

Does the use of ICT empower teachers to teach mathematics better? A case of lower primary teachers in Mombasa

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Abstract

This article reports on a study that sought to establish whether the use of ICT in the classroom empowered teachers to teach mathematics better. An exploratory sequential mixed methods research design was employed to conduct this study in which quantitative data was initially collected in the first phase. Qualitative data was then collected in the second phase to explain the quantitative data collected in the initial phase. The study targeted all the teachers teaching in lower grades in both private and public schools. A sample size of 40 lower primary schools were purposively selected based on the availability of ICT tools for instructional purposes in those schools. Three teachers teaching in grade one, two and three were then selected using simple random sampling technique especially in cases where more than three teachers existed. Teacher Questionnaire, Teacher Interview Protocol and Observation Protocol were used to collect data. Data was analyzed qualitatively using descriptive phenomenological analysis in which data transcriptions were divided into themes and sub-themes related to phenomena under study. The study found that ICT was capable of empowering teachers to teach mathematics better. It was recommended that teachers be supported in their use of ICT in teaching mathematics.

Introduction

Mathematics is one of the most essential and useful subjects in the school curriculum (Wanjala, Aurah & Symon, 2015). This argument is buttressed by the position mathematics holds in most school curriculums around the world. For instance, in Kenya as in many other countries, mathematics is a compulsory subject both at the elementary and advanced learning levels. Davies and Hersh (2012) viewed mathematics as the most important subject not only from the point of view of being an important academic qualification at a school or college, but also as a subject that prepares learners for future life irrespective of which career path they may choose to undertake. Mefor (2014) summed it all up by asserting that mathematics relates to everything in life beginning from smallest to the largest.

According to Oldknow and Taylor (2000) there are at least three reasons for integrating ICT in the teaching and learning of mathematics; namely, desirability, inevitability, and public policy requirements. In desirability, ICT motivates, encourages, and stimulates learners during mathematics learning sessions. On the part of the teacher, ICT improves the teacher's efficiency in the teaching of mathematics

concepts. Use of ICT also makes teachers less administrative during mathematics instruction consequently allowing them more time to focus on students' work and thereby enabling them to develop better assessment strategies of students' progress in learning mathematics.

British Education and Communication Technology Agency (BECTA) (2003) highlighted several key benefits of using ICT in teaching and learning of mathematics. First, ICT leads to increased collaboration between pupils, increased focus on mathematics strategies and interpretation and provides fast and accurate feedback leading to increased level of motivation among pupils. Secondly, the interactive nature of multimedia features of ICT tools goes a long way in motivating learners thereby leading to improved performance in mathematics. And thirdly, ICT provides pupils with advanced communication tools that allow them to use graphics, images, sound, and text in their course of learning. It also helps them to effectively demonstrate their understanding of mathematical concepts.

Didactical functions of ICT in teaching and learning of mathematics

According to NCTM (2008) ICT is an essential mathematics learning tool particularly in this 21st century. However, according to Drijvers (2012) a lot of stakeholders in education and researchers alike are confronted by the question, “Does ICT really work in enhancing teaching and learning of mathematics?” Several studies have been done to examine the influence of ICT in the teaching and learning of mathematics. One of the initial studies conducted to investigate the influence of ICT on the teaching and learning of mathematics was an experimental study done by Heid. Heid (1998) in his experimental study, calculus concepts were taught to first year university students. The students were also briefly taken through computational skills at the end of the course. The experimental group used ICT tools for computational work while the control group performed computational tasks by hand. The results of the study showed that the experimental group performed far much better in a calculus test than the control group. The subjects in the experimental group reported that ICT helped them work out computational tasks leaving them to focus on problem solving skills. Drijvers, Doorman, Boon and Gravemeijer (2010) described this phenomenon as the didactical tool function of ICT devices in a mathematical task situation. Furthermore, the students in the experimental group indicated that ICT tools enabled them to feel more confident in their calculus computations. The findings from this study demonstrate the potential of ICT in boosting students’ performance in mathematics. Furthermore, the findings of the Heid (1998) study support the idea of concept-first approach in teaching mathematics. Drijvers (2012) argues that concept-first approach in the use of ICT in teaching mathematics, lays more emphasis on the development of concepts without undermining development of hand skills in the process. This approach helps the teacher to lay more emphasis on the development mathematics concepts first.

