Bringing a Maths Camp to Ghana

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Abstract

Last year in Cape Coast, Ghana, a maths camp was held, bringing together both international and local, university students, lecturers and teachers to engage secondary school students in the subject through puzzles, games, technology and extra-curricular mathematics. The goal was to spark a lifelong love for mathematics in students, open their eyes to new ideas in the subject, and increase the chance that they will pursue mathematics and science in the future. The idea for a maths camp began with a group of AIMS (African Institute for Mathematical Sciences) postgraduate students who wanted to share their experiences and inspire school students in mathematics. This led to one of them visiting Kenya to participate in the Maseno Maths Camp, and from this a maths camp was brought to Ghana. This paper presents the core values behind the success of the Maseno Maths Camp and how the model has been adapted to the Ghanaian context. A report on the first maths camp in Ghana is
given, as well as ideas on how schools and teachers could adopt these ideas through maths clubs. Finally it will be mentioned how the maths camps have also spread to Ethiopia, and the UK, illustrating the potential for innovation in such low resource environments to have global impact.

**Keywords:** Maths, technology, games, Ghana

**INTRODUCTION**

“I learnt a lot especially the fact that ‘mathematics is not about only calculations’ but sometimes much more interesting than that”¹. This is a quote from a student who attended a maths camp at the University of Cape Coast in Ghana. At the maths camp, students learnt mathematics through games, “The most fun part of the day is when I was able to find the secret of the 21 game, now I am undefeatable”, using the latest mathematical software, “I seriously love the software for solving maths”, and solving puzzles, “the puzzle has open my mind in terms of thinking ahead”, the importance of which in teaching mathematics is widely recognised (Ernest, 1986) (Bragg, 2003). Emphasis was on problem solving, logic and critical thinking, “I have learnt to be practical, thinking and analyzing questions”, “I must confess I’m now using my brains (thinking hard)”. The maths camp aims to change the negative attitude students hold towards mathematics, and many students leave the camp viewing the subject differently, “The maths camp have helped me to have a different mindset about maths”, while others gained confidence, “I have learned to persevere no matter how difficult the situation”, “I knew nothing before but now I know when persevere you conquer”. The maths camp is inclusive and promotes the idea that anyone can do mathematics.

Students experience mathematics in a new way and it is clear that they enjoyed the teaching and learning methods, “once again I will talk about how you people teach in the class...you try to put us in practice so it can stick in our mind”. This exposure has given confidence to students in other subject areas, “before I get back to my school, I change my attitude towards learning, not only maths but rather all the subjects”, as well as impacts outside the classroom, “it is really going to help us in school, outside, and even in future”. For many students, the use of technology was a clear highlight, “I have never handle a computer before but...I had the honour to handle it and I was so glad. I can now play games on the computer, learn on it and get more information from it”.

The experience of organising the maths camp run in 2014 in Ghana shows that students become much more positively inclined to mathematics after the camp and agree that the camp changed their understanding of their own mathematical subjectivity.

This paper discusses how the Maseno Maths Camp inspired the first Ghana Maths Camp to take place. The core values of the maths camp are explained and justified by organisers’ experience and previous literature. A report, including feedback on the Ghana Maths Camp

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¹ All quotes in the introduction are from students who attended the Ghana Maths camp in 2014.
is presented, before discussing similarities and differences between the camps currently run in Kenya and Ghana, and presenting plans for future related initiatives.

Learning from the Maseno Maths Camp

The Maseno Maths Camp was founded in 2011 as a way to inspire Kenyan students in mathematics, as a response to a strong negative attitude towards the subject across Kenya. The camp has been held at Maseno University every year since, catering for numbers between 30 and 120 students. It was started by lecturers and postgraduate students at Maseno University, who were supported by international volunteer teachers and mathematicians. This led to the formation of two organisations: African Maths Initiative (AMI) (African Maths Initiative, 2012), a Kenyan NGO organising the camp, and Supporting African Maths Initiatives (SAMI) (Supporting African Maths Initiatives, 2014), a UK charity formed by the international volunteers of the Maseno Maths Camp who wanted to support and expand such initiatives in Africa.

In this section we discuss how and why the idea of running a Math Camp in Ghana germinated, as well as how the link between the Maseno and the Ghana Maths Camps came about. We also discuss the core values of the maths camp, which were adapted from the Maseno Maths Camp, and explain the reasons for their adoption to the Ghanaian context.

