

Initial Reflections on Teaching and Learning Mathematics Using Tablets in a Prison Education Centre

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Abstract. The reflections reported in this paper involve an intervention using a tablet as a tool for enhancing teaching and learning of mathematics in a Prison Education Centre in Kenya. The tablet is connected wirelessly to a server running the tutor-web mathematics software, installed at the Centre. The prison staff-teachers first duty is security and then teaching. With these priorities, the teachers sometimes do not attend to their mathematics lessons for hours or days and hence inmate-students miss continued mathematical instructions. To address the challenge, the use of tablet was implemented as a tool to facilitate continued instructions times and subsequent learning. The participants were Form 1 students in the secondary section of the Centre. Findings show that the use of technology did not only facilitate continued learning, but also changed the inmate-students negative attitude towards mathematics, motivated them and improved their mathematics performance. Challenges of using the tablet as a tool were noted. In general, the project continues to facilitate achievement of the mission of Kenya Prison Service (KPS) of containment and rehabilitation of offenders, responsive administration of justice, social reintegration and community protection. Future improvements on the project have been suggested. The findings inform the governments implementation of digital learning of mathematics which is key for the development of the country.

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1. INTRODUCTION

Teaching and learning mathematics has for some time been a challenge due to limited resources, it is a greater challenge when the trained teachers are inadequate or when untrained teachers have the greater responsibility of teaching. This is the case in Naivasha Maximum Security Prison Inmates Education Centre (NIEC), where the authors collaborated to implement

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teaching and learning of mathematics using tablets, tutor-web, in the secondary section to supplement teachers instructions. The team set out to strategically use technology in mathematics classroom National Council of Teachers of Mathematics (NCTM)[9],to aid the process.

The reflections reported in this paper involve an intervention in the teaching and learning of mathematics using a tablet which is connected wirelessly (WiFi) to a mathematics tutor-web box installed at the Centre. In it we share the success, challenges and possible solutions to the challenges for the purposes of improvement.

2. BACKGROUND

The Ministry of Interior and Coordination of National Government through Kenya Prisons Service (KPS) and in partnership with sponsors provide learning opportunities for inmates. This is in line with the State Department of Correctional Services and Rehabilitation mission of containment and rehabilitation of offenders, responsive administration of justice, social reintegration and community protection Kenya Prisons Service, (KPS) [7]. To achieve this mission, the KPS has rehabilitation programs. They include vocational training that are industry, tailoring, mechanic, carpentry, metal work and agriculture and education. In particular, the Prisons Department in conjunction with Ministry of Education, Science and Technology, Department of Adult Education, provide education facilities and opportunities for inmates . Long term educational programs which are in line with the formal education curriculum are most appropriate where inmates have a long term stay in the prisons. These are in the main prisons and Naivasha Maximum Security Prison (for men) falls in this category where the inmates terms of imprisonment generally vary from a minimum of 5yrs to life imprisonment. In the process of their service, some inmates voluntarily join the educational programs.

The inmates enter into the educational programs as adult learners at different levels and abilities. These abilities are realized during admission process where previous education and work experience is sought. Some start schooling from the lowest grade, Standard 1 ; others join high school or tertiary education while some are professional teachers of mathematics and school administrators. The willing professionals are absorbed as inmate-teachers in the Centre to work with prison staff-teachers. The prison staff-teachers are few and those trained as teachers are even fewer. The first duty of the prison staff is to provide security. Therefore, at the times when they are called upon to provide the much needed security, they do not attend to their classes. This may sometimes take hours or days. There is then lack of continuity in teaching and learning, yet the students are expected to sit for a national examination at the end of their fourth year. The need to fill the teaching and learning of mathematics gap arises, albeit temporarily; there is need to intervene and ensure continuity in the process. Continuity in teaching and learning is here taken to mean the teaching and learning happening in all scheduled lesson times in the timetable.

The population of the secondary school students was 200 students as of January 2017. The number of students per class is erratic; there are low and high seasons. The high seasons are as a result of security concerns which increase the inflow of inmates to this Maximum Security Prison. Secondly, transfers from other prisons especially during the start of the year where inmate-students seek further education. During the high seasons, the teachers handle classes of between 40 and 50 students hence a high student-teacher ratio which has implications for one-on-one mathematical interactions. With time, some students transfer to other prisons on appeals, medical or security reasons and some are released and hence some low seasons. Furthermore, there has been a general negative attitude towards learning mathematics and many students have perceived it as a difficult subject. Prison routines allow for limited time for teaching, three and half (3.5) hours between 0930hrs and 1130hrs, and between 1400hrs and 1530hrs

