



## Setting the Scene

The Covid-19 pandemic has focussed attention on online education. This stimulating virtual session of BRIDGE’s Maths and Science CoP, attended by over 60 participants, engaged with aspects of online learning and teaching from two different but complementary perspectives.

UCT medical and neuroscience student Ilyaas Amien described the philosophy, development and work of Tunic, a free online tuition service providing maths support to high school learners.

Nonhlanhla Masina, of the African School for Excellence (ASE), shared lessons learnt by ASE in implementing remote teaching and learning of maths and science during the Covid-19 lockdown, including using the home as an environment for learning.



## Overview of Presentation 1

### *Providing free, quality online mathematics tuition and support to high school learners – Ilyaas Amien*



Ilyaas Amien

Founded by Ilyaas Amien in 2016 and developed and run by student volunteers, Tunic provides free, quality maths support to high school learners – and teachers as well.

After starting out as a simple question/answer service on WhatsApp, Tunic grew progressively as more effective and sustainable ways were developed to meet learner needs. In 2017 it began producing videos on demand to answer specific questions submitted by learners, and in 2018 began producing concept videos, which lay down an essential foundation for each topic in the maths syllabus.

Tunic’s approach to maths support emphasises the need for learners to build up a solid grounding of conceptual understanding, to develop the ability to interpret and think through maths problems, and to receive individualised guidance and feedback when they need it. To express these principles, Tunic has created a maths learning algorithm<sup>1</sup> that takes learners on an academic journey.

#### *Stage 1 establishes and builds understanding of concepts:*

Learners use a combination of concept videos and interactive mindmaps that organise the concepts. Tunic has created 250 concept videos covering every topic in the maths syllabus from Grade 8 – 12, and mindmaps covering every section. This way of organising the content allows learners to see the big picture as well as the underlying structure. It enables Grade 12s to see the Grade 12 work but also the journey they should have taken in the

<sup>1</sup> An algorithm can be broadly defined as: a step-by-step procedure for solving a problem or accomplishing some end (Merriam-Webster dictionary).

earlier grades to reach that point. For example, when starting trigonometry, learners can see what concepts they missed and need to go back to (using the concept videos) to equip themselves to do trigonometry. Students are urged not to attempt past papers until the concepts are well-grounded.

### **Stage 2 checks understanding of the concepts:**

The aim is to identify and close the gaps in learners' knowledge. For this, Tutonic has created various concept quizzes. When learners respond incorrectly, they receive an explanation and a link to the concept video that teaches the concept they got wrong.

"A big problem in our society is that children grow up thinking that there are people who are good at maths and others who aren't – that you're either a maths person, or you are not a maths person. We don't give maths the appreciation it deserves. Also, the enjoyment of maths is very much linked to its understanding: the more people understand maths, the more they enjoy it."

### **Stage 3 is the application of concepts:**

Tutonic has developed a bank of questions for learners to work through. Each question has a video solution which shows how to break down the question, how to interpret it, and the thinking process to reach the solution – in other words, how to apply the concept (a fundamental aspect of maths learning).

"The beautiful thing about the question bank questions is that they were all previously asked by learners – so learners are actually learning from each other."

### **Stage 4 is where learners interact with tutors and ask their own questions:**

A group of volunteers (mainly UCT students) supports learners who call in in various ways. Their focus is on emphasising the thinking process and facilitating learner engagement – with the maths as well as with the tutor. Ilyaas notes that 'every student learns differently, so the opportunity to talk things through is all-important'. At the same time, questions tend to be repeated – and because Tutonic has created videos relating to most of the questions asked, the responses and explanations can be recycled. This approach makes it possible for a small group of 23 tutors to share the workload of providing meaningful tuition support to over 700 learners, while prioritising and working around their own studies ('... kind of like Uber').

