or not (Campbell & Stewart, 1993; Dunham, 1996; Smith, 1996). A t-test showed that there was a significant difference between male and female teachers' beliefs, that students should develop inquiry skills in mathematics problem solving with a calculator, with more males indicating a positive view than females.

Conclusions and Recommendations

The findings provide some clues on teachers' beliefs about technology use during mathematics instruction. Both male and female teachers felt not confident in the use of calculators in their teaching. Also most teachers felt incompetent in the use of calculators during mathematics instruction. This study has also shown that majority of teachers strongly believed calculators were helpful to students as a tool that could develop inquiry skills in mathematics. The teachers appreciated the use of technology as a tool that students could rely on in their future endeavors. Moreover, many teachers believed that the use of calculators in testing procedures could produce higher achievement scores than paper-and pencil efforts, both in basic operations and in problem solving. Majority of teachers believed students were capable of using a calculator for the betterment of their higher order skills. The findings also indicated that most teachers believed calculators could make students dependent on them, hence hampering the development of basic computational skills. The study, therefore, recommends that:

1. Training preparation institutions should review the mathematics pedagogical content to include a topic on the "effective use of calculators". This is intended to empower future teachers with technological and pedagogical skills for classroom use.

2. School Academic Heads (School heads, Deputy Heads, Senior Teachers for Math and Science) should organise School Based Training geared towards empowering teachers with calculator skills for effective use during math instruction. This will help increase teachers' confidence levels with the use of calculators. This therefore calls for the Ministry of Education and Skills Development to increase the budget for school based workshops and seminars to enable School Heads organise quality workshops for teachers without being constrained by financial resources.

3. Officers from the Department of Teacher Training Development who are responsible for mathematics subject teachers in schools should monitor the effectiveness of calculator use during math instruction and develop intervention strategies to address the challenges experienced by teachers.

Finally the research findings have implications on research and practice in that future research need to be conducted with the following pedagogical issues in mind:

- What skills and abilities do teachers need to effectively implement use of calculators?
- What support is needed by teachers to effectively implement use of calculators during math instruction?

Another, significant implication of findings on research and practice is that key stake holders can establish challenges experienced by teachers during technology integration and come up with classroom oriented strategies such as school based training on effective calculator use. As a consequence, teachers' technology beliefs and their pedagogical practices on use of calculator use would be improved. Having considered the above implications, it is reasonable to look at teachers as instructional implementers who need to re-define their beliefs about use of technology and adopt positive beliefs intended to promote effective use of technology as a catalyst to learning mathematics with understanding. For these reasons, teachers should strive to embrace technology and make it the basis of their classroom mathematics instructional practices.

References

Akbaba, S. & Kurubacak, G (1998). Teachers' Attitudes towards technology. Technology and Teacher Education Annual. Charlottesville: Association for the advancement of Computing in Education.

Babbie, E.R. (1973). Survey Research Methods. Retrieved 10 March, 2013, from: http://www.books.aisc.ucla.edu/cbrpdfs/tusgb3.pdf.

Bogoan, R.C. & Biklen, S.K. (1998). *Qualitative Research for Education: An Introduction to theory and Methods* (3rd Ed.). Allyn & Bacon: Boston.

Borris, H. (2004). Teachers Instructional Beliefs about integrating Educational Technology. Retrieved 09 March, 2013 from: http://www.calculators research\teachers belief calculators.htm.

Botswana (1994). *Revised National Policy on Education*. Gaborone: Government Printers.

Botswana 3 yr. J.C. Curriculum Blueprint (1996). *Three year J.C syllabus 1996*. Curriculum Division.

Botswana 3 yr. J.C. Curriculum Blueprint (2010). *Three year J.C syllabus 2010*. Curriculum Division.

Brown, E. T., Karp, K., Petrosko, J. M., Jones, J., Beswick, G., Howe, C., Zwagnig, K. (2007). or Catalyst: Teachers' Beliefs and Practices Regarding calculator use in mathematics instruction. Retrieved 16 February, 2013 from http://www.eric.ed.gov /ERICWebPortal/ search/detailmini.jsp?_nfpb.

Bryman, A. and Cramer, D. (1997). *Quantitative Data Analysis*. London: Routeledge.

Calculator Information Center (1977). *Research on Hand – Held calculators, K-12*: Bulletin No.9. Columbus, Ohio.

Campbell, P.F. & Stewart, E.L (1993). "Calculators and Computers." Early Childhood Mathematics. Ed. Robert Jensen. NCTM Research Interpretation Project. New York: Macmillan Publishing Company.

Clayton, M (2000). "Calculators in class: Freedom from Scratch paper or "Cratch", Christian Science Monitor. Retrieved February 14, 2013 from: http://www.csmonitor.com.

