Highlights of Maths and Science Community of Practice Meeting

Speculations on impending curriculum changes in Maths and Science

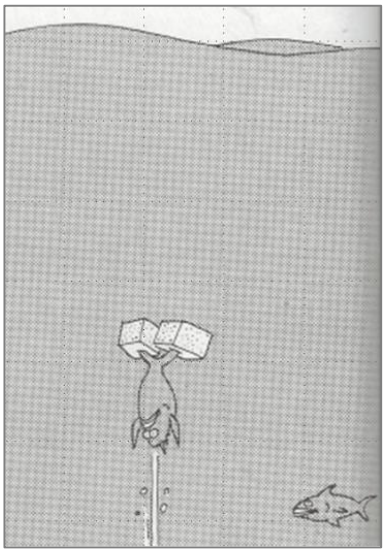
30 October 2018

Setting the Scene

The fourth and last Maths and Science Community of Practice meeting of 2018 opened with a look at the use of humour in Mathematics and Science education. This was followed by a wide-ranging conversation on the changes that might be expected in Mathematics and Science curricula at primary and secondary levels. Participants were asked to speculate, based on how curricula have changed in the past and the issues that have been raised with respect to the current curricula, what the response might be. The discussions were led by Ingrid Sapire of the University of the Witwatersrand, and CoP facilitator and science educator Peter Glover.

Overview of Presentations

The role of humour in the teaching of mathematics and science



Peter Glover's visual essay on humour took a light-hearted look at some of the ways humour can be used to give information educational significance. It illustrated the value of doing something slightly absurd to introduce concepts, in ways that focusses attention very directly on what is important about those concepts – rather than starting with the theoretical aspect.

Participants shared some ideas for using humour in the classroom, especially for 'getting through' to teenagers (such as using the example of a romantic relationship to illustrate the concept of 'mutually exclusive'). It is important, though, to bear in mind that humour is subjective: we laugh at those things we know about and that speak to us.

Here we see an example of **using the absurd to introduce the concept of density** (does one need to know about the Mafia's 'concrete boot' method.

Click here to view the presentation

Speculations on impending curriculum changes in Maths and Science

Ingrid Sapire has been extensively involved in maths teacher education in various capacities including lecturing, research and the development of materials. This has included leading the team that developed support materials and training for the Foundation Phase in the GPLMS, and the team that implemented the Foundation Phase mathematics strategy for PILO in KwaZulu-Natal and the Northern Cape.

Ingrid headed the team tasked by the DBE with developing a framework for the teaching and learning of mathematics in South Africa.

Ingrid is currently working on a PhD focussing on the language policy for mathematics in the Foundation Phase.

The mathematics curriculum – some thoughts to stimulate discussion

Although the CAPS curriculum compares favourably with mathematics curricula used in other African countries and internationally, it is generally viewed as 'too wide, not deep enough and very cluttered'. This reflects the shift from an outcomes-driven to a more content-driven curriculum, as well as the spiral design that sees the same topic 'coming around' several times during a school year, with a little more of the topic being covered each time. In the lower grades, especially, these small pieces tend not to accumulate and are easily forgotten by the learners. Teachers become frustrated by having to redo previous work each time the topic 'comes around', and feel that it would be more effective to take sufficient time to deal thoroughly with the topic. *Sequencing* is therefore an important element in need of attention.

Progression has also been identified for attention. In some cases, the same words are used in relation to topics within and across phases, so there appears to be a lack of progression and the requirements are open to interpretation.