Digital games and learners’ confidence

Ku, Chen, Wu, Lao, and Chan (2014) in their study in United States of America examined the influence of game-based learning on children’s confidence and performance in mathematics. The findings of this study revealed that digital-game-based learning significantly improved children’s level of confidence in mathematics. The findings further revealed that the students who learnt in the paper-based learning environment did not significantly improve in their level of confidence towards mathematics. Low confidence among students is one of the critical

reasons that make mathematics learning a difficult experience. According to Brown, et al. (2008) negative feelings towards mathematics make students get discouraged. Regarding performance, the study found that both students in digital and paper-and-pencil learning contexts gained significant improvement in mathematics performance, although the digital-game-based learning group achieved much more than their counterparts in paper-and-pencil learning. Digital games have been found to enhance students’ confidence and performance in mathematics. This is because they are goal specific; they give immediate feedback and provide various levels of challenge to learners. According to Ku and colleagues, the specific-goal function of digital games gives students a chance to obtain a sense of success. Immediate feedback plays the role of supporting and allowing students to move at their own pace achieving their goals (Bello, 2014). Digital games also provide learners with different levels of challenge thereby allowing learners of different ability levels to enter the flow state (Ku et al, 2014).

Impact of ICT on students’ mathematics teaching and learning

Chrysanthou (2008) in her study in Cyprus explored the potential a Mathematics learning Software called Geogebra in teaching mathematics. This software is used to teach mathematics by linking geometry and algebra in a single easy to use package. Data was gathered through three tools: video-recorded lesson observations, teacher interviews and a student questionnaire. Three broad themes emerged from qualitative data analysis as follows; classroom organization and management, cognitive amplification, and student attitudes. Under the broad theme classroom organization and management, the study found that the Geogebra Software brought about changes in the classroom environment that was a departure from normal routine. The use of ICT in teaching mathematics was viewed by teachers and students alike as a break from normal classroom routine. This consequently contributed in making mathematics lessons more interesting and enjoyable to the learners (Chrysanthou, 2008). The software was also found to enhance productivity in classroom activities. The participants reported that the software assisted them in saving time while at the same time boosting the number of examples given in a single mathematics lesson. Finally, on this theme, the study found that the software was able to transform the relationship between teachers and learners in the classroom. The second broad theme that emerged was cognitive amplification. The Software was found to buttress and enhance learning of mathematics

concepts. Pea (1985) argues that Geogebra provides powerful cognitive tools that improve learners' ability to construct knowledge thereby opening new possibilities of thought and action. The findings of this study revealed that ICT can help students to improve in their areas of weakness, correct mistakes, generate accurate results, conceive novel ideas, and enhance attention and concentration (Chrysanthou, 2008). The study findings also revealed that ICT increased opportunities for low achieving students to actively participate in mathematics lessons. In addition, ICT enables learners to adduce mathematics features by generating visual representation of mathematical figures learnt. In this study, the students were able to enlarge or shrink a variety of shapes thereby enabling them to reflect on the mathematical relationships, discover patterns and construct understanding of mathematical concepts. Finally, on the third broad theme of student attitude, the findings revealed that ICT was able to make mathematics learning easy, attractive, and enjoyable. The students in this study characterized mathematics learning sessions as fun, easy, exciting, and pleasurable. ICT was found to increase learners' engagement and autonomy in their learning of mathematics. Papert (1994) asserts that the best way to increase learning effectiveness is to let learners take charge of their own learning.