The student group with a desire to create positive perception

The idea of a maths camp in Ghana began with a group of postgraduate students at the African Institute for Mathematical Science (AIMS) from the 2012-2013 class in Ghana (AIMS Ghana, 2012). AIMS is a non-governmental organization which seeks to promote mathematical science education in Africa through the creation of pan-African centres of excellence in education and research. It recruits talented graduate students from all over Africa to prepare them for careers in the Mathematical Sciences.

During their time studying at the AIMS centre in Ghana, a group of students formed to discuss what they could do to change the perception that younger students have of mathematics and the wide spread idea of a difficult or non-existent future as a mathematical scientist. They were inspired by what they experienced at AIMS: an innovative and relevant curriculum within a unique 24-hour learning environment that promoted critical thinking and problem solving as core values. AIMS sparked an interest in these students to contribute to Ghanaian education and development by making them think about the many challenges in Africa and how they can be Africa’s problem solvers. This led the group to want to share these positive experiences with school students.

As in Kenya, public perception of mathematics in Ghana is mostly negative. As stated by a popular Ghanaian news site (GhanaWeb, 2003): "There is a national aversion to mathematics. Math phobia has permeated all rungs of the education ladder. Mathematics learning has been a problem even when Ghana had the best educational achievements in Africa. It is a problem that parents, teachers and education authorities are continually grappling with, because mathematics forms the basis of science and technology from which industrial development can take off".
This quote illustrates that having a strong national mathematics culture and background in all hierarchies of education is a prerequisite to building and developing an industrious nation. Ghana has seen multiple efforts by both governmental and non-governmental organizations to improve mathematics and mathematical science education (Ministry of Environment Science Technology & Innovation Ghana, 2015) and (Anamah-Mensah, 2004) for example. Despite the various efforts, the quality of education across the country still remains very low (Hanushek & Woessmann, 2010).

Actually the existence of a negative attitude towards mathematics is well documented in a number of studies (Osborne, Simon, & Collins, 2003) much more globally. Previous work shows that students’ vision of mathematics is relevant in shaping both their emotional disposition and perceived competence in mathematics (Di Martino & Zan, 2010) and is therefore most likely to affect not only their achievements (Barkatsas, Kasimatis, & Gialamas, 2009) but also their subsequent decisions in education and for their future careers.

However, a study of students’ narratives by Di Martino and Zan (2010) show how the relationship with mathematics is rarely told as stable, even by older students, suggesting that it is never too late to change students’ attitude towards mathematics. Palmer (2009) provides evidence that alternative ways of teaching mathematics influence and affect early childhood education, students’ attitudes towards maths and how they understand their own subjectivities as more or less mathematical.

The group of AIMS students wanted to do something about this negative attitude of students. They had some of the AIMS Ghana lecturers as patrons, one of whom established a link between AMI who run the Maseno Maths Camp (African Maths Initiative, 2013). Through this link, Dr. David Stern, a representative of AMI, visited the group in AIMS Ghana to arrange for collaboration in improving and promoting maths education in Ghana.

**Observing the Maseno Maths Camp**

Dr. Stern was very impressed with the group at AIMS Ghana and this led to one of their members, Francis Torgbor, visiting Maseno, Kenya to participate in the running of the 2013 Maseno Maths Camp. It was an intriguing experience for the Francis, who wrote: "I could not overlook the excitement expressed by the high school students at the camp. Students at the camp had quickly developed a love for mathematics and now had a great passion and enthusiasm towards it. I felt enlightened at the camp and was even challenged with some of the activities that took place. The joy, excitement and diligence demonstrated by the students in participating in activities at the camp made me look back at my days at senior high school and thought that my mathematical life and education life as well as that of other maths local educators could have been better if we had been exposed to the Maths Camp at this age. The teaching style, the focus on problem solving, critical and logical thinking and the use of latest software to learn mathematics, reminded me of my experiences at AIMS. I resolved that myself, my team members and other local maths educators could still gain from this experience and relay this education style to Ghanaian students". The idea of a Maths Camp in Ghana was born.