Cockcroft, W.H (1982). *Mathematics Counts*: Report of the Committee of Inquiry into the teaching of mathematics in schools under the chairmanship of Dr. W.H. Cockcroft. London: HMSO.

Cohen, L. & Manion, L. (1994). *Research Methods in Education* (4th ed.). London: Routledge.
Creswell, J. W. (1994). *Research Design: Qualitative & Quantitative Approaches*. London: Sage Publications.
Dunham, P.H (1995). "Calculators use and Gender issues." *Association for women in mathematics Newsletter*, 25(2), 16-18.
Dunham, P.H. (1996). Hand-held Calculators in Mathematics Education: A Research Perspective. Retrieved on 10 February, 2013, from: http://mathforum.org/technology /papers/papers/dunham.html.
Farkas, S. & Johnson, J. (1997). *Teachers talk about Public Education today*. New York: Public Agenda.
Fleener, M.J. (1994a). Is experience enough?: A survey of mathematics teachers' philosophies of calculator use. In J. Willis, B. Robin & D. Willis, (Eds.), *Technology and Teacher Education Annual* – 1994 (pp.543 – 547). Charlottesville, VA: Association for the Advancement of computing Education.
Fleener, M.J (1994b). A research study of teachers' beliefs about calculator use. In G. Marks (Ed.), *Mathematics/ Science Education and Technology* – 1994 (pp. 56 – 61). Charlottesville, VA: Association for the Advancement of Computing in Education.
Fleener, M.J. (1994c). A survey of mathematics teachers' attitudes about calculators: The impact of philosophical orientation. *Journal of Computers in Mathematics and Science Teaching.* Charlottesville, VA: Association for the Advancement of Computing Education.
Fleener, M.J. (1994d). The relationship between experience and philosophical orientation: A comparison of pre-service and practicing teachers' beliefs about calculators. *Journal of Computers in Mathematics and Science Teaching.* Charlottesville, VA: Association for the Advancement of computing Education.
Gay, L.R., & Airasian, P. (1996). *Educational Research: Competence for analysis and application*. New Jersey: Prentice – Hall.
Hale, J. (2011). The 3 Basic Types of Descriptive Research Methods. Psych Central. Retrieved on 10 February, 2013 from: http//psychcentral.com/blog/archives/2011/09/27/the 3- basic- types-of-descriptive – research- methods/.
Handal, B., Bobis, J., & Grimson, L. (2001). Teachers' mathematical beliefs and practices in teaching and learning thematically, Numeracy and beyond. Retrieved February 10, 2013 from: http://trove.nla.gov.au/version/166860056**.**
Hartsell, T., Herron, S., Fang, H., & Rathod, A. (2009). Effectiveness of professional development in teaching mathematics and technology applications. Retrieved February 16, 2013 from: http://www.sicet.org/journals/jetde/jetde09/taralynn.pdf
Hembree, R & Dessart, D. J (1992). Research on calculators in mathematics education in J. Fey and C. Hirsch (eds), *Calculators in Mathematics Education*, *National Council of Teachers of Mathematics*, Reston VA, 23-32.
Howard, P. (1992). Teachers' attitudes towards the student use of calculators on K-6 mathematics classes. Retrieved 10 February, 2013 from: http://trove.nla.gov.au/ version/166928509
Howson, G (1991). National curricula in mathematics. Leicester: The Mathematical Association. Retrieved 09 February, 2013 from: http: // www.eric.ed.gov/ERICWebPortal/search/ detailmini.jsp?_nfpb=true&_&ERICE
Huan, S., Compley, R., Williams, B & Waxman, A (1992). Investigating middle – school mathematics teachers' attitudes toward calculator use. Technology and Teacher Education annual. Charlottesville: Association for the Advancement of Computing in Education.
Kaino, L.M. & Salani, E. (2004). Students' gender attitudes towards the use of calculators in mathematics instruction. Retrieved on 10 February, 2013, from: _http://www.kurims.kyoto _u.ac.jp/ EMIS/ proceedings/ PME28/ RR/ RR303_kaino. pdf.

Kastberg, S., & Leathan, K. (2005). Research on graphing calculators at the secondary level: Implications for mathematics teacher education. Retrieved January 7, 2013 from: http://www.editlib.org/p/5641/.

Keraz, E., & Ozdemir, D. (2006). The relationship between Educational Ideologies and Technology acceptance in pre-service teachers. Retrieved January 8, 2013 from: http://scholar.google.com/scholar.

Kilpatrick, J., Clements, K., Bishop, A.J., Keitel, C (1996). *International Handbook of Mathematics Education: Part 1*, 4. Dordrecht: Kluwer academic Publishers.

Kyeleve, J.I, & Williams, J.S. (1995). Gender, courses and curricula effects on students' attitudes to mathematical modelling in 16-19 mathematics programmes. Retrieved on 10 January, 2013, from: http://www.bsrlm.org.uk/IPs/ip15-1/BSRLM-IP-15-1-5.pdf.

