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EXPLORING THE ROLE OF EXTRA CURRICULA MATHS CAMPS AND CLUBS IN KENYA AND BEYOND

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Abstract

For the last four years Maseno University, Kenya, has been running a maths camp bringing together both international and local, lecturers and teachers to engage secondary students in the subject through puzzles, games, technology and extra-curricula mathematics. This paper presents the core values that are behind the success of the camps as well as how the initiative has evolved to scale out to more students through school maths clubs. A case will be made that there are changes happening in Kenyan education which have created a window of opportunity for such initiatives to prosper, where traditional teacher training has not been a success. Finally it will be mentioned how the camps have already spread to Ethiopia, Ghana and the UK, illustrating the potential for innovation in such low resource environments to have global impact.

Keywords: Maths, camp, club, extra-curricular, technology, games, Kenya.

1 INTRODUCTION

"It's not a must to cram large formulae for you to know Mathematics"¹. This is a quote from a student who attended a summer maths camp at Maseno University in Kenya. At the maths camps, students learn mathematics through playing games, using the latest mathematical software and solving puzzles. "The ways we used to approach the puzzles changed my entire perspective of looking at them. The approaches made the puzzles easier and simpler to solve". Emphasis is on problem solving, logic and critical thinking, "Having puzzles to solve maths activities is challenging but is a big measure in solving problems. Likewise the puzzles open our thinking critically making it easier to understand".

The maths camps aim at changing the negative attitude many students hold towards mathematics. Many students leave the camp viewing the subject differently, "It has made me like maths", while others gained confidence, "This maths camp truly empowers us and gives us another hope of learning maths. What I am sure of is improving in maths". The maths camps are inclusive and promote the idea that mathematics "is the subject for all not half for all".

Students experience mathematics in a new way, become exposed to areas unseen before and see real world applications, "Actually I am glad to have a maths camp because I feel exposed to so much on the world of mathematics." This exposure has given confidence to students in other subject areas, "The assertiveness towards maths made me to create a positive attitude to all subjects". It is clear that students enjoyed the teaching and learning methods, "It is a privilege to us", and want to continue learning using technology, "How I wish the ministry of education could allow and create chances for computers in daily maths lessons."

¹ All student quotes in the introduction are from the previous four years of Maseno Maths Camps. The conclusion includes student quotes from all maths camps (Kenya, Ethiopia, Ghana, UK).

Enthusiasm from students to share the ideas learned from the maths camps, "I am going to share what I have learned to my friends.", "I just couldn't wait to go home or at school to share the ideas with my friends both at school and at home and still look forward to learning new things.", has spawned other initiatives such as half day or full day mini maths camps in schools, and school and university maths clubs. As a result, ideas from the maths camps have spread naturally through students.

This paper will discuss the current technological and pedagogical situation in Kenya, the Maseno Maths camp initiative, student case studies and mention initial efforts towards going to scale.

2 TECHNOLOGY AND PEDAGOGY IN KENYA

Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) is a centre established in Kenya to offer in-service training (INSET) and education in the mathematics and sciences. It was launched in 1998 with the Strengthening Mathematics and Science in Secondary Education (SMASSE) Project, a joint technical cooperation between the governments of Kenya and Japan through the Kenyan Ministry of Education and the Japan International Cooperation Agency (JICA). The main objective of SMASSE was to improve delivery of mathematical concepts through an activity based learning approach (ASEI-PDSI) according to [1]. The evaluation of the project shows that it succeeded in putting in place an INSET structure that could be used nationally for teacher training, it failed however at impacting teaching methodologies and attitudes towards the use of learner centred methodologies emphasising the problem solving approach.

Despite several years of INSET programmes [1] poor performance in secondary school mathematics continue to be recorded in national examinations in Kenya. This has been blamed on poor learning and teaching procedures [2] devoid of training problem solving skills, a focus on traditional methods and an obsession with a rigid examination curriculum [3] that does not allow for teachers to explore more innovative methodologies driven by technology.

Kenya is one of the African driving forces in technological integration with innovations like MPesa being a world leader in mobile banking. The government commitment is captured in key policy documents such as Vision 2030 [4], National ICT Policy [5], Sessional Paper Number 1 of 2005 [6] and National ICT strategy for Education and Training [7]. The current government campaign strategy has a strong focus on technology, setting as one of its key flagship development programmes a laptop project in primary schools. Although the full scale implementation of this project may be abandoned due to cost constraints [8],(8), it is very likely that there will be a government ICT integration plan of some form, due to popular demand.