Upon returning to Ghana, Francis shared his experience with his team members who were enthusiastic about the prospect of setting up a Maths Camp in Ghana, although most of
them had travelled out of the country by that time to further their education and careers. This led to the formation of a new team in Ghana comprised of highly motivated senior high school maths teachers and the executives of the Mathematics Student Association of Ghana (MASAG) at the University of Cape Coast, who were equally excited and poised to turn the Ghana Maths Camp idea into a reality.

Core values of the Maths Camp

The Maseno Maths 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 (Fleming, et al., 2015).

Most of the core values for the Ghana Maths Camp were learnt from observing the Maseno Maths Camp and interacting with their organisers. Here we discuss how these core values were adapted for the Ghanaian context, and explain the reasons for their inclusion.

Sustainability

The Ghana Maths Camp followed a similar implementation to the Maseno Maths Camp, with an aim of being a locally sustainable initiative, with local and international educators volunteering their time freely and covering their own travel expenses (Fleming, et al., 2015). There was support from local institutions, AIMS Ghana, the University of Cape Coast and the Mathematics Students Association of Ghana (MASAG). The fees paid by students almost covered local expenses, with some students paying a reduced fee, and the remaining local costs were covered by SAMI.

Volunteers included 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, helping to make the camps sustainable (Fleming, et al., 2015).

Returning students will be encouraged and exceptional participants will be given the opportunity to become volunteers at future camps once they finish senior high school. This follows the model already implemented at the Maseno Maths Camp (Fleming, et al., 2015).

Extra-Curricular Mathematics

The camp was designed to open students’ eyes to the world of mathematics, show that mathematics is not all about calculations and introduce mathematics not found in a classroom, both through the choice of content and through the delivery of the subject material (Fleming, et al., 2015). The camp focused on a number of different “themes” in mathematics: views of mathematics, code breaking, statistics using Gapminder World, programming, and logic (these are further discussed in section 3). The focus, in line with the Maseno Maths Camp values, was on understanding concepts, developing critical thinking, creativity and being logical and persistent in problem solving situations, which is very different from the students’ experience in school which emphasises calculations and formulas. This focus enabled the camp to be inclusive (see below) since previous
achievement in mathematics were not prerequisites for a student to succeed at the camp. In line with the Maseno Maths Camp, the organisers also tried making high level mathematics accessible to high school students (Fleming, et al., 2015).

Inclusive

All senior high school students (aged 15 to 18) were welcome to attend the camp. There were no entry requirements and the camp aimed to have a mix of students with different socio-economic backgrounds and different achievements in mathematics. There was a maximum number of students from any one individual school to ensure that a variety of schools could be represented (Fleming, et al., 2015).

These principles were followed to ensure that during the sessions students would not be separated by these differences. Basing on the experience of the Maseno Maths Camp, the wide diversity in ages, backgrounds, schools and mathematical ability of students who attend the camps has never been a limiting factor (Fleming, et al., 2015), on the contrary the students learn the spirit of cooperation through teamwork.

Everyone Learns

The camp was set up to allow learning opportunities for everyone, not just for the students attending. Local university student volunteers learnt ideas applicable to their university maths clubs and got valuable new input to their studies. They got to meet and work alongside local and international lecturers, teachers and PhD students and integrate themselves into a wider professional network. Teachers who accompanied their students could meet during a few separate sessions to discuss what they have observed and learnt from the sessions, how they could take this back to their classrooms and how they could receive support from the organisers in doing so. In general, teachers attended the sessions together with the students and learnt alongside them. Local and international teachers had 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 teachers saw a different style of teaching in action. Volunteers learnt new branches of mathematics from being involved in a dynamic group with different specialisms. Mathematics researchers gained hands-on teaching experience alongside experienced teachers and received feedback on their input. This is a similar value shared at the Maseno Maths Camp which has been attracting enthusiastic and skilled volunteers consistently over the years because of this (Fleming, et al., 2015).

