Influence of Mathematics Teachers' Beliefs on the Integration of Technology in Classroom Instruction in Secondary Schools in Kenya

Dr. Edwin Masibo and Mrs. Jane Barasa

Department of Curriculum and Instructional Technology

Kibabii University, Kenya

ABSTRACT

Mathematics teachers' beliefs and conceptions, particularly about the nature of mathematics and about the teaching and learning of mathematics have an impact on the type of mathematics instruction they deliver in the classroom. This study investigated the distribution of mathematics teachers in secondary schools in Bungoma County in the three belief categories as espoused by Ernest (1988) thus the Instrumentalists, the Problem Solvers and the Platonists. It was done against the background that the teacher's belief category influences the teacher's likelihood of integrating technology in classroom instruction. The beneficial effect of improvement gains in learners attitudes and performance in mathematics when classroom instruction is supported by relevant technology points to the need for teachers to integrate the said technology resources in their classroom instruction to enable the learners to tap on their potential to enhance the mastery of mathematical concepts. This study adopted the descriptive survey research design and targeted all the four hundred and seventy eight (478) secondary school teachers of mathematics in the entire Bungoma County. The sample for the study was two hundred and ninety eight (298) secondary school teachers of mathematics who attended the SMASSE In-Set training at the four in-set centers in the district. Data was collected using a questionnaire that captured the teachers' beliefs about mathematics and how instruction in mathematics should be carried out. Data was analyzed using descriptive statistics involving the use of means, frequencies and percentages. The main findings of the study was that theteachers of mathematics held different belief categories as entailed in Ernest's Model and they therefore held varied views about mathematics and how the subject should be taught for meaningful learning to take place. It is observed that since mathematics is a core subject in the school curriculum, meaningful reforms in the subject should involve challenging the teachers' strongly held beliefs and how they impact on classroom instructional programmes. It is also observed that as the ministry of education seeks ways of improving the standards of education in the country in line with the Vision 2030, emphasis is being put on releasing to the job market graduates who are adaptable to the high technological demands. The study established that teachers' beliefs may act as barriers towards realizing this national goal of education. It therefore recommends that necessary professional development be undertaken in the teacher education sector to help equip teachers with skills, attitudes, knowledge and values that will promote meaningful instruction that will enable learners to benefit from the learning experiences and participate meaningfully in national development.

1.0 Introduction

Several curriculum reforms have been attempted in Mathematics education over the years. These have ranged from reforms in pedagogical approaches, Mathematical content and the use of teaching and learning resources. Despite the multiple reforms, observation of the classroom pedagogical practice reveals that teachers continue to teach in the same way as they did in the past. It is reported that the predominant use of the textbook, whole class instruction with the teacher controlling the talking in the classroom is common (Niess, 2005). According to Mutunga and Breakel (1992), Mathematics education in Kenya dates back to the pre-colonial times. The two noted that during that period learning was done informally and through intuition. Mathematics served the immediate need in the society by enabling people to manage their possessions. People used mathematics to count the size of their cattle, sheep, goats or other domesticated animals. This would be done through matching real objects with representative forms like sticks or stones. When missionaries and settlers came, they effected changes in learning from the informal mode to a more formalized system. They offered basic education aimed at meeting the need of getting Africans who could provide cheap labour on the white settled farmlands. The curriculum aimed at enabling Africans to do manual work on the European farms and simple clerical work. Later the curriculum of traditional mathematics was introduced aimed at enabling the natives Africans to get an education that would help them to meet their socio-economic needs. The curriculum offered was mainly the 3-R's that involved Reading, Writing and Arithmetic. The mathematics curriculum was compartmentalized into Algebra, Arithmetic and Geometry. The education programmes were offered on racial lines with the Africans being offered an inferior quality educational programme that restricted them to only mastering skills that enabled them to provide cheap labour on the farmlands. The teaching method was mainly drill and practice and rote learning. Learners never developed skills to apply the knowledge gained in real life situations. In 1961 the conference of African states on development of education in Africa held in Addis Ababa, Ethiopia observed that the education content and practice was not in line with the existing conditions and development needs of African countries, and that the education being offered was not providing room for African children's intellectual development (Shiundu and Omulando, 1992). The conference recommended that African governments should revise their education systems and curriculum to suit their physical, social, and economic needs. In Kenya in 1964, the Ominde commission report recommended provision of equal chances in access to education. Education was seen to serve as a means to foster quick socio-economic development of the nation (RoK, 1964). In line with changes taking place in the western world, the New Mathematics curriculum was developed in 1967 and in 1970 when the Ministry of Education was satisfied with the results of the experimental New Primary Mathematics programme, the programme was rolled out the programme in all the primary schools in the country in 1971. This curriculum laid emphasis on the role of technology in developing learners' competencies and understanding of mathematics concepts. Therefore, traditional mathematics was discarded to give way for a new curriculum that would guarantee more and better trained graduates from the school system. These curriculum changes involved changes in teaching approaches from rote learning to more learner-centered approaches that enhanced learners' competence in skills and understanding of the content taught. The changes were also motivated by the need to bring instruction in line with research findings by psychologists on meaningful learning through properly sequenced instructional programmes (Bruner J.S, 1969 and Dienes Z.P, 1971 in Mutunga and Breakel 1992). There was also the need to bring the school mathematics curriculum course in line with trends in further education and training so as to meet the increasing demand in commerce and industry. However, the New Mathematics curriculum was later