Tutonic's system caters for a large learner to tutor ratio, because learners engage with the first 3 stages at any time, and at their own pace. Only the 4th stage depends on human interaction, by which time most of the questions that learners would have asked a tutor have already been answered – because they have 'been on a journey of gradual accumulation of maths facts and concepts'.

"We need to encourage a culture of learning how to learn. If we teach young people how to learn, they will be able to apply these tools and skills throughout their lives, whatever they do after school."

Ilyaas noted that the role of Tutonic's tutors is not to teach maths, but rather to guide and refine the personalised, individualised learning being undertaken by the learner – with the ultimate goal of helping them to become lifelong learners.

## **How has Covid-19 affected Tutonic?**

Tutonic has seen a massive influx of new users during this time. Teaching online is their primary philosophy, so that has not changed, and the infrastructure to deal with the current circumstances was already in place.

A major challenge is that many new joiners resist following Tutonic's learning algorithm because that is not how they have been taught. Many matriculants take the approach of working through large numbers of past papers – but do not have a strong grasp of concepts. They believe that practising questions and memorising memos will

help them through the exam, and approach Tutonic simply to get the answers. Tutors then have to work hard to get these learners to see the value of developing an approach to questions that is ‘grounded on solid conceptual understanding’ – and that if they follow Tutonic’s learning algorithm they will find that ‘most of their questions naturally start to be answered through their own efforts’.

“In the medical field, we believe in not just treating the symptoms, but in tackling the underlying factors that cause and perpetuate the symptoms. What Tutonic does is not just about helping learners with maths, but also about the structural challenges that are contributing to learners even seeking tuition in the first place.

Looking at the big picture, how can we change the structural conditions of our classrooms?”

## What does Tutonic offer teachers?

Tutonic welcomes teachers engaging with and using their resources.

- Teachers can download and use the free concept videos either to refresh their own understanding, or with their learners. Tutonic recommends that learners should ideally watch the videos before coming to class, to form a foundation for the lesson (a flipped classroom approach). This would contribute to maximising classroom efficiency, as teachers would then be able to build on this foundation and concentrate on closing the remaining gaps in their learners’ understanding.
- The concept videos are especially beneficial when learners view them at their own pace, as many times as needed, pausing and repeating sections to make sure of their understanding. However, creative ways can be found to incorporate them effectively into the classroom.
  - As an example, an enterprising individual in the Eastern Cape has sought to overcome device and connectivity challenges by downloading all the concept videos and taking them around to schools, where he uses a TV set to show the videos and facilitates follow-up discussions with learners.
- A collaborative platform where teachers around the country can discuss matters of common interest or seek assistance from each other.
- Tutonic also works directly with teachers, for e.g. with matric teachers in the Eastern Cape.

“We want to encourage student to explore maths, not just ‘do it’. Our platform does not teach maths in the traditional way, and there will always be some resistance if you offer something new. But once they see the benefits, they are motivated to pursue the new methodology.”

## Way forward

Up to now, Tutonic has concentrated on development and proving its effectiveness. Building its resources on questions asked by learners has proved a good way to assess and target the greatest needs. The platform is also dynamic in that resources can easily be added or adjusted, to take new questions (needs) into account.

Tutonic is currently working on, or considering the following for the future:

- Becoming zero-rated
- Including primary level maths
- Diversifying language, specifically to include African languages, and by broadening the range of voices and regional accents in their videos to ensure they are widely accessible.

### Contacting Tutonic:

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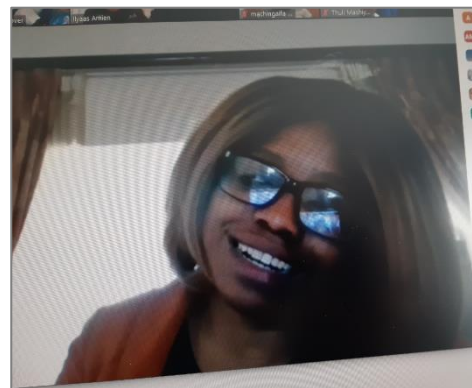
## Overview of Presentation 2

### ***Opportunities that Covid-19 has revealed for maths and science teaching and learning in a low-income community – Nonhlahla Masina***

Nonhlahla is the co-founder of the African School for Excellence (ASE), which is situated in Tsakane in Ehurhuleni East. Her own academic background is in biochemistry, molecular biology and pharmaceuticals, but teaching is her first and greatest interest.