Theoretical Underpinnings

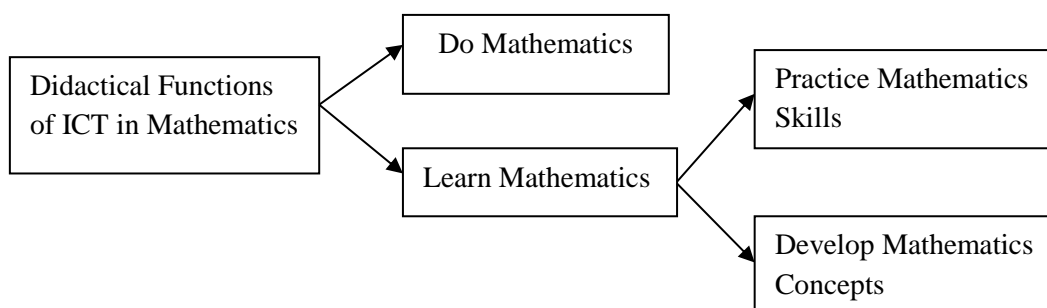
There are fundamental questions that need to be explored in the light of using technology in the

classroom. According to Drijvers (2012) stakeholders in education are being confronted with the following fundamental questions about the use of ICT in teaching and learning of mathematics:

“How can teachers exploit the potential of ICT in enhancing children's learning of mathematics? Does ICT enhance teaching of mathematics? And if it does work, what factors are decisive in making it work or in preventing it from working? Does it make learning more effective and efficient?” (Drijvers, 2012)

These fundamental questions can be explored using the theory of didactical functions of ICT in mathematics instruction by Drijvers, Boon, and Van Reeuwijk (2010). According to the theory, there are three main didactical functions of ICT during a mathematics learning session. First, ICT has a tool function for doing mathematics, which refers to the outsourcing work done by ICT devices that could also be performed by hand in a paper – and – pencil learning milieu. In this function, ICT performs the work that the hand of the learner does in the process of solving a mathematics problem. Second, ICT provides a stimulating learning environment for practicing mathematics skills. Third, ICT creates a stimulating learning environment necessary for developing basic mathematics concepts. Figure 1 depicts a model showing the didactical functions of ICT in the teaching and learning of mathematics.

Fig. 1: Didactical functions of technology in mathematics education



Source: Drijvers, Boon, and Van Reeuwijk (2010) ICT Didactical Functions Model

Methods

Research design and participants

Mixed methods research design involving a combination of quantitative and qualitative data collection and analysis techniques was adopted for this study. Both quantitative and qualitative data collection methods were incorporated in the study. The study

targeted teachers from all the public and private lower primary schools in Mombasa County. Seventeen (17) public and twenty-three (23) private primary schools in Mombasa County with ICT facilities were purposively sampled for the study. Then 120 teachers teaching in lower primary were randomly selected from the 40 schools sampled.

Procedures and data analysis

Data was collected in two phases. During the first phase, the researcher collected quantitative data using a questionnaire for teachers (structured survey). In the second phase of the study, video recorded lesson observations and post-lesson semi-structured interview was conducted to collect qualitative data. Data was then analyzed using both quantitative and qualitative techniques.

Findings and discussions

Ten themes emerged from the data coding process as follows: ICT is a break from routine (BFR), it produces interactive learning styles (ILS), it reduces pupil weakness (RPW), and makes mathematics to become attractive (MBA) as well as increasing pupil engagement (IPE). ICT was also found to facilitate classroom activity (FCA), raise pupil attention (RPA), increase pupil concentration (IPC), promote learner autonomy (PLA), improve Pupil's memory (IPM), and increase class attendance (ICA). The ten themes were further categorized into two broad themes: Effective classroom management and cognitive amplification. The broad theme effective classroom management concerns orchestration on the classroom environment thereby making it conducive for learning. Chrysanthou (2008) found that the use of ICT in teaching brought about positive changes in the classroom environment. Under this broad theme effective classroom management, the researcher included the following themes: Break from routine, interactive learning styles, increase pupil engagement, facilitate classroom activity, and increase class attendance. The broad theme cognitive amplification concerns enhancement and reinforcement of mathematics learning. Pea (1985) argued that ICT provides learners with powerful cognitive tools that enable them to enhance their ability to construct knowledge by opening new possibilities of thought and action. Under the broad theme cognitive amplification, the researcher included the following themes: Mathematics becomes attractive, raise pupil attention, increase pupil concentration, promoted learner autonomy, and improve pupil memory. The following is a discussion of the themes that emerged under the broad theme facilitation of effective classroom management:

Break from routine

The use of ICT in teaching mathematics was reported by the teachers as a break from normal school routine which may at times be quite boring. In most of the mathematics lessons that the researcher observed in various schools he visited, children were seen to be in high spirits and were enthusiastic. The mere fact that mathematics lessons were conducted in the computer

laboratory rather than ordinary classrooms was seen as a break from routine. One teacher noted that routine at times could be quite boring making learning unattractive experience. The use of computers, laptops, and tablets in working out mathematics problems rather than using a typical exercise book was also seen by learners as a break from normal routine. This finding implies that at times breaking from normal classroom routine was a catalyst for effective learning. This finding is consistent with findings from previous research by Chrysanthou (2008) in which teachers and students attributed use of ICT in teaching mathematics as a break from normal boring classroom routine. This break from normal classroom routine contributed immensely in making the mathematics lessons more interesting, attractive, and enjoyable to learners (Chrysanthou, 2008). The students found the use of computer laboratories for learning mathematics rather than the ordinary classrooms as a break from their normal routine. It was a time that students always longed for.

Interactive learning styles

The use of ICT in the teaching of mathematics was found to be associated with increased interactions in the learning process. "*Children are always incredibly active in class whenever ICT tools are used to teach mathematics;*" reported one of the teachers interviewed. Most of the teachers interviewed reported that ICT tools facilitated interactive learning environment during mathematics lessons. They noted that children were rather more active in the classroom whenever they used ICT tools in the computer laboratory than when they did it in the dearth of ICT tools in their ordinary classrooms. One of the teachers was asked to explain how ICT facilitated interactions during mathematics learning sessions. In responding to this, below is an excerpt of what the teacher said:

"Every child in my class gets an opportunity to use a laptop or tablet. They (children) normally consult one another. They always help one another. Whenever we are in the lab, no child is ever idle and learning mathematics is always fun. Infact with ICT children can learn without the teachers. They are always engaged in something constructive. You know they take pictures, play games and compete with one another." [Teacher in 5th interview]

In one of the mathematics lessons observed, the researcher noted that pupils worked collaboratively on their tablets as they learnt basic mathematics concepts

such as simple addition. The children worked independently on their gadgets while at the same they consulted and shared ideas with each other. The researcher recorded a conversation between three pupils who were working on their tablets to perform an addition operation of whole numbers as captured in the following transcription (the names used are pseudo names for the sake of protecting the children's identity):

Pauline: (To a pupil seated next to her) Use cows instead of hands. Cows look good. Look at mine. (the researcher moves next to Pauline to see what she was doing).

Philip: Ok. Let me see. (He fidgets with his tablet to change image settings from hands to cows). Oh, look my cows are yellow while yours are green. I have never seen green cows. (He attempts to perform addition and gets excited about results displayed on his screen).

The teacher explained to the researcher that the programme was designed as a self-learning mathematics programme. It uses multimedia features of sound and images to demonstrate addition operation. A child was heard nearby trying to explain to another child on how to perform an addition operation. The following is an excerpt of a conversation between the two children:

Sinclear: (To another pupil seated next to her) Touch here.