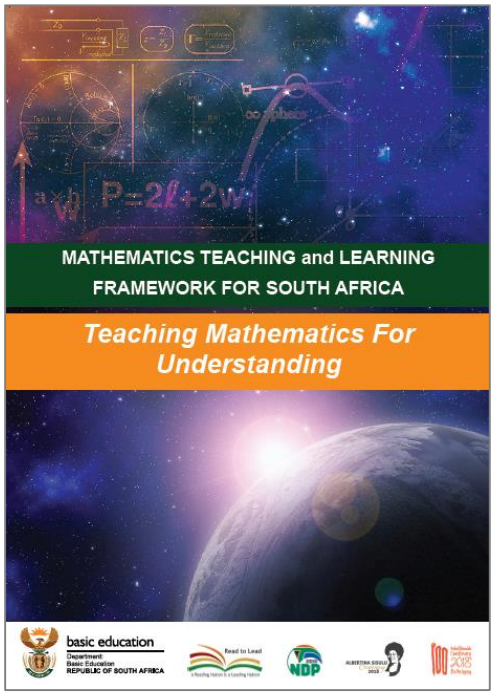
Ingrid also highlighted the role of *assessment* as a major driver of the curriculum, and flagged the need for the maths community, while working with the process, to consider changes in assessment. In this respect, Ingrid's view is that because assessment exerts so much influence, it is important for issues of assessment to be informed by teachers and decided as a community.

> "As a mathematics teacher and teacher educator, I wish we could reach a point where the curriculum is not driven by assessment – and I do believe that the maths community is strong enough to achieve this."
>
> **Ingrid Sapire**

The DBE has undertaken a review of the curriculum, starting with assessment. The Foundation Phase appears to have been handled well. As one moves upwards through the grades, however, the work is limited to guidelines on what to test and how to allocate marks. Teachers of the Senior and FET Phases are particularly advised to view the documents on the DBE website and to submit their comments.

The DBE has extended the period for comment until early December.
Everyone with an interest in mathematics education is urged to comment on the curriculum review.

Mathematics Teaching and Learning Framework: Teaching Mathematics for Understanding



After the Mathematics Education Indaba in 2016 the DBE set up a task team to develop a framework for the teaching and learning of mathematics in South Africa.

The framework is intended to help teachers implement the current curriculum in ways that support teaching and learning for understanding. It does this by providing a model and exemplars to guide teachers in transforming the way they teach.

The framework speaks for teaching maths meaningfully, to build understanding. It has the following four dimensions:

- conceptual understanding
- procedural fluency
- strategic competence, and
- mathematical reasoning

… with teaching taking place in *learning-centred* (not learner-centred) classrooms.

Click here to view the Framework

During the course of its work the Framework task team reviewed the curriculum, which led to questioning of certain aspects and recognition of certain shortfalls and concerns (such as overloading). A curriculum committee, which has still to be appointed, will take this work – essentially a refining of the CAPS curriculum – further. This committee is still to be constituted, and will be fully representative.

The Science curriculum – some factors influencing curriculum change

Peter Glover has had extensive experience in the world of science education. This has included teaching, lecturing, curriculum development and research, directing and managing development programmes, and the writing of science, technology and mathematics materials.

Peter's particular interest has been in the training and professional development of science teachers. In this area, his focus has been on supporting teachers to use innovative learner-directed, activity-based approaches aimed at developing scientific literacy, even in poorly resourced classrooms.

Peter Glover traced the various developments that have taken place in the Science curriculum since the 1970s, and linked these to some of the factors that influence curriculum change. In doing so, Peter made the point that the significance of curriculum change often lies not so much in the content changes that are made, as in the process by which the changes come about.

Some of these influences are:

People hold dear the things that made them successful – and want this to be passed on to succeeding generations. This is one reason why curricula are slow to change and may retain elements that are no longer used in the 'real world' (cf. vacuum tubes vs silicon chips)

Using assessment as the driver – teachers want to know the kinds of questions that will be set, and to feel comfortable with that. One reason for the demise of OBE was that assessment based on outcomes rather than content was too complex.

The university influence – topics may be retained in the senior phase curriculum (e.g. geology, which is linked to mining, and astronomy) but not included in the FET Phase. This factor may also lead to an over-emphasis on what universities require, at the expense of what is 'actually needed out there'.

Issues of control – a major element of the curriculum is about controlling what teachers teach, with an emphasis on compliance. This is closely linked to the issue of trust in teachers (or the lack of trust).

Inter-personal processes – although curriculum committees are set up to be broadly representative, it is inevitable that that some personalities and views will dominate during the course of development.