#### **School context**

ASE is a high school that offers the Cambridge International AS curriculum. The learners and many of the teaching staff are drawn from the local community. Class numbers are small (averaging 20 per class). ASE is an NPO and operates on a tight budget. Fees range from R350 to R850 per month – this is possible because the school's rotation model (see below) requires fewer highly skilled teachers, and fee income is supplemented by fundraising.



Nonhlanhla Masina

#### **Preparing for remote teaching and learning in a low-income community**

From the beginning of lockdown, ACE effectively ran a full school on WhatsApp. In adapting to remote teaching and learning, certain factors proved beneficial, while others were challenging.

##### ***Use of rotation model and problem-based learning (beneficial)***

ASE's rotation model and problem-based learning methodology enabled it to be adaptable and responsive during the Covid-19 lockdown. Learners already had some experience of working independently and of applying investigative, problem-solving methods.

In the rotation model, every class is divided into three parts. The first component is a peer learning, practical problem-solving session (related to real life experience) to explore and develop the concept(s). This is followed by a technology-based session to check for understanding in which learners work independently, e.g. on a quiz or exercises using Khan Academy (the offline version is used to allow self-checking). The third component comprises class instruction and discussion dealing with more complex aspects of the topic. Parts 1 and 2 are overseen by learning assistants, while part 3 is facilitated by a qualified teacher.

##### ***Access to devices and data (challenging)***

ASE uses WhatsApp for all interactions between teachers and learners. The school provided data (10 gigs per learner) and ensured that teachers and learners had access to devices to use at home. Most parents already had some sort of device (e.g. smart phones) – but many did not know how to use them optimally. In the days before lockdown, learners brought these devices to school, so that the school could update the systems, install the necessary apps and train learners to use the devices. Where needed, ASE loaned devices to parents (those that are normally used in school for the independent work component).

The school also found that 'a lot can be done' with the kind of devices that learners have access to ('even a simple Mobicel or Huawei device can provide access through WhatsApp and have Google Classroom installed').

Data consumption was reduced as ASE makes use of Khan Academy which was zero-rated on Telkom during the period, and parents were all required to obtain Telkom sim cards. This facilitated planning and allowed the school to use a variety of individual and group activities (quizzes, exercises, videos, etc). ASE worked through parents/guardians to control the use of the sim cards, with the result that data issued to learners lasted for the entire lockdown period.

### ***Access to a productive space in which to work (challenging)***

This was a significant barrier for many learners and creative thinking was required to ensure that learners would be able to learn at home.

### ***Involvement of parents/ guardians (beneficial)***

A considerable percentage of ASE's learners are orphaned, or their parents work elsewhere, and are being looked after by their grandmothers. Parents and guardians are included in the WhatsApp communications. Their role is to 'generally keep tabs on how the children are working'. Many go further, for e.g. watching the explanatory videos sent to learners and collaborating with them on solving the problems, or even taking learners through individualised feedback that their teacher provides via video call.

## **Implementing teaching and learning in the home environment**

Adapting the ASE's model for remote learning included:

***An emphasis on practical learning*** – this was aimed at giving learners a physical experience of the concept.

In the examples shared (of a senior class using a graph to explore linear and exponential relationships), learners used simple resources found in the home and followed instructions to carry out investigations and collect, analyse, and review data. They used their phones to video (or take pictures of) their work and uploaded this to Google Classroom. Teachers would then give individualised feedback (e.g. by adding comments to pictures) – and if learners needed to review concepts, teachers would form them into small groups and address these needs via WhatsApp video calling – and then assign work on Khan Academy to strengthen concepts as needed.

