Highlights of Maths and Science Community of Practice Meeting

Role of Maths and Science Education in the Economy and Career Development

22 May 2018

Setting the Scene

The importance of maths and science education for the economy is an on-going theme. Many positions in the job market call for knowledge and expertise associated with maths- and science-oriented qualifications – and there is an urgent need to increase the number of students qualifying to enter these courses of study with a sufficiently strong foundation to cope successfully with their demands.

The CoP was pleased to welcome Dr Ahmed Bawa, who is a member of the Human Resource Development Council (HRDC) – a national advisory body concerned with enhancing human resource development to improve national economic growth and development. Dr Bawa described the HRDC's key processes and, in particular, its concerns and actions in respect of mathematics and science education.

The second half of the session featured a panel of successful individuals from ostensibly non-maths-and-science fields discussing their experience of school maths, how this impacted on their subsequent career pathways and working lives, and their views on what might be done differently.

Overview of Presentation

The role of the HRDC in mathematics and science education

Dr Ahmed Bawa

Dr Ahmed Bawa is the CEO of Universities South Africa (USAf). He is a theoretical physicist who has held various positions in the HE sector including Deputy Vice-Chancellor of the University of KwaZulu-Natal, and Vice-Chancellor and Principal of the Durban University of Technology.

Dr Bawa has an enduring interest and significant research output in physics, as well as a deep interest in the relationship between science and society.

To locate this aspect of the HRDC's work, Dr Bawa opened with a few significant examples that starkly illustrate some of the challenges in maths and science education:

- Less than a third of learners who pass matric maths qualify to enter STEM fields of study, or other fields such as accounting that also require a minimum of 50% in maths
- While learners obtaining 50% are predominantly male, the ratio of women students to men in HE is almost 60:40 – this further reduces the numbers able to enter fields requiring maths
- In the recent TIMMS study the performance of quintile 5 school learners was below that of the average performance of the full range of learners in the best performing middle income countries
- In the 2012 Grade 9 ANAs, 92% of learners scored below 30% for maths.

These examples show that the challenges are substantial. There is something fundamental going on that will need much more than tweaking during high school to fix. There is a lot that is hard to understand – we need to think much more broadly about this. (Dr Ahmed Bawa)

HRDC purpose, structure and processes

The HRDC is concerned with developing human resources and productivity to increase growth, development and competitiveness in the South African economy. It has a national structure with provincial chapters made up of local experts. It operates at both TVET and HE levels, and its membership includes government, business, organised labour, the academic community and civil society.

Dr Bawa describes the HRDC as an apex structure that contributes to the national debate on education issues and facilitates linkages between education and the economy. A key aspect of the HRDC's work is the evaluation of learnings from interventions in its areas of interest to determine where the major levers lie, and then consolidating these understandings to bring South Africa into line with international practice.

The HRDC standing committee for mathematics and science education

Formed in 2016, this committee is chaired by mathematics education specialist Prof Mamokgethi Phakeng, the incoming Vice-Chancellor of the University of Cape Town. The standing committee provides advice and recommendations to the HRDC on:

Strategies to improve public engagement and participation in maths and science education

- The HRDC has a strong view that the problem of maths and science education does not only reside in schools but is a broader social issue. As such there is a need to widen the discourse to include parents, communities and employers.

Strategies to improve performance in maths and science, in both basic and higher education

- This includes the development of clear maths and science learning standards, curricula and assessment tools that specify expectations for each phase – and what teachers require, and need to do, in order to meet these expectations. The emphasis in HE is primarily on initial teacher education.

Appropriate assessment standards for matric maths and science to ensure readiness for higher education studies

Translating these recommendations into initial teacher education, and into education and support for maths and science teachers

This includes attracting a higher calibre of young people, and understanding the impediments to that. There is a strong focus on curricula standards for initial teacher education programmes. The key debate in this area is around the level to which maths teachers should be qualified, and the kinds of maths they need in order to teach effectively and confidently. Another aspect deals with how best to provide practising teachers with opportunities to upgrade their skills, and what kinds of in-service training programmes would most effectively facilitate the upgrading of maths and science teachers' skills.

The HRDC is also concerned with the way these developments relate to the DBE's minimum standards for initial teacher education (MRTEQ) – and to what extent universities are fulfilling their roles in terms of teacher education.

Click here to view BRIDGE's resource on standards for teacher performance.

@CoP Discussion

In response to a question on **preparing young people for the kinds of changes that new technology will bring**, Dr Bawa highlighted three issues that he considered essential for development:

- Competence with regard to digital technology: Although many young people are 'tech savvy' in terms of using devices for communication, few are able to use simple software packages.
- Understanding data and statistics: This is needed not only for the new world of work, but also to manage ourselves, and includes developing a measure of scepticism.
- Capacity for continuous lifelong learning: To keep up with dramatic changes in the world of work, people will have to continuously learn new knowledge and skills, and will need to be able to manage their own learning.

> "How to prepare for the vast changes that are taking place in the world-of-work is a critical issue on the HRDC's agenda. It is clear that what we as a country do in mathematics must not just be about getting us to where others are, but also about designing our approach and our curriculum in such a way that it positions us for the future." (Dr Ahmed Bawa)

Several participants raised issued relating to **improving initial teacher education and professionalism**:

- exposure to poor examples during teaching practice resulted in student teachers developing negative attitudes toward the profession
- the importance of equipping teachers to use textbooks effectively, as a lack of textbook competence severely impacted the quality of teaching and learning
- the lack of correlation between the curriculum for student teachers and school requirements made it difficult for school mentors to bridge the gap during teaching practice between the expectations of schools and those of university observers.