found to be too rigorous as it put a lot of demands on both the teacher and the student. This resulted in disinterest by the learners in the mathematics being taught in school because the syllabus and course texts being used were far too difficult for the learners. The course content was found to be too demanding to both the teacher and the learners and there was no clear link between the intent and the real life experiences in the learner's environment. The syllabus was too overloaded due to inclusion of new topics thus teachers had no time to plan and execute the instructional programmes effectively, neither was there time for them to learn the new content that they had not learned before yet they were expected to teach it. The language of the course texts was far too difficult for the users thus inhibiting understanding of subject matter. Cumulatively, therefore, the learners lost interest in the subject and this resulted in the presidential degree in 1981 to review the mathematics curriculum with the view of introducing Appropriate Mathematics that was a blend of Traditional Mathematics and New Mathematics. This new curriculum aimed at enabling learners to solve problems related to their day to day life experiences. Despite the large series of curriculum changes, student performance in mathematics never improved and neither were there any significant changes in teachers' teaching approaches. This has necessitated continuous reviews in the mathematics curriculum aimed at improving the status of mathematics in schools. In 1998, the Strengthening of Mathematics and Science in Secondary Education (SMASSE) was piloted in nine districts in Kenya namely, Kisii, Gucha, Kakamega, Butere-Mumias, Lugari, Kajiado, Makueni, Murang'a and Maragua. The programme was rolled out on the national scale in 2004. The aim of the programme is to enhance better instructional approaches in mathematics and sciences focusing on learner centered teaching models. The SMASSE programme has, however, been riddled with challenges ranging from open reluctance by target teachers to participate in the Inset to their failure to implement the ASEI and PDSI approaches in classroom instruction (Wabwile, 2009). The poor history of implementation of reforms in mathematics education has been attributed to; lack of congruence between the intent of the curriculum innovation and teachers pedagogical knowledge, beliefs and practices, mismatches between the official curriculum prescribed by policy and the actual mathematics curriculum taught by teachers in classrooms, and that most reforms in mathematics are introduced by education authorities through top down approach which ignores teachers beliefs, pedagogical practices and the changes which would be necessary for them to be able to embrace the innovation (Fullan , 1982). In spite of national policies that encourage the use of educational technology in mathematics instruction, many teachers rarely use it (Barron, Kemker, Harmes and Kalaydjian, 2003). Those teachers who do use educational technology during instruction often use it for drill and practice which is not recommended by teacher- educators (Van de Walle, 2004). Central to successful implementation of educational technology utilization in mathematics instruction is the role played by the beliefs held by the mathematics teacher about the subject and the way the subject should be taught. It has been noted that teachers' beliefs affect their teaching practices (Brinkerhoff, 2006).