Natalia: (Attempts to touch on the screen of her tablet using index finger but it doesn't respond) Nothing is happening! (She exclaims)

Sinclear (Picking up the tablet) Let me show you. (She touches on the screen lightly with her thumb and it responds) This is how it's done (makes a hand gesture).

Natalia Give me I try. (She attempts, and it responds)

The mathematics programme used in this class produced symbols, images, and sounds simultaneously as children work through addition of whole numbers. The programme began by a female voice defining addition as 'putting together'. When a child touched a number on the tablet screen (for example number three), the number was displayed on the screen in figures (that is 3), at the same time three cows (or any object that the child had previously selected) came on the screen as a female voice called out the number. When the child touched the addition sign (+), a voice was heard in the background saying, "put together." Again, when the child touched another number (for example two), its symbol was displayed on the screen (i.e. 2), and a corresponding number of objects (in this case two cows) were produced together with voice called out the number in the background. Finally, when the child touched the equal sign (=), the answer was produced in terms of voice calling out the answer (that is 5), while at the same time a figure was displayed on the screen and images of five cows (or any object of choice according to a child's preference) corresponding to the answer appeared. This finding is consistent with findings of previous studies which found that ICT facilitated interactive and collaborative learning. Chambers (2011) found that the use of web 2.0 based ICT tools such as forums, blogs and podcasts enabled primary school children to work mutually together. BECTA (2003) assert that ICT facilitates improved group work and co-operative skills among learners.

Increase pupil engagement

Use of ICT tools in teaching mathematics was also found to be associated with increase of the level of pupils' engagement in the learning activities. Most of the teachers interviewed in the present study reported that whenever children were allowed to use computers to learn mathematics, they always became much more absorbed in the learning activities. One of the teachers interviewed reported:

"They (children) never get tired of learning mathematics whenever they can use computers. They are not even willing to take a break as long as they are working on computers. Whenever they do mathematics in their classrooms, they are always eager to go out for break. But interestingly, whenever they are in the computer lab, they get so engrossed with computers that they are willing to forego even their break just to continue working on mathematics on their computers.

Nothing motivates them to learn mathematics better than computers do.” [Teacher in 4th Interview]

This increased engagement in learning activities stems from the fact that ICT allows children to work mathematics solutions at their own pace. Most of the teachers overwhelmingly endorsed the idea that ICT tools facilitate learning of mathematics at the learners’ own pace. The teachers noted that the mathematics software installed in most of the computers and tablets were meant to allow children to learn individually at their own pace. One teacher reported this by saying:

“The mathematics software installed in the computers was designed as a self-learning programme. The child follows instructions given and can get feedback. This programme is also self-correcting. The child does not need the teacher. He or she attempts the assignment given and after several trials the system provides the right answer. It also rewards the learner accordingly. For example, if the learner gets the answer correct, it says “correct answer, very good or wrong answer, try again.” [Teacher in 1st interview]

This finding agrees with Chrisanthou’s (2008) finding that Geogebra mathematics software enabled students to work out mathematics problems at their own pace without holding or waiting for others. NCTM (2000) also argues that ICT can transform abstract mathematics concepts into concrete and visual representations that are easy for children to understand. NCTM further argues that ICT fosters children’s engagement with mathematics concepts by making them real and enjoyable.

Improve class attendance

The teachers interviewed in this study reported that the use of ICT in the classroom practice generally helped to reduce instances of truancy among the pupils. They reported that children were always excited about the prospect of using ICT in learning. It was reported that whenever they expected to use the ICT in learning, their class attendance improved. The following is an excerpt of what one of the teachers reported:

“The use of computers and laptops in learning mathematics takes place in the computer laboratory. There is only one computer lab in the school

and therefore a programme has been put in place to control its use. Each class in the school can use the computer lab once per week. My class is normally scheduled to use the computer lab on every Wednesday. On that day I can assure you, we always have almost 100% attendance.” [Teacher in 7th interview]

This finding is consistent with BECTA (2003) founding that ICT leads to improved attendance at school. BECTA further argues that ICT sparks students’ appetite for learning and increased enjoyment and commitment to learning. Children who enjoy and are committed to learning are more likely to attend class regularly as compared to their counterparts who are not committed to learning.