Lin, Y.C & Yuan, Y. (2009). The elementary school teachers' beliefs of integrating calculators into mathematics instruction. Retrieved 10 February 2013 from: http://atcm.math and tech.org/EP2009/papers full/28/2009_17270.pdf.

Lovat, T. J., & Smith, D. (1995). Curriculum: Action on reflection revisited. Australia: social Sciences Press. Retrieved 08 February, 2013 from: http://link.springer.com /article/10.1007/BF03217369#page-1.

Mason, A. (2010). Integrating calculators in the secondary Mathematics Classroom: Teachers' attitudes and Perspectives. Retrieved January 01, 2013 from: http://www.eric.ed.gov/.

Mergendoller, J.R. (1994). The curry school of education, University of Virginia. In Exemplary approaches to training teachers to use technology, Vol. 1: case studies (pp.4.1-4.24).

Mosimaneotsile, N (1999). Effects of calculator usage in junior secondary schools. Unpublished manuscript.

Murphy, C.A., Coover, D., & Owen, S.V. (1989). Development and validation of the computer self-efficacy scale. *Educational and Psychological Measurement*, 49, 893-899.

NCTM (1974). NCTM board approves policy statement on the use of mini calculator in mathematics classroom. *NCTM newsletter*. Retrieved February 10, 2013, from http:// standards .nctm.org /document/ appendix/numb.htm.

NCTM (1980). An agenda for Action*: Recommendations for school mathematics of the 1980s*. Retrieved February 10, 2013, from http:// standards .nctm.org /document/ appendix/numb.htm.

NCTM (2000). Principles and standards for school mathematics. Number and operations standards. Retrieved February 10, 2013, from http:// standards .nctm.org /document/ appendix/numb.htm.

NCTM (2003). NCTM Position Statement. The use of Technology in the Learning and Teaching of mathematics. Retrieved February 10, 2013, from http://www.Nctm.org/uploadedFiles /About_NCTM/Position_Statements/technology.pdf.

Padron, Y (1992). Education students' attitudes toward the effectiveness of instructional technology. Technology and Teacher Education Annual. Charlottesville: Association for the Advancement of Computing Education.

Planov, M., Baunder, D., Carr, D& Sarrar, R (1993). Structuring teachers' attitudinal changes: A follow, up study. Technology and Teacher Education annual. Charlottesville: Association for the Advancement of Computing Education.

Ponoesele, J.B (1993). The impact of calculator/computer in some Botswana Senior Secondary mathematics classrooms. Unpublished manuscript.

Powers, R., & Blubaugh, W (2005). Technology in mathematics education: Preparing teachers for the future. Retrieved on 09 February, 2013, from: http://www.merga.net.au/ documents /MERJ_15_1_Handal.pdf.

Ruthven, K (1992). Personal Technology and classroom change: A British Perspective. *Calculators in mathematics Education, National Council of Teachers of Mathematics*. Reston, VA, 91-100.

Smith, B.A (1996). A Meta-analysis of outcomes from the use of calculators in mathematics Education, Texas A & M doctoral dissertation, December, 1996, pp.101.

Suydam, M.N (1976). Electronic hand calculator: the implications for pre-college education, final draft. Washington, DC: National Science Foundation.

Suydam, M.N (1982). The use of calculators in Pre- College Education: Fifth Annual State-of-the-Art-Review. Columbus, OH: Calculator Information Center. Retrieved February 06, 2013, from: http://education.ti.com/sites/US/downloads/pdf/the role.pdf.

Suydam, M.N (1985). *Research on Instructional Materials for Mathematics*. Columbus, OH: ERIC Clearinghouse for science, mathematics, and Environmental Education.

Szetela, W. (1979). Hand –held calculators and the learning of trigonometric ratios. *Journal for Research in Mathematics Education*. Retrieved January 05, 2013 from: http://eric.ed.gov /?id=EJ200094.

Tarr, J.E., Uekawa, K., Mittag, K., Lennex, L. (2000). A comparison of calculator use in eighth – grade mathematics classrooms in the United States, Japan, and Portugal: Results from the Third International Mathematics and Science Study: *Official Journal of School Science and Mathematics Association, founded 1901*,100, 139-150.

Viera, C. R., & Gaspar, M.F. (2013). Plenatitude Teacher Education for effectiveness and well-being with Neuro- Linguistic programming. Retrieved on February 09, 2013, from http://www.eric.ed.gov/PDF/ED540211.pdf.

Walmsley, A. (2003). Integrating calculator technology in an elementary and middle school preservice teacher program: A personal journey. *Contemporary Issues in technology and Teacher Education*, 3(2), 116-127.