despite the normal seven (7) school hours in formal schools. The time is not sufficient for syllabus coverage, yet the inmate students sit the same examination as other students at the end of the fourth year. Thus there is further need for use of appropriate technology in the teaching and learning of mathematics to enhance learning and syllabus coverage. This is in line with the National Goals of Education of promoting social, economic, technological and industrial needs for national development, and promoting individual development and self-fulfillment. Due to the limited numbers of teachers and their limited teaching times during mathematics lessons, the initial idea was one of volunteering as mathematics teacher, which happened once in a month. This was, however, not enough to supplement for the mathematics prison staff-teachers absence. At a second level, intervention to enhance teaching and learning of mathematics using technology, tutor-web, was initiated. The technology was meant to assist both the teachers and the students by bridging the gap in which the mathematics teachers are unavailable.

3. OBJECTIVES

The objectives of the intervention;

1. To explore how the tablet has facilitated continuity of teaching and learning of mathematics during the temporal absence of the teachers.
2. To explore how the use of the tablet has improved change of attitude, motivation and performance of mathematics.
3. To explore challenges experienced in teaching and learning when using the tablet.

4. USING TECHNOLOGY IN MATHEMATICS EDUCATION

The use of technology to teach and learn mathematics is widely accepted and is fast growing. In its position statement, the National Council of Teachers of Mathematics [9] set to explain what it considered as the Strategic use of technology in teaching and learning mathematics, that is;

”use of digital and physical tools by students and teachers in thoughtfully designed ways and at carefully determined times so that the capabilities of the technology enhance how students and educators learn, experience, communicate, and do mathematics”

This means that the use of technology should be aimed at supporting, facilitating and enhancing learning and teaching, communication and practice of mathematics. In a classroom situation, the teacher needs to learn how to use the technology as a tool to deliver mathematical content to students while the students need to learn skills of how to use the technology and the mathematical content, concepts and procedures. The focus should be on the mathematics and not the technology itself. Furthermore, timely use of technology should also enhance learning. Previously when technology for teaching and learning were not in place, the process happened by other means and therefore, the use of technology should be part of means to teaching and learning mathematics, and not the only means.

In introducing the use of technology, teachers can capitalize on students informal learning styles. This can be from the everyday ways of using mobile phones and computers. For some students it could be the first time to use the technology and hence the teachers need to develop means of how to train them. The teachers may also take advantage of students natural propensity to teach one another Bowels and Stephens [1].

Technology has been used in mathematics classrooms for different reasons; to prepare teachers for the 21st century mathematics classroom, to deliver content and pedagogical knowledge, to

explore and explain mathematical relations Bowels and Stephens [1]. By using technology, it has been noted that there is change in students perception of mathematics; from mathematics as a collection of rules and procedures to mathematics as an intellectual game, a response to curiosity, a human endeavor Goldenberg et al [3]. In fact, strategic use of technology in mathematics classrooms has the potential to support the development of advanced mathematical proficiencies such as problem solving, reasoning and justifying Gadanidis and Geiger [2] and also monitor students working and providing information on their progress.

The use of technology presents an opportunity for student-student and student-teacher interactions, which supports and enhances sense making. Opportunities for more student centered teaching, self-learning and peer teaching, collaboration and the need for inquiring on information, knowledge and resources that would facilitate further learning [11] also present themselves. The Kenyan government through the Ministry of Education and in conjunction with the Ministry of Information Computer Technology acknowledges the use of technology as a tool for teaching and learning [10] and has since intervened by digitalizing learning and teaching. In fact, the government aims at using Information Communication Technology (ICT) as a tool for management, teaching, learning and research in education and training nationally.

In that regard, the government has since 2016 commenced a laptop program in all primary schools starting from Standard 1 with the key areas being numeracy and literacy Republic of Kenya (RoK) [11]. The teachers and pupils in primary schools continue to be integrated into the digital platform of teaching and learning. In fact, it is noted in the Sessional Paper of 2012 [10] that it is at a very young age that learners can begin to acquire digital skills which they increasingly use to explore and exploit the world of information and to craft that into knowledge; hence the commencement of the project at Standard 1 level. The secondary school students and private students are currently not considered in the government project. Furthermore, majority of the teachers and students in secondary schools in Kenya have a general capability and capacity in the use of digital resources in teaching and learning. The specifics in each area are very limited.