The Ministry of Education in Kenya permitted the use scientific calculators in mathematics instruction in secondary schools at Form three level in 2004. As part of enhancing the attainment of the Vision 2030 in Kenya and the Sustainable Development Goals (SDGs), focus is being put on e-learning that seeks to integrate technology and Computer-Based Instruction (CBI) in classroom instruction. Given the central role that mathematics plays in the school curriculum, the subject being a critical filter for learners' career development, meaningful instruction in this subject that incorporates new and emerging educational technologies is bound to have profound effect on the country's quick socio-economic development. However, given the background of teachers' reluctance to take up reforms in instruction, based on their varied beliefs about the subject; it

noteworthy that some of the beliefs strongly held by the teachers may be an embedment towards the realization of this goal.

2.0 Conceptual Model

This study adopted Ernest's (1988) model that describes what mathematics teachers' belief about the nature of mathematics and about the teaching and learning of mathematics. The three belief systems identified by Ernest were categorized thus, the Platonists, the Instrumentalists and the Problem Solvers. The Platonist belief is associated with the explainer model of teaching. In this case learning is viewed as reception of knowledge. The teacher seeks to modify text book approaches as he enriches them with additional activities. The role of the teacher is to lecture and explain concepts with the view of enabling the learner to understand the logical relationships of mathematical concepts. The Instrumentalist belief is where the teacher assumes the role of an instructor with the intention of enabling the learner to master the skills needed in mathematics. The teachers who follow this belief strictly follow the course book. The learner is expected to be compliant. Emphasis is put on rules not necessarily linked with understanding of why the rules work. The teachers who hold the Problem Solvers belief act as facilitators of learning. The belief encourages learning by active construction of one's knowledge. Ernest (ibid) noted that the practice of teaching mathematics depends on key elements which he highlighted as; the teacher's mental contents or schemas, particularly the systems of beliefs concerning mathematics and its teaching and learning, the social context of the teaching situation, particularly the constraints and the opportunities it provides and the teacher's level of thought processes and reflections. These factors taken cumulatively determine the autonomy of the mathematics teacher and subsequently also the outcome of teaching innovations like problem solving that depends on teacher- autonomy for their successful implementation. This study addresses the first key element, the teacher's mental content or schemas including the system of beliefs concerning mathematics and its teaching and learning. The teachers' mental contents or schemas include; mathematics content knowledge, beliefs and attitudes displayed towards an object or a group of objects and the subject and belief systems about the nature of mathematics and the teaching and learning of the subject. Ernest (ibid) observed that although mathematics content knowledge is important, it is not enough to determine teachers' readiness or capacity to shift to more desirable teaching approaches. He quipped that reforms in teaching cannot take place unless teachers' deeply held beliefs about mathematics and its teaching and learning change. The model designed by Ernest to outline the teachers' views about mathematics and their implications is as shown in Table 1.

Nature of views of Mathematics	Teachers role	Intended outcome of instruction	Use of curriculum materials	Learning methods
Instrumental	instructor	Skills mastery with correct knowledge	Strict following of rules	Compliant behavior and mastery of skills
Platonist	Explainer	Conceptual understanding with unified knowledge	Modification of textbook approach enriched with additional problems and activities	Reception of knowledge model
Problem solvers and posers	facilitator	Confident problem posing and solving	Teachers' or schools' own construction of the mathematics curriculum	Active construction of understanding model and possibly exploration and autonomous pursuit of own interests model

Source: Teachers' Views about Mathematics and their Implications Based on Ernest's Model.