Facilitate classroom activity

Finding revealed that ICT was useful in facilitating effectual learning activities during mathematics lessons. Most of the teachers interviewed particularly those from public primary schools indicated that ICT tools helped in regulating classroom activities. They reported that the TDD (teachers’ digital devices i.e. the laptops) and LDD (learners’ digital devices – the tablets) came preloaded with two systems that helped manage learning activities during mathematics lessons. One of the systems was referred to as *net support system* while the other one was *content hub*. According to the teachers, the net support system helped the teacher to develop lesson plan, manage learning activities on children’s tablets, monitor learning activities, send assignments to children on their tablets, collect assignments done by the pupils, mark the assignments and finally give feedback to the learners. The following is a transcription of what one teacher said about the use of net support system:

“First, net support system helps me develop a lesson plan, either by using word or power point program. Look here.” She shows the researcher a lesson that had been developed earlier on a power point program on her laptop. “I can present this lesson to the whole class using a projector or can just send it directly to the individual learners through their tablets. Second, it helps me to send learning content to the learners through their tablets. But it only sends to those children whose tablets are activated on the

system. When the system is turned on, it automatically detects all active tablets in class, and then prompts learners to register by typing their names in a dialogue box. Look here.” She shows the researcher the pupils already registered on the system. “The system enables the teacher to send learners tasks and assignments on their tablets. It also helps the teacher to modify existing content to suit learners’ needs.” [Teacher in 6th interview]

On responding to the question about how the net support system helps to manage and control the class, here is what the teacher had to say:

“I normally use the system to either blank the tablets or lock them out. When I blank the tablets out, their screens darken so that the learners can’t use them anymore. Locking the tablets make their touch screens inactive. When I blank or lock out the tablets, the learners become attentive to me as they try to seek my attention and help. Sometimes the children become so engrossed on the tablets that they do not pay attention to me at all. Other times they deviate from the expected learning activities. Therefore, blanking or locking out their tablets helps me to attract their attention back.” [Teacher in 6th interview]

So according to the teachers interviewed, ICT devices can be used to manage class activities and give teachers command on class control. Oldknow and Taylor (2000) assert that ICT motivates, encourages, and stimulates learners during mathematics lessons. BECTA (2003) leads to increased motivation and commitment to learning tasks in literacy as well as mathematics concepts.

The following is a discussion of the themes that emerged under the broad theme cognitive amplification:

Reduce pupil weakness

The teachers who were interviewed reported that ICT provided a lot of opportunities for children with lower academic abilities in mathematics to actively participate in mathematics learning activities. One of the teachers interviewed reported that computers

enabled all learners to actively participate in mathematics activities regardless of their ability levels in mathematics. Here is what the teacher had to say:

“Computers provide opportunities for all the children to work out mathematics problems at their own pace. Mathematics concepts are simplified through animated objects and games. Mathematics has become much simpler even to children who had viewed it initially as difficult and unachievable.” [Teacher in 3rd interview]

This finding agrees with Chrysanthou (2008) who found that Geogebra mathematics software was able to extenuate students’ weakness in mathematics learning. The program provided opportunities for students with low learning abilities to be able to actively participate in the mathematics learning activities. Furthermore, BECTA (2003) found that ICT leads to enhanced sense of achievement among students especially those who had previously been under-achieving in class. BECTA also argues that ICT creates a culture of success among learners by stimulating interest in mathematics learning activities.