Technology

Technology played a key role in the camp, and software were used to give students the opportunity to explore mathematics and programming in an interactive environment (Fleming, et al., 2015). Some students had not used a computer before, but they learnt how to use the technology at the same time as they are doing mathematics. This is in line with results from previous work done in similar resource-poor environments (Kim, et al., 2012). As in the camps run in Maseno, free open source software was used and all the resources that the students were exposed to were given to them at the end of the week on a DVD.
Development of New Educational Material

Following the Maseno Maths Camp model, the camp week in Ghana was preceded by a preparation week where local and international organisers and volunteers got together to prepare the maths camp. The preparation week served as a training for local and international volunteers and as important team building in preparation for the camp week, allowing sharing expertise, to learn new mathematics and to explore new teaching methods. Little new educational material was developed, as compared to what has been produced at Maseno Maths Camps (Fleming, et al., 2015). Rather, time was spent adapting resources that had been outputs of the Maseno Maths Camp, for the Ghanaian context.

However, development of new educational material is a value that the organisers strongly believe in, and it is hoped that the next camp will have a stronger focus on local and international partners working together to create new educational material, developing and testing new ideas and concepts.

Immersive Environment

During the camp, students were 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, and allowing them to visualise mathematical concepts through interactions. It is a core belief of the camp’s organisers 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 independently explore the programmes they have been introduced to.

Community

There was a conscious effort of creating a sense of community at the camp. 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 challenging each other and learning 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 (Fleming, et al., 2015).

It is hoped that this sense of community will build further at the next camp as a few returning students are expected to attend. Some may even become volunteers after they leave school, as has happened at the Maseno Maths Camps. Students expressed interest in sharing what they had learnt when they return home, and almost universally stated an enjoyment of mathematics when leaving the camp. This is a small but important step towards creating a community of individuals that are enthusiastic about mathematical ideas, and eager to embrace mathematical concepts in their future endeavours.
THE PREPARATION OF THE CAMP
This section describes the process that was followed to organise the first Ghana Maths Camp, which involved building institutional support, recruiting volunteers and students, identifying a suitable venue, and last but not least planning the content of the camp.

The involvement and role of institutions
Getting institutions on board with the Maths Camp, particularly local ones, was always a priority, as this would help make the Maths Camp sustainable for the future. Many local and international organisations provided support in various forms for the Ghana Maths Camp.

AIMS Ghana was an obvious choice for an institution to approach due to its existing involvement in mathematical science in Ghana and the connection that many of the local organisers had with the organisation. Representatives of AIMS Ghana formed part of the local organising team, and allowed the time of one of its tutors to help facilitate at the camp while some alumni became volunteers for the camp. AIMS Ghana also provided its facilities to volunteers during the preparation week of the camp.

Through AIMS Ghana’s existing link with the University of Cape Coast, a partnership with one of its societies, the Mathematics Student Association of Ghana (MASAG) was established. MASAG was mainly in charge of the sensitization and publicity of the Ghana Maths Camp in the Senior High Schools within the Cape Coast vicinity. Some of their members also came to the camp as volunteers.

The involvement of AMI had been ongoing since a representative first visited the student group that initiated the process at AIMS Ghana. AMI provided guidance and knowledge from the previous experience in running the Maseno Maths Camp for several years. Representatives from AMI were also involved in the camp as international volunteers.

Due to its connection with the Maseno Maths Camp, SAMI’s involvement naturally followed through AMI and its role was to recruit international volunteers. SAMI also provided funds to cater for the portion of local costs of the camp that were not fully covered through student fees.

Each institution provided something different to the camp and the hope is that these continuing partnerships will help make the camp sustainable going forward.

Volunteers and Student Recruitments
Recruitment of volunteers occurred naturally through links with the institutions mentioned above. The international volunteers, recruited by AMI and SAMI were important in ensuring that the ideas intended came across during the camp week.

Local volunteers helped to recruit students through their existing connections. A website (African Maths Initiative, 2014) was also set up, hosted by AMI, which contained information about the camp and allowed students, volunteers and organisations to apply online to participate in the camp.

The camp was targeted at senior high school students (aged 15 to 18), those in their final years before university. This group was chosen to closely match the target group of the
Maseno Maths Camp, which also recruits pre-university students. Students were required to pay a fee of 80 GHC ($25) to participate, which would cover their costs during the camp week. Students could apply for full or partial funding if they could not afford the full fee, and the selection of the beneficiary students was done on a case by case basis.

The choice of the venue
At the Maseno Maths Camp, students are exposed to a university environment in the hope that, thanks to this experience, they begin to view university as an exciting and realistic option for their future. It was felt that Ghanaian students could also benefit in a similar way and so a university campus was a desirable location.