In today's evolving digital world, the ability to understand and effectively use technology is essential on many levels from personal to professional, and is key to future employment opportunities on a technology-driven job market. In and around Kenya, in addition to the government drive, there are numerous large and small scale initiatives that are currently being developed and implemented with the aim of integrating technology into school education, e.g. [9] [10]. Apart from computer labs, laptops and tablets, there is evidence that mobile phones will be a key player in technological developments in education [11]. Considering the scale and multiplicity of these initiatives and policies, it is likely that some form of technological tools will be available to Kenyan students in the years to come.

Several studies have been done that highlight the opportunity that technology can provide for mathematics instruction in Kenya [12] [13]. There are plenty of challenges related to integrating technology into mathematics and statistics education [14] [15] [16], but the potential benefits include promotion of mathematical understanding, developing pupils' perspectives, collaborative and self-paced learning, positive attitudes towards the subject and scaffolding of mathematical concepts. Many studies [14] [15] [17] note that technology can make mathematics instruction effective, but also identify challenges to implementation such as: lack of time in the school schedule, already overloaded educators, insufficient practical training, inadequate technical support, lack of ICT skills and inaccessible resources for comprehensive ICT integration.

This situation where technology is just becoming widely available and the challenges to its integration are being understood provides a window of opportunity for substantial change. Integration of technology into the Kenyan classroom is becoming a realistic possibility for educators especially as the internet is starting to become more widely available giving access to a wealth of resources. Taking advantage of this situation may require initiatives at all academic levels [18] some way of achieving scaled impact. One possibility for scaling might be to identify innovations that have the potential to 'go viral' [15], where this is interpreted as an initiative having a bottom up, voluntary approach to adoption.

3 MASENO MATHS CAMP

The Maseno Maths Camp was founded in 2011 as a way to inspire Kenyan students in mathematics. The camp has been held at Maseno University every year since, catering for numbers between 30 and 120 students. The camps have been highly successful in part due to their key values: sustainability, teaching extra-curricular maths, being inclusive, creating an immersive environment where everyone is learning, using the latest technology, developing and communicating new educational resources, and creating a community of mathematical enthusiasts.

3.1 Sustainability

From its inception, the Maseno Maths Camp was an initiative instigated and supported by lecturers at Maseno University as a locally sustainable initiative. It is a not-for-profit venture, with local and international educators volunteering their time freely. In 2014, the camp was able to run with all local expenses covered by student registration fees. Full fees for the week including accommodation and food are 5000 Kenyan Shillings (around \$60) with a large number of local students paying reduced fees.

Volunteers include a mix of local and international mathematics students, teachers, educators, lecturers, academics, researchers, PhD students and mathematics enthusiasts, a mix designed to maintain engagement of participants whilst ensuring that the event does not rely on any given individual. Exceptional participants are encouraged to become volunteers and are mentored into a new role once they finish school.

3.2 Extra-Curricular Mathematics

The camps are designed to open students' eyes to the world of mathematics and show that mathematics is not all about calculations. The aim is to introduce mathematics not found in a classroom, both through the choice of content and through the delivery of the subject material. Each camp focuses on five different "themes" in mathematics, such as modelling, combinatorics, programming, code breaking, statistics, non-Euclidean geometry and game theory. Whatever the theme, the focus is on understanding concepts and problem solving situations, very different from the calculation and formula emphasis students experience at school. Moreover, the organisers believe in making high level mathematics accessible to high school students.

Even though the camps are not tailored to help students with the mathematics covered in the school curriculum, students often find that their achievements in mathematics improve on their return to school, and even see improvements in other subjects. The case studies of Cabrine and Evans, in section 4, illustrate this point even if they are exceptional rather than representative students.

3.3 Inclusive

All high school students from Form 1 to Form 4 (aged 14 to 18) are welcome to attend the camps. There are no entry requirements and the camps aim to have a mix of pupils with different socio-economic backgrounds and different achievements so far in maths. Equal numbers of boys and girls at the camps is a target, with a good mix every year so far, and there is a maximum number of students from any one individual school to ensure that a variety of schools are represented. Many students come from local public schools, but private and national schools are also represented.