The purpose of the practical learning sessions was to 'get learners into the right frame of mind' for the class discussion and questions (i.e. the 'lesson'), which was conducted via WhatsApp.

***Having an output for each session***, e.g. setting learners a task, or having them respond to questions posed on WhatsApp. These outputs were marked, to increase accountability. The daily register was also based on whether learners produce the work assigned for the session.

***Maintaining a sense of community*** – this included engaging learners on non-academic issues, such as the safety of their environments in relation to Covid-19, discussing topics raised during presidential addresses, or dealing with specific challenges faced by learners. To encourage engagement in larger groups, teachers would pose questions and learners would send in video responses or voice notes. Smaller groups could be more interactive.

"We just have to be creative around how we maintain a form of community while continuing to teach remotely – because learning is social and emotional in nature, learners need to connect with each other and to their teachers."

Nonhlanhla noted that younger learners needed simpler and more exciting things to do at home, so with them the focus would be on quicker wins.

## Challenges experienced

There was a period at the start of lockdown when only a handful of learners would check in to the remote learning. To get all the learners working, teachers made sure to have an output per session, and parents/guardians were added to the WhatsApp groups (and were contacted if learners were not present or did not submit assigned tasks).

## What does remote teaching and learning mean for teachers?

**Planning and preparation** – Having learners do practical maths and science work in their homes requires careful and thorough planning and preparation. All activities must be highly scripted. ASE typically starts with a topic from a past paper and modifies the task to use materials that learners will be able to find in their homes.

**Giving feedback and grading work** – Doing this remotely (e.g. adding comments to pictures) takes much longer. Teachers found this difficult to manage initially but did adjust, with ‘some really taking to it’. It helps that teachers use Google Classroom to track work and mark schedules are populated automatically.

**Using technology** – Teachers experienced some challenges adapting to the technology but found strength in collaboration, e.g. by sharing folders and helping each other create and improve resources. Nonhlanhla noted that while teachers had previously received training on Kahn Academy, Google Classroom and Google Forms, and had been encouraged to use them, they had never fully done so – but with Covid-19 and remote teaching making these platforms essential, teachers’ confidence and proficiency in using them had quickly increased.

## Key lessons learned

ASE’s biggest learning has been that it is not only possible for learners in disadvantaged communities to work effectively in their home environments, using simple materials found in the home, but that there are actual benefits to doing so (provided learners receive the necessary support).

**Working at home is beneficial for learners who typically struggle when required to solve problems in a lab setting.** Such learners felt safer making mistakes, could take as much time as they needed, and showed greater accountability and confidence when working at home, at times with the help and encouragement of family.

**Learners working at home engage more fully with concepts.** Guided by the prepared scripts, learners were able to investigate and experiment without the time and resource pressures they would have had to contend with in the school lab. Learners also did more independent work (than they would have done at school) and were able to get a better sense of their own performance.

“Learners who have worked in this way are less likely to be caught out in an exam as they will have seen and engaged physically with the concepts.”

**Working at home creates possibilities for integrating maths and science in the same lesson.** Instead of always teaching the subjects separately, teachers can design tasks that combine maths and physics (or maths and chemistry) so that when learners do their conceptual investigations, they learn about both at the same time. Nonhlanhla notes that not teaching maths in isolation has important benefits for learning, because ‘the mathematical component is always about showing the relationships that we see in nature’.

Combining maths and science in the same lesson also means getting more value for the time spent. Preparing for, and having learners do conceptual investigations at home does take longer – but ASE has found ‘the outcomes offered to be a lot better than anticipated’.