Mathematics becomes attractive

This theme relates the learning of mathematics concepts with the use of ICT as a pleasant and attractive activity. In the third lesson the researcher observed, children were seen excitedly tapping on their tablets, they were deeply enthralled with the ongoing mathematics activities. Children were seen sharing experiences and information on their tablets. In fact, most of the teachers interviewed reported that ICT stimulated the learners’ interest in mathematics concepts and their concentration on mathematics learning activities was noticeably more than usual. In one of the lessons the researcher observed, children seemed reluctant to break for lunch. Their teacher reported as follows:

“Use of computers for teaching and learning purposes has made mathematics learning activities more attractive than ever. Infact we literally force children to get out of the computer laboratory to go for tea break, lunch break and games.” [Teacher in 6th interview]

One of the teachers interviewed reported that the ICT tool’s inbuilt multimedia features were responsible for the children’s increased interest in mathematics

activities. The following is an excerpt of what the teacher had to say:

“The computers enable children to learn mathematics through text, animated images and thrilling sound effects. They (computers) enable children learn mathematics with so much fun.” [Teacher in 4th interview].

This finding is consistent with Chrysanthou’s (2008) finding that ICT makes learning more attractive and enjoyable. The study found that Geogebra software contributed in making mathematics more appealing and enjoyable to students. BECTA (2003) argues that ICT stimulates and sparks students’ appetite for learning and at the same time creates a culture of success among learners. BECTA further notes that ICT leads to enhanced enjoyment in learning tasks and increased sense of achievement.

Raise pupil attention

ICT was found to contribute immensely in raising of pupils’ attention during mathematics learning sessions. Most of the teachers interviewed reported that children paid more attention during mathematics lessons whenever ICT tools were used for teaching and learning purposes. The teachers reported that there was a great difference in the children’s attention during mathematics lesson conducted in the computer laboratory than in their ordinary classrooms. One of the teachers interviewed reported that she always witnessed unusual increase in pupil attention during mathematics learning sessions whenever ICT tools are used. Here is an excerpt of what the teacher said:

“Computers enable children to learn mathematics through games and animated images. This makes learning of mathematics fun and interesting resulting in increased attention in class.” [Teacher in 3rd interview]

The 4th teacher to be interviewed added that ICT devices make children to enjoy learning mathematics thus increasing their attention in their learning of mathematics. The teacher reported as follows:

“Through tablets, children find mathematics learning session an enjoyable experience. Since the inception of tablets in the teaching of mathematics, children are always looking forward to learning

mathematics.” [Teacher in 4th interview]

Chrysanthou (2008) found that Geogebra mathematics software stimulated children’s attention in the classroom. The software enabled the students to focus their attention on learning mathematics concepts and procedures while at the same time freeing them from engaging in subordinate tasks.

Increase pupil concentration

Nearly all the teachers who were interviewed in this study overwhelmingly reported that ICT increased children’s concentration on the on-going mathematics learning activities. The teachers indicated that children’s level of concentration in mathematics activities always increased whenever ICTs were used in the teaching mathematics. The 5th teacher interviewed reported that whenever she used computers there was neither noise making nor unnecessary disturbances in class that were the usual case in the absence of ICTs. Here is excerpt of what she noted:

“Whenever I use computers to teach mathematics, my work is always very easy. There is no shouting, keep quiet! Children simply settle down right away for learning and concentrate on tasks at hand. Nothing else captures their (children) interest better than computers do.” [Teacher in 5th interview]

It was also noted that ICT increases the children concentrate on a task. The 2nd teacher to be interviewed reported that children in her mathematics class were able to concentrate on learning mathematics concepts for a long time. Here is a transcription of what she reported:

“Computers encourage children to discover concepts by themselves even without the teacher. They therefore concentrate on their gadgets for a long time without ever getting tired of them (computers). With computers, these children don’t ever get tired. The level of concentration is so high whenever they are working with computers.” [Teacher in 2nd interview]

In addition, Teacher 7 noted that ICT brings joy and excitement in children consequently increasing their

level of concentration in learning. Teacher 7 reported as follows:

“Children normally get so excited whenever they are allowed to use computers to learn mathematics. This increases their level of concentration in learning mathematics.” [Teacher in 7th interview]

This finding agrees with BECTA’s (2003) argument that ICT stimulates, motivates, and sparks students’ appetite for learning as well as creating a culture of success. Furthermore, BECTA (2003) observes that ICT increases learners’ commitment to learning; enhances their enjoyment, interest, and sense of achievement in doing mathematics.