Students are not separated by any of these factors during sessions at the camps and despite the wide range in ages, schools, backgrounds and mathematical ability of students who attend the camps, this has never caused an issue. The focus at the camps is not on the facts and formulas memorised in school but on critical thinking, creativity and being logical and persistent in solving puzzles and problems, so any student can succeed at the camp by applying themselves.

3.4 Everyone Learns

The camp is set up to allow learning opportunities for everyone, not just the students attending. Local university student volunteers learn ideas applicable to their university maths clubs and get valuable new input to their studies. They meet and work alongside local and international lecturers, teachers and PhD students and integrate themselves into a wider professional network. Teachers who accompany their students are given a few separate sessions to discuss what they have observed and learned from the sessions, how they could take this back to their classrooms and how they can

receive support from the organisers in doing so. In general, teachers attend the sessions together with the students and learn alongside them. Local and international teachers have the opportunity to interact with mathematics lecturers and researchers and learn new academic depth and background to the material they teach at school level. Local lecturers and teachers see a different style of teaching in action. Volunteers learn new branches of mathematics from being involved in a dynamic group with different specialisms. Mathematics researchers gain hands-on teaching experience alongside experienced teachers and receive feedback on their input. Thanks to this sharing of expertise across all levels the maths camps have been attracting enthusiastic and skilled volunteers consistently over the years, facilitating the smooth running of the camps.

3.5 Technology

Technology plays a key role in the camps. Software such as Geogebra and Scratch are used to give students an opportunity to explore mathematics and programming in an interactive environment. Many students have not used a computer before; but rather than teach them how to use a computer, mathematical activities are designed which will allow them to learn how the computer works at the same time as doing the maths. Whenever possible free open source software is used and all the resources that the students are exposed to are given to them at the end of the week on a DVD.

3.6 Development of New Educational Material

Each camp week is preceded by a preparation week where local and international organisers and volunteers get together to prepare the maths camp. This model has proven to be very successful given the challenge of organising such an event with facilitators being engaged in other full-time work both locally and abroad. The preparation week does not only serve as a training for local and international volunteers and as important team building in preparation for the camp week, allowing to share expertise, to learn new mathematics and to explore new teaching methods, it is also a valuable opportunity to create new educational material. This is where new ideas and concepts are developed and tested with local and international partners working together on a tight deadline. Since 2011 a large number of resources have been created, both within and outside the preparation week, that are now more widely available. A secondary aim of the preparation week, in the last few years, has been to develop and improve the Maths Camp Starter Pack, a collection of mathematics resources that can be used by students, teachers, academics and interested individuals to run a similar event independently, be it for a half-day or a full week.

3.7 Immersive Environment

Students are immersed in mathematics throughout the whole week. The structure of the camp is designed to make time for physical activities and card games. Links between card games and mathematics are highlighted and physical activities are chosen carefully to involve team work, critical thinking and logic. It is a core belief of the camps that mathematics can be learnt through games. Students work in pairs and groups throughout the week to encourage mathematical discussion. There are puzzles of the day which students work on during their free time, and the computer labs are open outside formal sessions so that students are given the opportunity to explore the programmes they have been introduced to independently.

3.8 Community

Students enjoy the opportunity to meet peers from other schools and to interact with local and international students, teachers, lecturers and researchers. Breakfasts, lunches and dinners are all taken together; these and other activities outside of lessons create a good working relationship between all camp participants. They help create an environment that breaks through the traditional hierarchies in educational institutions and gives mental space for critical thinking, allowing to challenge each other and learn from each other across all academic levels and backgrounds. A key value of the camps is that there are no barriers between students and facilitators, there are interactions between everyone and everyone has a voice.

This sense of community builds with a few students returning year after year, in some cases even becoming volunteers after they leave school. Students are keen to share what they have learned on their return home, and almost universally state an enjoyment of mathematics when leaving the camp. This is a small but important step towards creating a community of individuals enthusiastic about mathematical ideas, and eager to embrace mathematical concepts in their future endeavours.

4 CASE STUDIES

The Maths camps are first and foremost developed for the students who participate. To illustrate how the camps can affect students we gave the opportunity to a couple of former participants to say what the Maths camp means to them.