In addition, a university campus offers the benefits of student hostels that can host students and volunteers, a canteen able to provide meals for everyone participating in the camp and easily accessible computer labs. Through discussions with the University of Cape Coast, it was suggested that since some university students will still be occupying student hostels at the time of the camp, the University Practice Senior High School (UPSS) would be an appropriate location on campus to host the camp. With the help of MASAG, an agreement with the school was made and a fee was paid to the school for use of the hostel.

The themes
During the preparation week the following five themes were selected:

- Views of mathematics
- Code breaking
- Statistics using Gapminder World
- Programming
- Logic

A theme consisted of five to seven sessions which had some common concepts and ideas. There was a progression through each theme, where sessions often built on ideas of previous sessions and increased in difficulty during the week, with the final sessions intended to be the most challenging for the students.

The themes were chosen to align with the core values of the camp, as described in Section 2. A desire to expose students to extra-curricular mathematics and for them to experience maths in a new way, were important factors, and so every theme included material that students would not expect to come across in school. Technology was used where possible. Views of mathematics contained sessions involving GeoGebra (International GeoGebra Institute, 2015) to explore concepts in geometry, MSW Logo (Wikipedia, 2015) and Scratch (MIT Media Lab) were used in programming, and the statistics theme was built around Gapminder World software (Gapminder) for exploring world data. Facilitator’s expertise and passions also influenced the choices. Some of the facilitators had experience at the Maseno Maths Camp and so some themes, such as programming and code breaking, were chosen because of their proven success in previous camps. Details of each theme follow below.

During the camp week, each day followed a similar structure, with five morning and four afternoon sessions, a morning and evening assembly, a session for physical activity, and an
evening session of card games. Three of the themes involved computer sessions and out of the 42 sessions across the six days, 18 were held in the computer lab.

**Views of mathematics**

The main idea in this theme was that an idea, problem or concept in mathematics, can often be viewed in multiple ways, and different representations can have different advantages depending on what is being studied. For example, the first session in this theme looked at '15 game', a two player game where players take turns to select a number from 1 to 9, represented by playing cards (Ace to 9 of the same suits) which are displayed in a line. Players keep their selected cards in their hand and the first player to have exactly three cards that sum to 15 is the winner. When the cards are displayed in a line, the game is slow and players must calculate based on their cards and their opponents to select their next card. However, when the cards are displayed in 3 rows as follows: 2 7 6 / 9 5 1 / 4 3 8, every row, column and diagonals sums to 15, and the game effectively becomes Tic-Tac-Toe, a much 'easier' game to play.

Following this were several sessions using GeoGebra, where students explored concepts such as reflections, the Golden Ratio and fractals. There were two sessions that looked at symmetries in very different ways: one looking at lines of symmetries of regular polygons, and another exploring symmetry through groups, by comparing sets of symmetries to modular arithmetic addition tables that were discussed in the code breaking theme.

Another session, which introduced Pascal’s Triangle, led into a session on combinatorics and counting problems. Finally, there was a session on Big Numbers and Infinity, and links were made here to a previous session on fractals.

**Code Breaking**

The first session of this theme introduced the students to modular arithmetic. The students were then introduced to the idea of coding messages and simple Caeser shifts were explained and demonstrated. Other methods of coding were looked at, involving multiplication and students saw the importance of the coding rule being a bijection to allow for unique decoding. Frequency analysis of letters in English was also discussed and it was shown how this can help to crack codes. In the final sessions, students were split into groups and were asked to create their own rule for coding a message, using anything they had learnt in the previous sessions. They were then given a message, coded using another group’s coding rule and there was a competition to be the first group to crack the message.

**Programming**

The first session of the programming theme introduced the students to the ideas of syntax, commands and rules, without the use of computers through the ‘robot game’. The students were shown four commands: ‘move forward one step’, ‘turn right 90°’, ‘pick up object’ and ‘drop object’, along with the symbols representing them. They were told that they had to instruct a robot (a fellow student) to perform a certain task (moving an object from one place to another) by giving the robot the correct sequence of symbols. They were told that the robot could only perform the four commands above and could only perform them if shown a sequence of symbols that represent the commands. In a tiled area outside, students were shown the starting position of the robot, the object to be picked up and the area the robot needed to drop the object. In groups, the students had to decide on the sequence of
commands that would enable the robot to complete the task, before giving the robot a sequence of symbols. Progressively complex tasks were given during the session.