There are challenges facing use of technology in education sector in Kenya which include; access, funding, inadequate ICT facilities, ICT not embraced as medium of instruction and management tool, inadequate capacity for teachers, dynamic nature of ICT technology [10]. The technology, however, is currently penetrating the teaching and learning process as a tool of instruction, especially in private capacity. The tutor-web is not new in supporting teaching and learning of mathematics. The tutor-web system has been used at several locations in Iceland, but most extensively at the University of Iceland, both as a vehicle for research and as a tool inside and outside the classroom.

Originally developed and used in a class on Linear Algebra and Statistics Stefansson [12], the system has been revised and extended several times, most recently into a mobile web-based system Lentin et al [8], which implies that a student using a tablet will be able to continue working offline, once drill items have been downloaded into the tablet.

The tutor-web system is in part developed as a research tool Stefansson [12] and has been used for several analyses, e.g. on student behavior in a web-based learning environment Stefansson and Sigurdardottir [13] and for experiments comparing students who use traditional homework vs web-based homework Jonsdottir et al [5]. When designing a system which includes a drilling component, many decisions have to be made on how to allocate items to students, whether and how to include timeout, how to compute grades. The exact formulations have been described in several research papers e.g Jonsdottir et al. [4], Stefansson and Jonsdottir[5].

In the light of how technology has been used in the past in mathematics classroom, in this paper we report how we used technology that is the tablet (as an intervention) to support and facilitate teaching and learning of mathematics; to deliver content and pedagogical knowledge.

5. METHOD

The implementing team had different resources which set base for supplementing the process. The members had different abilities in; mathematics education, statistics, ICT, curriculum development and implementation, hence an interdisciplinary collaboration and division of labor as per specialization Katz and Martin [6]. Our diversity led to sharing of knowledge, skills and techniques as we implemented the project. Due to our long spatial proximity, communication was commonly via emails. However, the team often met in the Center to deliberate and also implement the project. Permission to implement the project was obtained from the head office of the Ministry of Interior and Coordination of National Government Nairobi and in fact during the launch, in early June 2016, the head office was represented by the director in-charge of rehabilitation in KPS.

The targeted students were Form 1 students aged between 20 to 50 years. They were selected based on their performance in a mathematics test that was administered for the purpose of the project. Other criteria involved length of remaining period of stay in the facility, willingness to learn and discipline of the inmate. Out of 67 students, 30 best students were selected.

The tablet is a part of a system. The system consists of: A server (tutor-web box), Software, High Speed Modem (HSM), External Storage (128 GB), external signal booster, Tablets with Android operating touch system, ups and peripheral connectors. The tablets are WIFI enabled but CDMA disabled for security concerns in the prison. The tutor-web software and all associated educational material are stored in external storage (a USB stick) connected to the server. The tablets are connected to the server through the WiFi. The tablets are installed with the browser which accesses and downloads material from the server.

The material consists of the tutor-web material Stefansson [12] as a basis, but also the entire Wikipedia and a major portion of the Khan Academy material, including the entire set of mathematics videos, making these resources available also to those without Internet access. The tutorial materials include lectures and drills in integer arithmetic, prime numbers, fractions, powers, sets, number systems, countability, algebraic expressions, equations, inequalities and absolute values and lines in the plane. It is worth noting that not all areas are part of the Form 1 syllabus in Kenya but secondary students are expected to have basic knowledge of the same. Students, upon login in their individual portals in the tablets, are able to access mathematics contents in the server, perform calculations in real time, or store the resources in the tablets and work offline later. The platform provides step by step instructions on how to perform calculations. It also has a grading system. When the HSM is connected online to the server, the system administrator is able to access student individual performance and give any assistance required as well as analyze the content accessed.

Each student has an account on his tablet connected to the server, using a unique code which identifies and keep audit track of the tablet usage, access and submissions. The system has administrators who have full rights to access contents of the server as well as tablets whenever a network is present. Therefore, the administrator is able to track students performance, see the topics attempted or accessed by the students and compare the performances sequentially.

The teachers and majority of the students had basic knowledge on the use of computer and mobile phones. The teachers were briefly but intensely inducted for one day into the use of the tablets by the team. The team also had a brief induction period with the target students. There after the teachers in conjunction with members of the ICT Department of the Prison, trained the students. After two weeks of induction, the second author visited the Centre to see how things were working, and there was considerable improvement. After the initial induction into the use of the tablets both teachers and students were enthusiastic to learn how the system operates. They did so as individuals or in small groups discussing features, means of accessing the required information, and reading lecture notes. Currently, each student is able to log in their accounts, work on tasks and log out on their own.