In view of this model, the use of technology in mathematics instruction holds the promise of facilitating learners to develop a firmer grasp of mathematics concepts and improve in their problem solving skills. The technology also enables teachers to function as facilitators of learning other than controllers of the instructional programmme. However, it is noted that teachers' beliefs hold a big sway in choosing the extent to which this technology usage can go.

The technological advancements in today's society have prompted an increase in use of technology in the daily lives of many people. The mathematics classroom is no exception. The prevailing presence of education technology in school can give students from low income backgrounds where there is little or no access to technology the needed edge to compete with those from affluent backgrounds where the technology is commonplace. This can help to bridge the gap in realizing the curricular goals. However, the mere presence of the technology may not permit this to happen until this technology is properly utilized by both the teacher and

the learner. With calculators having been introduced to guide instruction and facilitate students' learning and academic achievement, and the stress on integrating computer-based instruction in the curriculum, there is need to establish how it is being utilized by the teachers and the learners in facilitating learning. In view of the varied beliefs that exist among teachers of mathematics about the subject and how instruction should be conducted, this study sought to determine how the varied beliefs can be promoted or challenged so as to make the maximum gain in the integration of educational technology in the classroom instruction.

3.0 Research Design

This study adopted the descriptive survey research design in an attempt to determine the distribution of the teachers of mathematics in the three belief categories. The target population was four hundred and seventy eight (478) teachers of mathematics in Bungoma County. The sample for the study was teachers of mathematics who attended the SMASSE Inset training in April 2011 at the four inset centers in the County. Thisprovided a total of two hundred and ninety eight (298) representing sixty two percent of the target population.Purposive sampling was used to sample teachers of mathematics who attended the district SMASSE at the four In-set centers. This is a non-probability sampling technique. The researcher was guided by the view that the small unit of teachers who attended the SMASSE had characteristics that could typically be representative of the whole mass of teachers of mathematics in the County. This was informed on the basis of the fact that the In-set programme was open to all teachers of mathematics to attend without any bias of sex, age, administrative position or otherwise. Therefore, the information obtained is quite representative of the whole universe of teachers of mathematics in the area of the study.Data collection was done through the use of a questionnaire. The questionnaire was preferred to other instruments because of the large number of respondents that were expected to be covered in the study within the expected time frame. The questionnaire sought to determine the respondents' belief category in line Ernest's (1988) three categories of the Platonists, the Instrumentalists and the Problem Solvers.

The researcher determined the reliability of the questionnaire through the test-retest method. Using the data obtained from the pilot study, the Pearson correlation coefficient (r) was calculated to show the correlation between the respondents' responses to the questionnaire items on both the test and the re- test. The computation yielded the value of Pearson's correlation coefficient (r) equal to 0.826. This was considered a good measure of a strong relationship between the test scores and those on the re-test. Therefore, the questionnaire was considered good enough and reliable to be used to collect data.Data collected on the questionnaires was coded in preparation for analysis. Since, it was analyzed using both descriptive and inferential statistics. The descriptive statistics used were frequencies and percentages.

4.0 Respondents' Beliefs about Mathematics

Thequestionnaire required the respondents to indicate the belief category that suited their conception of what mathematics is and how it should be taught. The belief categories were listed in line with the three outlined by Ernest (1988) which are the Platonists, the Instrumentalists and the Problem Solvers.

The statements that corresponded to the respective belief category were:

1. Mathematics is an accumulation of facts, rules and skills to be used in pursuance of some external end. It is a set of unrelated but utilitarian rules and facts.
2. Mathematics is a static but unified body of certain knowledge; it is only discovered but not created.
3. Mathematics is a dynamic, continually expanding field of human creation and invention. A cultural product. It is a process of inquiry and coming to know, not a finished product whose results remain open to revision.