Promote learner autonomy

The theme of ICT promoting learner autonomy during mathematics learning sessions emerged very strong from the present study. Nearly all the teachers interviewed reported that ICT promoted self-learning among children. The 1st teacher to be interviewed noted that normally children relied heavily on teachers’ guidance to solve mathematics problems. Here is an excerpt of what she reported:

“With ICT children learn and work out mathematics by themselves. The program we have enables children to learn mathematics concepts through play. In every topic children are given instructions on how solve math problems through audio-visual aids. Then they are asked to take assignments in which they attempt to solve similar problems. If a child is unable to get it right, the program prompts him/her to try again. After several attempts the program supplies the required answer. So, it allows children to learn mathematics on their own. The teacher’s role is reduced to a supervisory one.” [Teacher in 1st interview]

It was also reported that ICT provides learners with easy simple-to-follow instructions using multimedia. Therefore, learners were able to follow these simple instructions easily and solve basic mathematics problems by themselves. The teacher in the 4th interview reported as follows:

“The math program installed in the computers was designed for self-learning. The program gives learners easy and simple to follow age-appropriate mathematics instructions.” [Teacher in 4th interview]

The researcher was able to observe children work on their own gadgets with little or no intervention at all from the teachers. The little children were observed tapping on their tablets confidently as they solved mathematics problems. In one of the lessons that the researcher observed during the study, a child sitting next to the researcher was seen attempting to do addition of whole numbers on his tablet. He was seen pressing number three (3) on the tablet, as a voice called out ‘three’ in the background while at the same time three images of cows appeared on the screen. The child then pressed the symbols plus (+) and two (2). A voice in the background called out plus two as two images of cows appeared on the screen. The boy then pressed the equal sign (=) on the tablet and a symbol for number five (5) together with five cows appeared on the screen. A voice called out in the background that, “the answer is five.” One of the teachers interviewed reported that ICT motivated children to learn mathematics and therefore they did not require the presence of the teacher to learn. Here is an excerpt of what the teacher reported:

“Whenever I ask children to go into the computer laboratory to learn mathematics, they normally get so excited that they don’t seem to require any other enticement to learn mathematics.” [Teacher in 2nd interview]

This finding agrees with BECTA (2003) assertion that ICT has positive effects on students’ enjoyment and interest in learning. This goes a long way in increasing the learners’ motivation, independence, and self-directed study. Chrysanthou (2008) associated Geogebra mathematics software with promotion of pupil autonomy by asserting control on their own learning without the constant need of the teacher. However, NCTM (2000) argues that successful use of ICT in mathematics depends on the teacher because ICT is not a panacea parse. That teachers play a key role in selecting and creating mathematics tasks that take advantage of ICT to be effectively learnt.

Improve Pupil’s memory

It was overwhelmingly reported that ICT enabled children to easily remember mathematics concepts

previously learnt. One of the teachers interviewed reported as follows:

“They (children) never forget what they learn in the computer lab. They always remember everything they learnt previously using the tablets. Surprisingly, they normally find it difficult remember some of the things they learn in their normal classroom without ICT.” [Teacher in 6th interview]

Most of the teachers interviewed reported that the multimedia features embedded in ICT devices enabled children to learn mathematics concepts in a relaxed atmosphere and therefore they were able to retain most

of the concepts learnt. Here is an excerpt of what one teacher reported:

“Computers have multimedia features that allow children to learn mathematics through images, sound, motion and real-life experiences. It is very difficult for children to forget what they learn through such a stimulating environment.” [Teacher in 3rd interview]

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