4.1 Cabrine

Cabrine is one of the few students who attended all the camps throughout her school years. She completed her studies last year and obtained a mean grade A- in her final exams. She attributes her success to the camps which have helped her to gradually improve in maths performance from a B-score during her early years to an A student in her final year. She got a straight A in Maths for her final exam, and this had a ripple effect on her performance in other subjects like Chemistry and Physics, which she started understanding much better. With time she moved from a top ten student in her class to within the top four. Her mean grade moved from B to A-. Below is a summary of the story in her own words.

“My journey to success started in 2011 when I attended my first maths camp. Since then I have had a different story to tell about my performance in Maths and generally all subjects. The camp gave me a wider perspective in Maths and helped me discard the negative stereo-type that revolves around Maths. The several sessions and activities done helped me to acquire a positive attitude towards the subject and with time I became a Maths guru at school. My school also became a beneficiary following the installation of maths packages into the school computers.”

“In Kenya Secondary Certificate Examination (KCSE), I attained grade A in Maths and I am glad this will give me a wide range of careers to choose from. Due to this exemplary performance, I have gotten a letter of invitation from various schools to give maths talks just to encourage the students to have a passion for the subject and not give up. Lastly, I would like to give a lot of gratitude to the AMI team for creating a new dawn in my life that brings forth a bright future.”

4.2 Evans

Evans attended his first Maths camp as a final year student. He then was very insistent that he wanted to come again. It was pointed out that as he was no longer a student he could only attend as a volunteer and would have to prove he can make a positive contribution, which he proceeded to do by helping out on various initiatives in any way he could. Since going to university he has continued to stay involved not just in the maths camp but also setting up a maths club in Technical University, Nairobi, and helping out on other projects during his holidays. He attributes his current engagement largely to his first experience at the maths camp as he explains in his own words.

“Mathematics extends beyond classroom understanding of multiplication, addition, subtraction and even division. I got a better understanding of this when I first attended the 2012 Maseno Math camp. I used to consider Mathematics as a boring and irrelevant subject, with nothing interesting apart from being a teacher.”

“If classroom math was that boring what about a math camp? I really had low expectations on that first day of the camp. I knew it was going to be the usual cramming of formulas accompanied by examples from nowhere. But by the end of that day, I could see how most things involve math. The method of teaching was that nice and easy to understand. From the mathematical games, computer sessions, mathematical thinking, statistics sessions and inspirational talks from the organizers, it was a fully packaged math camp. The simple and real examples used in explaining the concepts made me see how math was that simple and real.”

“The integration of computer sessions within the camp was really a nice idea. I was able to interact with Geogebra, Gapminder and even Scratch. The active participation of everyone made the camp lively and friendly for learning new things. I could now understand the interesting part of mathematics and was even able to try simplifying math problems that seemed complicated.”

“The short video by Hans Rosling demonstrated using Gapminder became the turning point of everything; I got more interested in statistics. But I am really happy that I attended the camp three months before taking my final high school exam. This is because it led to improvement in my math grades and even grades of other subjects. Now, am proud to say that am taking Applied Statistics in my undergraduate studies.”

5 STEPS TOWARDS GOING TO SCALE

5.1 Building institutions

An unexpected outcome of the maths camp initiative has been the creation of institutions by the maths camp volunteers to support the scaling out of the initiatives. In Kenya, a group of Maseno University lecturers and a teacher who was a postgraduate student at Maseno teamed up to create an NGO called 'African Maths Initiative' (AMI) [19]. In the UK a number of the international volunteers wanted to find a way to contribute more to the project and set up the charity 'Supporting African Mathematics Initiatives' (SAMI) [20]. Although still both very young the Kenyan NGO and the UK charity are working closely together to find ways to help the success of the maths camp translate into an initiative of wider impact.

5.2 Maths Camps in other countries

The Maseno Maths Camp has been replicated in three separate countries since its inception in 2011. Since attending the Maseno Maths Camp in 2012, an Ethiopian lecturer has run a maths camp at Bahir Dar University in 2013 and every year since. The camp was copied in Ghana in 2014 after a Ghanaian post graduate student attended the camp in 2013 and decided to run a camp back at his university, University of Cape Coast. In October 2014, the Maseno Maths Camp had its first developed world offshoot with a very successful camp hosted at King's College School (Wimbledon, London), one of the UK's top secondary schools. This is an excellent example how a model developed for a low resource environment in a developing country can be applied and benefit students in high resource environments in a developed nation. The camps have been an instant success in all three new countries, and they will all be hosting maths camps again in 2015.