4.1 Distribution of Teachers in the Three Belief Categories.

From the sample of 298 teachers who were selected for the study, it was found that majority 119 (40%) of them subscribed to the problem solvers belief category. Teachers who subscribe to this belief assume the role of facilitators in the instructional programme. They engage learners in active construction of mathematical meaning through experimentation and investigative inquiry and exploration of concepts. Their aim is to produce learners who are confident in problem posing and problem solving. It is worthwhile noting that one of the out-standing objectives of mathematics instruction is to equip learners with skills that enable them to be competent and confident in problem solving. The members in this category hold the view that mathematics is best learned by learners constructing their understanding of mathematics concepts through practical exploration as the teacher plays the role of a facilitator. The teachers who hold this view seek to enhance their learners' relational understanding of mathematics. This is where the learner is able to apply the concepts in familiar and unfamiliar situations. The learners are actively engaged in learning since the teachers adopt a heuristic approach to instruction. The learners retain the learnt concepts for long and are able to demonstrate their mastery through good scores in examinations.

Secondly, 95 (32%) of all the respondents indicated that they subscribed to the instrumentalist belief category. In this belief mathematics is seen as a useful but unrelated collection of facts, rules, formulae, skills and procedures. Therefore, the role of the teacher is to provide instruction and to ensure that the learners strictly follow the rules for proper mastery of skills and become compliant in following the rules. The role of the learner is to know and remember how to carry out the proper procedures. This quite often leads to instrumental understanding of mathematics in which learners know what should be done, how it should be done but not why it should be done. Therefore, learners may not be able to apply the knowledge acquired in novel situations. The learners may not be able to relate the knowledge learnt in school and the common occurrences in their environment such carrying out any business transaction or even apply the knowledge in daily tasks like building and construction of a house despite performing very well in national examinations.

The teachers who hold the instrumentalist belief category focus on enhancing learners' strict adherence to rules and formulas without necessarily understanding why the formula works. This promotes instrumental understanding of mathematics. It is a teacher centered approach that focuses mainly on expository methods of instruction. The teacher assumes the role of an instructor who controls all the learning experiences. This reduces the learner to a passive participant in the instructional process and therefore, there is minimal retention of learnt concepts. The learners may not be able to demonstrate good mastery of learnt concepts because they are least engaged in the instructional process.

It should be noted that with the high enrolment and inadequate teaching resources in most Kenyan secondary schools, most teachers adopt this instrumental approach in their classroom instruction. This is coupled with the high demand for schools to perform exceptionally high in the national examinations. Therefore, most teachers seek to teach their students skills of passing examinations at the expense of enabling the learners to develop firmer mastery and conceptual understanding of the content they learn. This hampers the meaningful application knowledge by learners in their daily life experiences after school.

Lastly, 84 (28%) respondents subscribed to the Platonists belief category. In this category mathematics is characterized as a static but unified body of knowledge where interconnecting structures and truths play an important role. The role of the teacher is to explain and ensure that the learner develops conceptual or relational understanding of the mathematics concepts.

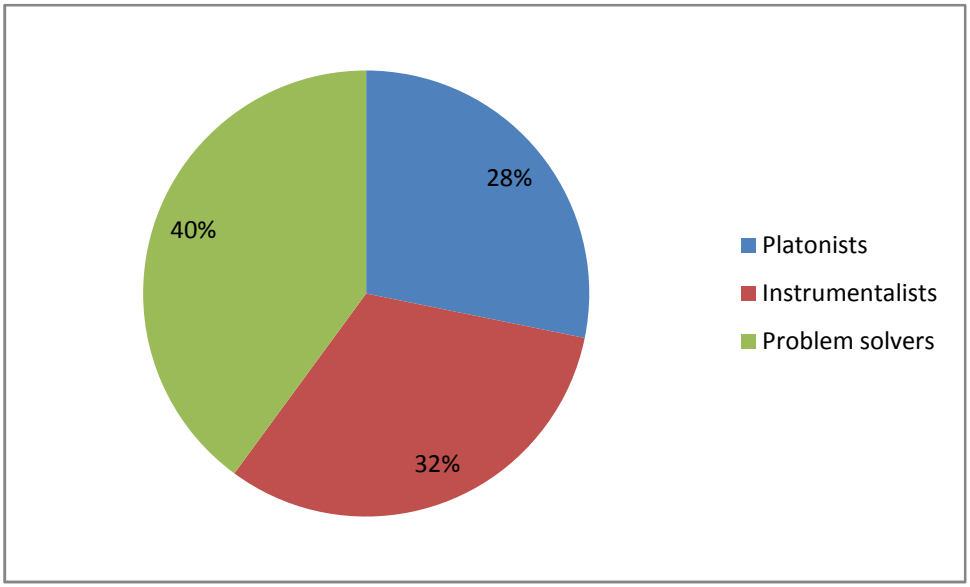
The learner is therefore, likely to develop better mastery of mathematical skills and their applications in solving problems in real life situations.