Peter's hope is that the curriculum review committees will look at why we are teaching science, and then design a curriculum and classroom offering that will help us to achieve that purpose. What comes up in any curriculum is a reflection of complex influences, and there are always competing forces to be balanced – but if there is awareness of the sorts of things that can happen in the process, there will be a greater likelihood of successfully resisting negative effects.

The example of geometry – why and how did geometry leave the mathematics curriculum and why and how did it later return?

The example of geometry is useful for understanding the type of thing that can happen during curriculum revisions. With good intentions, influence was exerted to exclude geometry to allow for a period of redress during which schools that had not previously taught geometry to 'catch up'. What happened was that some schools then simply dropped geometry altogether. When geometry was later brought back into the curriculum, this created significant trauma in the system.

At the time it was excluded, geometry was out of favour internationally and South Africa was one of only a few countries in the world teaching Euclidian geometry. Then, during the period South Africa side-shifted it, there was increasing international recognition of the value of geometry (for e.g., in developing reasoning and spatial appreciation) and it was brought back into curricula around the world. It is likely that this also drove South Africa's reinstatement of geometry.

An interesting point is that geometry is not included in university maths courses, so anyone teaching geometry will have acquired the competence by other means.

Discussions

> "The purpose of meaningful education is to prepare children for the future, which is getting closer every day. This means that curriculum review is inevitable: as the world and workplaces change, so must the curriculum."
>
> **CoP participant**

The purpose and process of curriculum review

Several questions and comments related to the need for, and purpose of, reviewing the maths and science curricula:

- Is the intention to improve learner performance and pass rates in maths and science?
- Is it based on a concern that teachers are not able to implement the existing curriculum appropriately?
- Is the concern just with improving the existing structure (sequencing, progression, overloading)?
- Is it aimed at supporting developments in the country, e.g. in terms of the SKA / astronomy?
- Is it because the curriculum is not really addressing current needs and the problems our country is trying to solve?
- Is the review confined to maths and science, or is the DBE also looking at the other strands?

Ingrid clarified that the aim was not to revise or replace the maths curriculum, but to refine it, incorporating inputs from the maths community in a coordinated way. Some other comments were:

- There appears to be a lack of strategy in the way reviews are done. Taking the example of astronomy: if we are thinking into the future for our country, astronomy is a key area needed in science – yet it is due to be removed from the IP & SP curricula because teachers are unable to teach it. Why not rather equip the teachers to teach astronomy, than cut it out?
- Curriculum reviews should be influenced by stakeholders who are closely involved in education, including the teachers themselves, rather than the 'men in suits'. Hopefully as we move into the future, this will happen.

Bridging the disconnect between high school and higher education and training

- Several speakers felt that students are at a disadvantage if school curricula do not expose them to concepts or topics that they will encounter at university.
    - Others suggested that meaningful learning at school level should be about the 'how', not the 'what', which would enable students to tackle concepts and topics not directly linked to what they studied while at school.
- Much of the maths that is taught in university maths courses is different from what is taught in school. What are the implications of this for teacher education and school level maths teaching?
- DBE matric maths does not prepare students for university level maths. To remedy this, the framework committee has suggested that an extra maths subject be introduced to bridge the gap between school and university maths level, for those who intend to take maths as a subject at university.

> "This would be a huge undertaking, but the framework committee has suggested it because there is a huge problem."
>
> **Ingrid Sapire**

Teacher Development

A CoP member who is involved in delivering teacher development programmes emphasised that the efforts being put into refining the curriculum would have no impact unless a special effort is made to engage teachers and develop their capacity to implement the curriculum. Many teachers resist development programmes, due to 'development fatigue' or a reluctance to acknowledge that they need help. In any case, the typical workshop approach to upskilling teachers is not effective. Our whole approach to teacher development has to be rethought, to come up with new strategies to address the many challenges.