This session was followed by a session on MSW Logo. Students were shown some of the commands in MSW Logo, and the similarity of these and the commands of the robot game were highlighted. Students were then asked to construct shapes such as a square, equilateral triangle, regular pentagon and five point star, which required them to use knowledge of angles and lengths in combination with the MSW Logo commands. This was followed by a series of session using Scratch. The idea that different software used different syntax for similar commands was discussed. First, students created a simple animation. This led into looking at ‘Snake’, a popular mobile phone game. Firstly, the game was demonstrated using students in a large area outside. The students were then shown a version of Snake made in Scratch. They explored the code used to create the game and were asked to identify which parts of the code corresponded to particular rules of the game. The remaining sessions were spent guiding the students to create their own two player version of Pong in Scratch. They were first asked to write down the rules of the game, what happens (actions), and the consequences. Subsequently, this was used to translate the rules of the game into Scratch code. Students were then encouraged to be creative and add their own rules or extra features to the game.

Statistics using Gapminder

Gapminder World is a software used to display interactive and animated graphs that shows indicators of development for every country in the world. This theme intended to show students how to interpret data from graphs and the importance of computers in analysing big data and displaying it clearly and visually. Students watched a video by Hans Rosling (Rosling, 2010) showing the history of 200 countries over 200 years. They then used the Gapminder World software to answer questions such as "Which country has the highest life expectancy today: Ghana or Togo?". There were discussions about how to interpret time series graphs, how to identify trends and how the graphs could be used to tell the story of a country. Students were then exposed to more open questions, such as "Which country is better to go to for the purpose of studying: USA or UK?", and they were then given the opportunity to create their own open questions, investigate graphs to answer their question and present their findings to the class.

Logic

In this theme, students could explore how logical thinking is applicable to many areas of life including mathematics, games and law. Activities in this theme included the game of Mastermind, the Monty Hall Problem, Pascal’s triangle and combinatorics, as well as sessions on the Constitution of Ghana and card tricks.

In the second session of the theme, on the Constitution of Ghana, students were divided into four groups and were asked to consider whether a law passed by Parliament mandating that "at least 50% of the incoming students at medical schools in Ghana must be women" would violate the Constitution. They were given relevant parts of the Constitution to consider when making their arguments and were told that their arguments needed to be backed up by relevant sections of the Constitution. Each group presented their case to the rest of the class with some discussion between groups. From this session, students gained an
understanding of the importance of rules and interpreting them and forming logical arguments.

Being systematic and strategic was discussed in relation to Mastermind and how this can be used to improve performance. In sessions on the Monty Hall problem and card tricks students were encouraged to think logically to understand things that may seem counterintuitive at first glance. The sessions on Pascal's triangle and combinatorics showed students how to make connections between different ideas and how to look at problems in different ways to make them more easily solvable.

Games and puzzles
A strong theme outside the five sessions was puzzles and mathematical games, especially card games. Students were taught about the importance of following rules and applying strategy to improve performance. The idea was to reinforce the notion of rules, which make games playable and mathematics do-able. It was felt strongly by the organisers that the idea of needing rules, which must be understood and then used as a baseline to follow strategy, as opposed to blindly applying formulae, would help students apply what they learnt at the maths camp to their current studies (Fleming, et al., 2015). The order in which card games were introduced was carefully chosen to build from simple games, which helped students learn the basics of cards games and their properties, to more complex ones which were rich in making students think deeply about strategy.

Daily puzzles were also presented in the mornings and students were encouraged to work on them in their free time. Puzzles were chosen so that generally the problem was easy and quick to understand, sometimes with little mathematical content, but requiring creativity, logic or mathematics to solve. The puzzles showed students the importance of conjecturing and testing ideas and not being afraid of making mistakes, but learning from them and improving. Solutions to puzzles were not presented until the following day, and students were encouraged to persevere with difficult problems, trying different approaches or simpler cases if they could not solve it, instead of giving up. This was intended to contrast typical school maths exercises where usually it is immediately obvious which technique or formula to apply which means it can be solved mechanically, very quickly. In school, if it cannot be solved by usual means, students often give up and wait for the answer from the teacher.