The tablets are used in conjunction with the mathematics syllabus and class text. Once a topic or area is learnt in class with or without the teacher from the text and exercise questions attempted, the students and teachers then look for more drill questions in the system. Thereby supplementing what they have already learnt.

The ICT Department and the mathematics teachers continue keeping consultation with the team to address issues that may arise in the process of using the tools.

6. REFLECTIONS

All students attempted the drill questions given in the tutor-web; the main attempts were in integer arithmetic, prime numbers, fractions and powers while there were no attempts on sets, and inequalities and absolute numbers. Majority of students scored above average in integer arithmetic and fractions. The two topics are part of the Form 1 syllabus and at the time, they had been covered in class. The lowest performed topics were number systems and lines in a plane; in practice only basic knowledge of the two topics is taught in Form 1. This could explain why few number of students attempted them and the low performance for those who did. Generally, the students engaged with the lectures and drills. Based on the guiding questions, the following observations were made.

6.1. The tablet facilitates continuity of mathematical teaching and learning during the temporal absence of the teachers

The tutor-web technology has been instrumental in facilitating continuity of teaching and learning; the students are able to use the tablets on their own. Majority of them are able to learn and perform arithmetic with minimal supervision even in the absence of the teacher. This could be during class session or out of class session. The portability of the tablets also enables the learners to take the tablets to the cells to use during their free times. They check answers, do corrections and proceed to other chapters. Most of the time, they work in small groups and discuss the process and outcome, thus enhancing their mathematical skills. This has also seen improved quality and frequency of discussions.

6.2. The use of the tablet has facilitated the change of students negative attitude towards mathematics, improved motivation and performance

Since inception of the program, there is noted change of attitude towards mathematics, improved motivation and performance of majority of the students. Students have changed their attitude; from a negative to a positive attitude towards mathematics and formal learning. The students are always enthusiastic to attend the mathematics lessons and subsequent use of tablets for self-teaching. In fact, to both students and teachers, mathematics has become an interesting subject, to learn and teach respectively and hence require more time.

Students are motivated to engage with mathematics by the systematic sequence given to solve mathematical problems and mathematical videos from Khan Academy. The mathematics videos show the sequential moves of performing arithmetic problems. Both staff and inmate teachers use the videos to sharpen their skills.

Improved performance is adduced from continuous assessment tests done at the mid and end of term and examinations, testing mathematical knowledge and skills. The skills tested in the examinations were recall, comprehension, evaluation and analyzing. The subject mean in the three consecutive tests done within the first six months (June – December 2016) of the use of the tablets show improvement were 37.83%, 39.43% and 39.83% respectively. While the improvement may not solely be attributed to the use of technology, students have been motivated to exercise more frequently and work on more questions due to the interactive nature of the system; that is, they get feedback on their attempts. Further, the use of the technology has facilitated improved processing of students learning outcomes which are shown by system

generated results and tutors reports.

Initially, there was fear that the students would abandon writing work methodologically as required; that is showing workings on how they arrive at a solution. Further, the team feared that one-on-one engagement of the teachers and students would be limited, and that the use of technology could interfere with syllabus coverage. These fears were dispelled; the students are encouraged to write out and show all workings whenever they engage with some exercise methodologically and sequentially guided by teachers. The tutor-web mathematics platform is also programmed systematically.

During the class session, contact has been maintained; first due to the need to continue using the technology and further the mathematics knowledge and problem solving skills. The tutors interact with each student and assist where need be, the students also freely engage with the teachers. Likewise, students support each other when learning and performing their assignments both when using the tutor-web or not.

While the positive factors described above were realized, the use of technology was not a straight forward process; there were challenges.

6.3. Challenges experienced in teaching and learning when using of the tablet

Time to do all that is scheduled seems limited; the students actually need more time. Initially, this was added to the fact that they were not used to the gadgets. On the other hand, one class session is of 45 minutes, which is inadequate to cover quite a considerable work because students need to be assisted. To improve on time, the teachers and Center administrators have planned for additional time during lunch sessions 1200hrs to 1400hrs and Wednesdays afternoon 1400hrs to 1500hrs .

The fact that students leave schooling is evident, due to the very nature of the prison institutions. There are students who have transferred to other prisons for purpose of security, call cases, appeals or medical attention across the country or even released from prison, others fall out of school. A major transfer in February 2017 has since affected the tablet project. At the time, the commissioner of Prisons, advised transfer of inmates to other correctional institutions or release to allow for decongestion of the Maximum security institution. In NMSP, the population had escalated to above 3000 mark and the facility was facing congestion with static number of security personnel. More than 1000 long term inmates were transferred and the institution has since remained with inmates serving life sentences and those on death row. Hence the population is much more likely to stay longer. The transfer affected the number of students in the tutor-web class. Initially, there were 30 students, which have reduced to 11 students. Those transferred left the tablets at the Center.