We should also be wary of assuming that schools are following CAPS, i.e. that the curriculum provides direction for teaching and learning. It is clear that not all schools follow CAPS, even when provincial papers are due to be written. The issues are not only content-based, but also psychological. Willing teachers would 'go an extra mile at all costs', for e.g. by asking other teachers for help when they do not understand.

> "The results that we think represent the learners, really represent the teachers. This is because often the teachers themselves do not understand the concepts they are meant to teach."
>
> **CoP participant**

Ingrid noted that the DBE is a strong driver of teacher development in maths. The *Mathematics Teaching and Learning Framework* is expected to bring about more coordination in the training and development of maths teachers. It advocates moving away from the idea of 'learner-centred' classrooms – which has created certain misconceptions on the part of teachers and has taken away some of the agency and authority of teaching – towards 'learning centred' classrooms. Ingrid also pointed to the danger of allowing a lack of trust to undermine teachers, and instead advocated showing respect for the professionalism of teachers, and building them up.

Other comments on the theme of teacher development were:

- Subject Advisors lack the skills to assist maths teachers in terms of content, and instead concentrate on compliance.
- Can we really develop teachers to teach demanding subjects, which they are nominally supposed to teach but are not managing, with the stance the unions take regarding inspectors and subject advisors?
- In so many of the development programmes that teachers go on, there is no real engagement, no incentive to do better, no levels set, and nothing to say they have completed them successfully.

- There is a disconnect between how teachers are trained and what they have to teach. Some initiatives (such as that of the HRDC) are engaging universities on rethinking their approach. One suggestion is to base initial teacher education in science on the school curriculum.

Assessment as a curriculum driver

Some strong views were expressed on the influence of assessment, such as:

- The emphasis on assessment in the curriculum review relates to wanting to control what happens in our schools. The review is being driven by assessment rather than by what is best for teaching and learning and by what is best for us as a country and society.
- Assessment as a means of control has come more to the fore over the last 15 years. We have been trying to solve the problem of a lack of trust in our teachers by providing more assessments, while skating around the real problem of a lack of trust. We should instead face the issue of lack of trust head-on. How do we give our teachers confidence and properly equip them to handle their subject areas? This type of change does not happen through workshops.
- We need to look at what is happening around assessment and understand how assessment affects the problems and successes in education. We should beware of allowing assessment to be a major driver of curriculum.

Building understanding of concepts and the skills to work with those concepts

- The example of geometry demonstrates our challenge with the maths curriculum. The value of geometry does not lie in the content, but in building understanding of the concepts and developing the skills to work with those concepts. Geometry is important for teaching logic – and logic is the foundation of maths.
- Science is in a worse situation than maths, in terms of building understanding of concepts. The problems start early, with the primary school science curriculum not developing fundamental concepts. For example, the term 'magnet' does not feature in the FP curriculum document. Neither is there any mention of concepts such as water waves, or force and motion. In the IP, these concepts are presented as 'lumps of content', with learners being examined on their memory of that content.

- The disconnects in the science curriculum do not occur only between high school and university, but also between primary and high school. Instead of building concepts gradually by tracking the conceptual threads though layered, structured content that builds up from the FP, conceptual concepts are 'thrown at' learners in grades 8 - 9 – with the result that learners are overwhelmed by concepts that they have no foundation (or even vocabulary) for.

Critical thinking and problem solving

- CAPS does make provision for developing higher-order thinking skills, but these opportunities are generally not used. Teachers are focussed on 'getting through' the content and simply 'show' this type of problem to learners as there is not enough time to let them 'figure it out' for themselves.
- Geometry lends itself to developing critical thinking skills (because it is contained, and includes all the basic premises needed to solve problems). To what extent do we make this explicit in the teaching of geometry? Are we doing enough to present it as being a subject where we learn critical thinking?
- Do we take into account the variety of factors that influence the success of the curriculum? The natural science curriculum gives us the 'what' – but it is the responsibility of teachers to temper that 'what' by providing an appropriate 'how'. A Western Cape steering committee is currently looking at the 'how': this initiative is at an early stage, but it is expected to help teachers adopt methods that develop higher order thinking skills and support real learning.