FEEDBACK AND MOVING FORWARD
A total of 32 students attended the camp, 23 girls and 9 boys, from 19 different schools and five regions of Ghana. Three secondary school teachers, accompanying their students, also attended the camp. They participated in the activities with the students and also attended some informal discussion sessions organised for teachers.

Feedback on the camp
Each evening students wrote a reflective journal which was collected the following morning. There was no structure that students had to follow, although they were encouraged to write about their experience of that day. Students also completed three surveys, one on arrival, one midweek and one at the end of the camp.
After the camp, analysis of both the journals and surveys were carried out. The feedback from the students was extremely positive. It also revealed that, for many students, their experience of the camp matched the organisers’ aims of the camp, as discussed in previous sections.

It was clear that students experienced mathematics in a new way, “Now I have realized that mathematics is not all about calculations but thinking”, “On the first day I learned that maths is not difficult and is not about using formulas but about different ways to solve it.”, “it is more interesting to practice maths because it makes me think and that is good”.2

Many students felt they gained skills that facilitators emphasised during the sessions, “now I have seen the tricks in mathematics and how to think carefully before answering questions”, “I have learnt to be practical, thinking and analyzing questions before doing any calculations”, “I have learned that I shouldn’t give up when I am solving a question and am not getting an answer. I have to continue trying”, “This camp has helped to improve my way of thinking”.

The teaching style was clearly different for students and they responded positively to it, “I really love the mode of teaching and I learned a lot”, “The teaching mode is very cool and I get the understanding better because the way of teaching is interesting and attractive ways to teach us, which would want us to know more and that’s not really how they will teach at school”. In response to the survey question: “What do you like most about the Maths camp?”, nine students made comments relating to the teaching style. Responses included: “How they use the practical aspect to explain the theory”, “The way the teachers teach”.

Many students commented on how they felt during the camp, “(The math camp) is full of fun and excitement”, “It is so much pleasure for me to be present”, “I have learned to think fast and tackle some difficult questions. I loved it very much”, “It was fantastic that we could use a pyramid or triangle to build a multiplication and addition table...I am really loving the Scratch part in the sessions”, and their attitude towards mathematics, “I have seen that maths is not difficult”, “I’ll advise someone who doesn’t like math to come to the maths camp because people hate maths mostly because of the calculations and here I have learned that maths is not all about calculations. So I am happy”, matching facilitators’ aims of making mathematics appear fun, enjoyable and do-able.

The arrival surveys indicated that most of the students had used a computer before, yet the experience of learning maths through a computer based environment was commented on by many students, “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. So now I know how to use a computer to do research”, “I can now operate computer by using it to find useful information about other countries”. For a few this was the very first time they used a computer, yet this didn’t prevent them from engaging with the computer activities, “I have never handle a computer before but through (the maths camp) I had the honour to handle it and I was so glad. I can now play games on the computer, learn on it and get more information from it. I have learned a lot within one day”.

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2 Quotes in this section were taken from student journal entries and survey responses.
Although the camp did not focus on improving performance in school maths, many students clearly felt they would benefit on returning to school, “(the Maths Camp) is a kind of program that I think it will help us in the school and also outside the school. And I loved it very very much”, “I really learnt a lot and I plan to use everything I learned here at school”, “before I get back to school, I change my attitude towards learning, not only maths, but all the subjects.”, “I think it’s going to help me in school, in class and even in future as well”.

Benjamin, a volunteer at the camp and undergraduate mathematics student at University of Cape Coast confirmed these findings when he described his observation of a student he had informed about the camp:

I was happy observing him during the camp. When a task was given to him, I was expecting that he would struggle, but many times you find him leading even those that are older. Afterwards, his mother called me and told me that the child’s performance had changed. Before, she complained that he doesn’t sit at home, but afterwards, because of the software given to him, and what he had learnt, he tries to practice those things at home and his performance is good. When he got an admission to the secondary school, she was happy to call me and say that the program we had run was very, very helpful to the child, so she was proud of what has happened.

Because of this I suggest that we should also encourage those that have just finished JHS (Junior High School) to be part of this camp. After going through the program before migrating to the secondary school, for some of them I think it will change the programs that they chose to study in the SHS (Senior High School) and the fear of mathematics will be eliminated.