Crucially, remote learning has emphasised *the importance of giving learners individualised feedback*, and of *making sure that tasks and activities are pitched at the right level*. Learners must be able to see the purpose and benefits of work assigned to them. Work must also ‘be scaled so that it fits the learners where they are’ – i.e. so that it presents a cognitive challenge while at the same time putting learners ‘in their zone of development’.

### Taking Covid-19 learning forward when schools reopen

With the lifting of restrictions, ASE intends to take forward the elements of remote learning that have proved beneficial. The most important of these is the extension into the home learning environment. Doing this will also help to make up lost time. Other elements include:

- Continuing with a version of the customised approach to lab work by having learners first trial activities at home (as homework and recording it on their phones). This is expected to increase engagement and reduce some of the fears that learners have, particularly with physics.
- Continuing to incorporate Khan Academy and Google Classroom, and to keep the integration between them. Although ASE learners previously had access to Khan Academy, this work was self-pacing. Since the start of lockdown teachers have set up platforms and individualised the exercises – and are seeing the benefits of this.
- Continuing to emphasise individualised feedback – currently ASE is trialling have Grade 12s bring their devices to school and using WhatsApp to give feedback, as was done during lockdown).

“We are all learning, and there are opportunities out there – anything is available, if you put your mind to it.”

The school’s closer engagement with parents/guardians during this time also has increased the community’s awareness of ‘what the school is about’. For a non-traditional school this kind of understanding is important, and ASE plans to continue reaching out, for e.g. by sharing learners’ work on social media.

“Interestingly, being in a township community, when we first said we wanted to do classes remotely, there was resistance from parents. People did not think it would work out. And now, with the lifting of restrictions, some parents want us to continue with remote learning.”

@CoP

## Group Discussions

This section highlights aspects of the discussions, arranged by theme.

### *Language and contextualising*

- Open educational resources are readily available but differ widely in quality and contextual relevance. As teachers we should be making our own videos where we link concepts to what our learners know in their own contexts, and make sure of quality.
- Language is well-recognised as a barrier for learning. With much of the generic material posted online, the unfamiliar accents and different terminology will confuse learners. It would be better to use online platforms for ideas and content, but to develop our own material which speaks to the environment of the children we are teaching. This should be done by involving the teachers of these learners.
- Although the language of maths is the same all over, the language of maths instruction has to suit the context – so we need to modify generic materials so that they link to our learners’ real life situations, based on their own learning space. For e.g. it serves no purpose to try to explain quadratic equations in terms of suspension bridges, when they do not exist in your area.

### ***Technology and the teacher's role***

- When it comes to digitally transforming educational resources, human behaviour and interaction is more important than the technology. It is not enough to simply put offline resources online, but more about creating pathways for learners to follow. This raises questions about the role of the teacher, especially in an online setting.

#### **This example of 'remote learning in action' shared by Nonhlanhla Masina of ASE helps to illuminate the discussion on context and the teacher's role:**

At one time during lockdown, the community of Tsakane was in the news for producing and selling fermented pineapple beer – and at the same time the topic of activation energy (exothermic vs endothermic reaction) needed to be taught. Instead of devising scripted lessons, the school sent learners out into the community to research and analyse the traditional process for making pineapple beer – documenting the steps (such as adding sugar and covering with a blanket) and trying to understand the purpose of each step. The teacher then led a discussion, asking questions to clarify understanding, and followed up with brief concept notes.

“In terms of the importance of context for learning, the role of the teacher remotely can be to help learners become more aware of their own contexts.”

### ***Managing department and union expectations:***

As a school implementing a non-traditional programme, ASE has found that it is important to be proactive, to document everything and to show how what they are doing relates to what the Department expects to see. It is also important to be proactive towards the Unions, inviting representatives into the school from the outset, so they can see what is happening, and keeping them updated on any changes.

### ***A brief look at conditions in the UK:***

Thuli Masiyane, who joined the discussion from the UK, shared her observations on current conditions in that country. Although on a different scale, many issues are similar to those teachers face in South Africa.