A trend towards reducing complexity

Peter observed that there is a noticeable trend towards wanting simplicity (despite the complexity of the world). Much of what is taught at school is simplified: learners just want the answer and skate over the complexities of getting to that answer. In the world of technology, problem solving is left to small groups of elite problem-solvers, while the rest of us enjoy the simplicity of using the software (that someone else has programmed).

There are signs that curricula are playing into this trend of removing complexity (and delivering 'a plain, bland menu'). How then are we to develop learners as problem solvers, and how are they going to learn to deal with complexity? How will we be able to produce young people who are educable for a world that is changing rapidly? Peter's view on this issue is: "If we see curriculum developers tending toward reducing complexity, we should voice our concerns."

Astronomy – responding to national developments

There was much interest in whether astronomy should be included in basic education.

- With the country investing heavily in astronomy, there is a need for education to respond and develop the skills needed to support that investment. This calls for inter-departmental discussions between the DBE, DST and DHET.
- Astronomy is now so important in this country with SKA and SALT. We are on the world astronomy map, so you would expect a push to cover astronomy in the curriculum. But there are some things in science that you can only teach by telling the story of: you cannot actually do the science. With astronomy, would we reduce all the complicated science to a story? How would we then examine it? Would we ask learners to tell the story back?

- We need to be a lot more creative in the implementation. Many astronomy concepts can be covered in maths or in terms of science concepts that are already in the curriculum, such as momentum.
- Is the astronomical community likely to push for more astronomy in the curriculum – and if so, what?
- It is important for people involved in the world of astronomy to contribute to education (just as people in the maths world should contribute to maths education). NASA, for example, is very involved in education, where it uses astronomy to teach maths concepts.

Looking ahead

- Are we developing our current learners to move into 'Fourth Industrial revolution' occupations? Is there a need to augment the curriculum to address the needs that will be brought on by destructive future technologies – in particular, to build the skills and literacies that people will require?
- Our children are far ahead of us in technology and able to access information, so instead of being the source of learning, let us rather be facilitators of learning. We clearly need to find a different way of engaging teachers, so that they adopt this vision for the future and a positive role for themselves.
- The country needs a collaborative approach to addressing issues in education. Can those in education leadership pull the rest of us in from our different spheres, so that we can contribute tools, resources and processes that have been developed in our areas, to assist in education? There would need to be a single common platform and direction, so that we could all work towards achieving a common aim.

Facilitator's Summing Up

Many of the issues and problems discussed at this session are not unique to South Africa, but seem rather to reflect trends in society across the world, some of which seem to be anti-educational. Are we at risk of losing some elements that previously had value for education, such as the discipline of learning and a willingness to deal with complexity? If we have any influence on curriculum processes, we have to try to prevent this.

Attendees

Name	Organisation:	Name	Organisation
Annemie Smit	Edenvale High School	Ogidan Tunji	Prakis educational services
Cheryl Taylor	Edenvale High	Peter Glover	Facilitator
Christiaan Visser (phd)	Independent	Sam Rametse	Zenex Foundation
Craig Johnson	BRIDGE	Simangaliso Twala	COUNT Educational Institute
David Semela	PROTEC	Thando Moeng	BRIDGE
Duduzile Ngoepe	PROTEC	Thuli Mashiyane	help2read
Dumisani Dlamini	funda afrika	Tracey Butchart	Reflective Learning
Frank Longwitz	3P Learning	Vhahangwele Netsharotha	PROTEC
Ingrid Sapire	Wits University	Irene Miya	Izibuko Primary
Jivan Ranisha	Cambridge/ACESA	Sydney Hadebe	IBM
Joseph Thocha	Tomorrow Trust	Adiremi Obilana	Prakis Educational Services
Keitumetse Molosiwa	Prakis educational services	Megan Rademeyer	SchoolNet SA
Leonore Hermanus	GDE	David Semela	PROTEC
Margie Vorwerk	BRIDGE	Elma Obilana	Prakis Educational Services
Novosti Buta	Primary Science Programme (PSP)	Benter Okelo	BRIDGE