Likewise, there have been 4 new entrants to the program on transfer in. They were selected on the same criterion as the rest and were allocated the tablets of those who left. These new entrants needed induction and hence the need for extra time on the part of the teacher. The addition of special sessions over lunch breaks and Wednesday afternoons partly addresses the limited time factor. With this situation, we can account for the performance of only the 11 students who have been in the program for a continuous period since its inception.

Since the introduction of the technology, the server connections have broken down twice. The first was the collapse of the contents in the external storage and the second has been WiFi connectivity error and access of the resources in the second external device. The problems have since been fixed. It is worthwhile noting that when the connection fails, students do continue to work offline on the stored resources in the tablet. The only challenge with this is that we cannot access the collective data of the tablets via the server.

Some minor challenges include low network signals hence not able to access and load data of students work, few staffs that are knowledgeable in ICT and, lack of commitment by few inmates.

The positive aspects and challenges experienced in this first phase of the project, are being used to plan for future phases

7. WHAT DOES THE USE OF THE TABLET MEAN FOR THE PRISON EDUCATION CENTRE?

The use of the tablet has enhanced teaching and learning of mathematics in the inmates education program; the time scheduled for learning especially in the absence of the teachers is used in further mathematical engagement and students are motivated to learn mathematics. The technology is not a security risk since it is not SIM card enabled and while the tablets can access internet via WiFi, it is not provided for in the facility. This means that using technology at the Center does not compromise security for both inmates and outside community. This is enabling the KPS to achieve inmates rehabilitation while the community is protected.

In the course of the six months of implementation, the mathematics performance of the students has been improving and more improvement is expected in the future.

NMSP is the first Prison Education Center to use tablets in teaching and learning mathematics in the East African region. This is in line with the vision of being correctional service of excellence in Africa and beyond. Findings from the project could be used to explore digital learning in other educational institutions.

The Centre has developed a Facebook page under the name Naivasha Maximum Prison Education Program. On the page, they inform and share with donors, well-wishers, other prisons and stake holders of what is taking place at Naivasha Prison. This platform has created awareness especially to other prisons drawing inmates in pursuit of education to request for transfer to Naivasha to acquire formal learning using technology.

The use of technology has facilitated the inmates to develop mathematical skills and more so web based mathematics skills. These are essential in most of the careers such as computer science or programming and in further or higher education. The acquisition of skills provides opportunities for improvement of the inmates employability and subsequent economic development during their stay in prison. This is because the prison institutions hire their skills services at minimal costs and income earned is credited to their accounts. For those who serving long sentences, the skills are key upon their release. These developments show that the project is in a way meeting the national goals of education of promoting social, economic, technological and industrial needs for national development, and promoting individual development and self-fulfillment.

8. WAY FORWARD

The tablet project has been successful despite the challenges faced. It will be replicated with a similar set of students in Form 1 in each of the years 2017, 2018 and 2019. This will see the whole secondary section of the selected students have access to tablets and hence a complete cycle will be achieved in four years.

Since teacher absence is also experienced in other subjects, the teachers and students have requested that other subjects be available through the system. In response, the education administrators of Center are in the process of requesting Kenya Institute of Curriculum Development (KICD) to provide soft copies of subject lessons prepared in form of notes, questions and other presentation and load them into the system.

In later times, it is expected that the teachers will begin developing their own presentations and uploading them and other learning materials on the tablets on a standalone server, avail the tablets to students who will work offline, collect the tablets afterwards and upload the relevant work for marking. Furthermore, this project opens up potential for research.

9. CONCLUSION

In this paper, we have discussed the first phase of implementing the use of technology in teaching and learning of mathematics at the secondary section of Naivasha Maximum Security Prison Inmates Education Centre. In fact, collaboration made it possible for the project to be implemented; ideas put together by collaborators with diverse knowledge for a common course. Teaching and learning have been enhanced and teachers and learners are being empowered with appropriate web based mathematics skills. The success and challenges facing the project have been noted; the challenges have and are been addressed so that future projects are informed. The project is helping KPS to achieve its mission of rehabilitation and reformation. *Acknowledgements:* We acknowledge the valuable contribution and support of Rosemary Kimani, Department of Applied Biology, Rift Valley Institute of Science and Technology which she provided during the year working on the project

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