- UK schools are currently working in a dual space of remote learning and two days of class learning per week. Attendance is rotated with only a quarter of students present at a time. This makes it difficult to build up momentum and to follow up on learning.
- Some aspects such as access to devices and data are less challenging, but it is a struggle to get children to attend remote sessions, or to involve parents. The atmosphere in schools is unsettled, with many changes taking place. Teachers are burned out, as on any given day they are not sure what they will need to do and are constantly inventing and testing as they go.
- Teacher groups are an important source of support, with collaboration and networking proving especially helpful. Teachers gather (online) for regular check-in sessions to let off steam, share practical tools, and give each other feedback on what they have tried and what works.
- Open source materials are a good source of ideas, but teachers are finding it far more effective to create their own self-made videos. Children find it comforting to see their own teachers explaining concepts.
- With the school year starting in September, teachers are under enormous pressure to get learners ready to leave primary and secondary school. The UK has cancelled exams in the GCSE – the final year of school for those who do not go on to do A levels – and intends to use other methods of assessment.





## Facilitator's Summing Up

CoP facilitator Peter Glover drew attention to these ideas emerging from the presentations and discussions:

- The value of one-to-one or individualised interactions, even though as teachers we are usually in situations of one-to-many – and now might not even be in spatial contact with one another.
- The increasing attention being given to hybrid models. “Clearly this is something whose time has come, and the teacher’s role is moving towards becoming a creator of hybrid education experiences.”



## Attendees

Name	Organisation	Name	Organisation
Akani Mkansi	BRIDGE	Margie Vorwerk	BRIDGE
Andrew Hofmeyr	Ukuqonda Institute	Michael Mhlolo	CUT
Barbara Valentine	ITEC	Nathalie Roelf	
Benter Okelo	BRIDGE	Nkhensani Baloyi	BRIDGE
Bern Fourie	Hlanganani Primary School	Nonhlanhla Masina	African School for Excellence
Boy-Boy Ndhlovu	Uplands Outreach	Nonhlanhla Tshabalala	Standard Bank Tutuwa Community Foundation
Bridget-Ann Mullins	Go for Gold	NS Baas	Free State Education
Bronia Vollebregt	Lasec Education	Ntombenkosi Lutotswana-Mangqishi	PMET
Chris Ramdas	MIET AFRICA	Onthatile Mataboge	
Christine Boxall	ADET	Oupa Segano	Mncube High School
Claire Flanagan	Private	Patrick Tshikane	PROTEC
Edzai Zvobwo		Peter Glover	Facilitator
Elizabeth Henning	UJ	Phumi Nhlapo	Amy Foundation
Ezethu Mfono	Nova Pioneer Midrand	Princess Chigiya	Hlanganani Primary School
Fazeela Hoosen	Benita Williams Evaluation Consultants	Razia Ghanchi-Badasie	Brenthurst Primary School
Gabriel Mphuthi	UNISA	Rebecca Wakeford	Midlands Community College
Given Mashabane	Penreach	Rosann Naidoo	IIE Varsity College
Grant Titus	Inclusive Education South Africa	Shelton Chadya	OLICO
Hassiena Marriott	GTI	Simangaliso Twala	COUNT Educational Institute
Ilyaas Amien	Tutonic	Susan Jobson	
Inba Jungbahadur	Cape Academy for Mathematics, Science & Technology	Themba Moyo	AIMSSEC
Jade Pieterse	BRIDGE	Thuli Mashiyane	Private
Jane Mabaso	Imperial and Motus Community Trust	Ummi Kulsum Shaik	Nova Pioneer Midrand
Jenny Dry	IBL	Violah Moya	Uplands Outreach
Kauthar Conrad	BRIDGE	Wellington Mupukuta	Sparrow FET Enterprises
Machingaifa Kazayi	Royal Bafokeng Institute	Zingiswa Jojo	UNISA