Of the other students, I think they had the same experiences. At the end of the program, when we individually asked students about the camp, they said the camp has been very successful; they have never had any teaching practice like that because what takes place in their classroom is quite different to what is happening here.

Benjamin also discussed the impact the camp had on him personally, which demonstrates one of the core values of the camp ‘everyone learns’:

I for instance have also gained some experienced. I was impressed with some software that I have never been in contact with and some ways of analysing some mathematics problems that I have never approached before. So being a volunteer, I would say I have learnt even more than some of the students, throughout the preparation week and during the camp itself. I encourage more university students to get involved, especially those pursuing mathematics and education students, because it’s something that will really help them in their teaching in the classroom and also help them personally in their reasoning.

After the camp I was able to use Scratch to write some games and GeoGebra to practice some of the geometry and Gapminder is something I’ve been playing and I have been able to show the software to my friends, some not even in the field of mathematics. If we can have a program for the university students as well it will also be very helpful.
The maths camp going forward

Due to its initial success, a second Maths Camp has been scheduled to take place in August 2015. The role played by AIMS Ghana and its involvement have increased. In 2015, not only the preparation week, but also the camp week will take place at AIMS, and it will provide accommodation for the students and volunteers. The number of students and volunteers at the 2015 camp are expected to increase. 40 students are expected, some who attended the first camp, but most will be participating for the first time. A larger group of local volunteers are involved in helping recruiting students, compared to the previous year where the capacity was not reached. There is expected to be 20 volunteers, 7 international and 13 local, including: school teachers, students, AIMS alumni, PhD candidates and mathematics educators. It is believed that the continued support of local institutions will ensure that the Ghana Maths Camp becomes a long term, sustainable initiative.

Looking forward, the aim is to create a community of maths educators, maths enthusiasts and mathematicians by supporting students and teachers on different levels, extending the maths camp ideas into schools. At the first camp, students and local facilitators were given a DVD containing all the software used at the camp, and a year’s worth of resources that could be used for a weekly maths club. Students were encouraged to set up or improve maths clubs in their schools, using these resources. This approach presents an opportunity to empower students to take responsibility for their own learning process inside and outside school and has emerged in Kenya as an effective model. With the expected involvement of more local volunteers, it is hoped that support will be available for students, teachers and schools after the camp who want to set up maths clubs to help them integrate the ideas from the maths camp into schools.

In Kenya, the Maths Club initiative has been implemented over the last year. Implementation and resources of the initiative are still being tested in Kenya, as well as Tanzania and Ethiopia and the resources are currently being translated for use in schools in Costa Rica. However, this shows early signs of being a highly scalable low cost model that can be used in different environments (Fleming, et al., 2015). It is hoped that feedback from the experience of trialling the Maths Club initiative in Ghana will contribute to the improvement and development of the initiative, not just in Ghana but across Africa and more globally.

CONCLUSIONS

There are many similarities between the Maseno Maths Camp and Ghana Maths Camp. The emphasis on extra-curricular content, and the ideas that the organisers hoped to put across to students were very similar, as were the teaching methods and the strong emphasis on using technology. The Ghana Maths Camp even adapted materials that had been produced at the Maseno Maths Camp. The immersive environment is present across camps as is the sense of community.

However, there are some differences in how the core values of the maths camps have been implemented. The Maseno Maths Camp had a strong sense of ownership from Maseno University from the start, with many of its lecturers and students being involved as facilitators. The Ghana Maths Camp differed in that respect where an organisation, AIMS
Ghana, and not a university, have taken more ownership of the camp. The Ghana Maths Camp has however, had undergraduate students from a university society, MASAG, involved as volunteers at the first camp, whereas this took longer in Maseno.

The preparation weeks also differed, in Maseno there is a stronger emphasis on developing new educational material, whereas in Ghana, the focus was more on training volunteers to understand the ideas and materials to be used at the camp.

This paper has demonstrated how a successful initiative (the Maseno Maths Camp) was adapted to work in a different country and environment, through observation, discussion and collaboration. Moreover, the feedback given during and after the Ghana Maths Camp (see Section 4) shows that the camp was a success in terms of providing a different experience of mathematics to students and changing students’ attitude towards the subject as well as involving local volunteers and allowing everyone to learn from the experience.

The next step is now to build from this experience and investigate how to spread the ideas from the maths camp to more students, teachers and schools.
REFERENCES


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