The distribution of the respondents in the three belief categories is presented in Table 2 and Figure 1.

Table 2: Distribution of the Respondents' in the Three Belief Categories.

Belief	**Platonists**	**Instrumentalists**	**Problem solvers**
Frequency	84 (28%)	95 (32%)	119 (40%)

Figure 1: Proportions of Respondents' distributions in the three belief categories



6.0 Conclusions and Implications of the study Findings

The distribution of teachers in the three belief categories indicates that there is no common approach among the teachers of mathematics on the way that instruction should be carried out in the subject. This finding is in agreement with findings by Cooney (1985) who identified that there was conflict among teachers with some adopting problem solving approaches to instruction but with their students rather preferring content-based instruction. Such learners would prefer instrumental approach to teaching and therefore would work well with teachers who hold the instrumental belief category.

From this findings, the Ministry of Educationshould initiate in-service training programmes for teachers to address teachers' beliefs and the impact of the beliefs in classroom instruction and more so the use of educational technology in the classroom so as to demystify the use of the technology in instruction in schools. This will ensure that the school graduates will receive meaningful instruction and will be able to develop conceptual understanding of mathematics concepts which they will use in their daily real life experiences.

Teacher training institutions should design programmes that address beliefs of their prospective trainees so that they can help modify the beliefs that may not be in line with the desired educational development goals. The teacher training institutions should adequately prepare their graduates by engaging them in hands-on interaction with the pertinent technologies. This will go a long way in preparing the graduates to integrate the very technologies in their instructional programmes in school.

REFERENCES

Barron,A.E.,Kemker,K.,Harmes,C.,&Kalaydjian, K. (2003). Large-Scale Research Study on Technology in K-12 Schools: Technology Integration as it Relates to the National Technology Standards.Journal of Research on Technology in Education, 35,489-507.

Brinkerhoff (2006). Effects of a long-duration professional development academy on technology skills,computer self-efficacy, and technology integration beliefs and practices. Journal of Research onTechnology in Education, 39, 22-43.

Brown, A. B., and Baird, J. (1993). Inside the Teacher: Knowledge, Beliefs and Attitudes. In P. Wilson (Ed.), Research ideas for the classroom: high school mathematics (pp. 245-259). New York: Macmillan.

Cooney, T.J. (1985). A Beginning teacher's view of problem solving. Journal for Research in Mathematics Education 16(5) 324-336.

Ernest, P. (1988) "The impact of beliefs on the teaching of mathematics", paper prepared for ICME VI, Budapest, Hungary, July, pp.1-4.

Fennema, E. and Franke, M.L, (1992). "Teachers' knowledge and its impact" in Handbook of Research on Mathematics Teaching and Learning,in D.A.Grouws (Ed.) Macmillan, New York pp.147-164.

Fullan, M. (1982).The meaning of educational changes. Toronto: Oise press

Niess, M.I. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge.Teacher Education, 21,509-523.

Republic of Kenya (1964). The Kenya National Education Commission (Ominde Report) Nairobi: Government printer.

Van de Walle, J. A. (2004). Elementary and middle school mathematics: Teaching developmentally (2nd custom Ed.)Boston: Pearson.