The success of camps in other countries is very useful and important to gain evidence that the model developed in Kenya works in new and very different environments. Resources are shared between the camps and the key values are upheld at all. However, running maths camps in more countries is not providing the scale up to the numbers of students who are in need of this sort of intervention; it is still a small scale project wherever it is run.

While the maths camp is a very good model for learning and developing resources and demonstrating that students can learn from interactions with computers and from each other, the organisers believe that their Maths Clubs initiative in tandem with the maths camps will better address this issue of scale.

5.3 Maths Clubs

The Maths Clubs initiative was founded in Kenya and has been implemented over the last year. At the end of the maths camp, alongside all the software used, students are given a year's worth of resources for a weekly maths club. All students who attend the maths camp are encouraged to set up or improve maths clubs in the schools on their return, using these resources. Organisers of the camp undertake follow up visits to students in their schools and support the students until they are able to run the clubs in an effective way.

This initiative is not limited to students who have attended one of the camps; many schools have been visited and benefitted from "mini maths camps", half or full day sessions that replicate the Maseno Maths camp, and then received resources and training to start maths clubs.

This initiative is building a large community of maths educators, maths enthusiasts and mathematicians, and is an opportunity to empower students to take responsibility for their own learning process inside and outside of school. It is however still in its infancy, when compared to the established maths camps which have been running for five years, and different ideas and implementations are being experimented with. It is hoped that it will develop into a sustainable, established programme which helps students not just across Kenya but more globally.

The Maths Clubs initiative is already being tested in Tanzania and Ghana and the resources are currently being translated to put to use in schools in Costa Rica. It shows early signs of being a highly scalable low cost model that can be used in different environments.

6 CONCLUSION

Students in Ethiopia found that the “Maths camp was awesome. We learned things we kind of knew but never quite got it” and “Maths is very easy, very fun, not only calculations, it’s not only apply by paper and pen. I learned hard topic I can learn maths by hand, sound, sport and so on...”. As in Kenya, there is clear desire for change in the school education system, “There is one thing about the maths camp the system that they use is really amazing. I wish if they could consult the education minister so that each and every Ethiopian learn like that. The more we are learned like that the more successful we are.”

Ghanaian students were very grateful that the camp had been organised by the African Institute of Mathematical Sciences (AIMS Ghana) on the University of Cape Coast campus “I really appreciate about everything that we’ve been doing because in Ghana, when the teachers are teaching they didn’t do any practical before or after the lesson, but here we do practical, so it make me understand more. Also in Ghana we don’t normally go to the computer lab, but here we always go to the computer lab which has helped me a lot” and felt it was going to help them succeed “Since the first day I step my foot on this campus for the maths camp. I have really gain a lot and I think when I get back to my school, there is going to be a change in my learning and also my way of life”.

Students in London enjoyed the fact that “the learning was all ‘interlinked’ here in a way it isn’t in school”, and that “there were lots of different topics e.g. Game theory, which I had not studied or thought of as maths before”. Games were also a highlight for UK students, “I thought it was very different because of the links to programming and the way the days started with fun games. Also, I enjoyed the way we had many different teachers so we had many different views”.

The overwhelmingly positive nature of the comments made by students and volunteers at replica camps, and the similarity of their comments with those from the Maseno Maths Camp, demonstrates how the core values and aims of the Maseno Maths Camp have translated across countries. The London camp is an excellent demonstration of how an initiative started in Africa can have a global impact. Excitingly, in Ethiopia, Bahir Dar University finances the camp hosted on their campus, the Ghanaian camp almost managed to break even in its first year and the London camp was actually a fundraiser for the work in Africa. This shows that the Maths camps across multiple countries are likely to be sustainable and expandable.

The big challenge remains to convert our experience into an initiative which could have scalable impact. The maths clubs are a first step in this direction. If something like them ‘goes viral’ it is possible that a positive perception of mathematics becomes the norm, not an exception. This could facilitate scaling through curriculum and institutional developments that would be needed to have a transformational effect on Kenyan Mathematics Education.

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