Dr Bawa noted that there was a growing understanding of the university as a social institution, and that this would be likely to lead to changes in approaches to teaching and teacher education.

While teacher education played a crucial role in professionalism, professionalism was also affected by the way teachers saw themselves in society, and how society viewed and rewarded its teachers. The example of Japan, where teachers were highly regarded and where admission to education faculties was sought by the best-qualified students, was instructive on this issue.

Maths academies that served all levels from primary school teacher to university professor could enhance the professional status of maths teachers. The responsibility for improving the quality of teaching would then be shared, and educators at all levels would have opportunities to develop.

On the question of textbooks, Dr Bawa noted the need to bear in mind that there were no longer single sources of information and learning. Teaching had to incorporate this element and develop learners' capacity to make judgements about the value of information.

The importance of **integrating conceptual learning and application** drew attention and was referred to several times during the meeting:

"Both the CAPS and the IEB maths curricula state that the drivers of learning should be problem-solving and modelling. However, teachers do not purposefully pursue activities that support learner capacity to problem-solve and model. Instead, learners are trained in the technical procedural aspects of maths. This is one reason why so many students, even those who enter university with very high matric maths marks, fail.

To address this problem we need to look closely at what the core learning in maths should be – and at what teacher education has to do to equip teachers not only to give their learners an understanding of the technical aspects of maths, but also to build their capability to apply what they learn." (CoP participant)

Dr Bawa noted that this issue was receiving the HRDC's attention. In his view, the skills debate in South Africa had taken an unfortunate turn when it failed to recognise the significance of skills in higher order activities. Separating conceptual learning from skills learning had been a major mistake. The way to develop both a thorough understanding of mathematical concepts and the ability to use maths was through the nexus of concepts and skills (theory and practice) and vice versa.

Several participants emphasised the need to **look more closely at how maths is taught at primary level:**

- This is an appeal to the HRDC to look seriously into the issue of language in the teaching and learning of maths. Foundation Phase learners who are taught maths in their mother tongue are at a severe disadvantage, particularly in areas such as fractions.
- Foundation Phase learners understand better when they learn by playing. They need to deal first with the concrete by doing things practically, and only later move towards developing conceptual understanding. They also need to feel emotionally secure while learning. The problem is that there is constant pressure on teachers to show evidence of performance. This leaves them with "no room to relax and just teach, to have their learners experience and understand". Countries that perform well in TIMMS emphasise the concrete and pictorial initially and move to the abstract later.

In response, Dr Bawa observed that there was a need for South Africans to *step back and ask ourselves what the purpose of education is* and *whether our interest in the idea of a knowledge economy is causing us to focus on the wrong areas*. Would it be more beneficial to follow the example of a country such as Japan, where primary education aimed to be character-building and children's performance was not assessed during their first four school years?

The LOLT for Foundation Phase maths had been recognised as a critical issue and was receiving attention.

On the question of **how best to direct CSI funding towards education initiatives**, Dr Bawa noted the value of focussing on "really interesting, small scale innovations". The country's main education issues could only be addressed by government. The HRDC had an interest in determining which aspects of such initiatives worked, and how to galvanise broader communities to become involved in improving education.

Panel discussion

What my school maths and science did not (or did) do for me.

Panellists Dr Tammy Hodgskiss, Sydney Hadebe and Melissa King

Our three panellists looked at the issues from a different perspective:

- **How has their school experience helped or hindered them?**
- **What did their school experience do for the way they work now?**
- **What more could have been done?**

Members of the audience were invited to share their experiences as well.

Melissa King is a Knowledge Management consultant at BRIDGE. She has worked as a teacher and lecturer, assessment specialist, curriculum developer, materials writer, and researcher. Melissa's experience of high school maths, after a promising start, was decidedly negative – and was made worse by her school's poor handling of the situation. The school advised Melissa to drop maths altogether, and as a result she was unable to pursue psychology, her first choice of career. Although Melissa has found ways to 'work around' her lack of maths knowledge in those aspects of assessment and research that require data analysis and manipulation, she acknowledges that there are aspects she "would have liked to have felt more confident about".

Dr Tammy Hodgskiss is an archaeologist and the Curator of the Origins Centre at the University of the Witwatersrand. After enjoying maths in primary school, Tammy struggled throughout high school, eventually dropping to standard grade. While working towards a Masters, Tammy found herself "suddenly in the world of science (having taken Science only to grade 9) and doing chemistry and maths again". Tammy has filled some of her knowledge gaps through her own studies, uses technology and software to good effect, and works collaboratively with colleagues. Although she acknowledges not fully trusting her own knowledge of maths and science, Tammy does not find this limiting as she focusses instead on the areas she is good at and calls on specialist assistance when needed.

Sydney Hadebe is the Head of Corporate Citizenship at IBM South Africa. Sydney attended a rural school and completed both maths and science successfully for matric, in spite of his matric maths teacher resigning midway through the year and not being replaced. In retrospect Sydney sees this experience as having been a valuable learning opportunity as the class was forced to find its own solutions. Without the benefit of career guidance, Sydney opted to study geology – but then found that he was completely unsuited to the occupation of mining geologist. Although maths and science are not considered core skills for CSI management, Sydney feels that these subjects have benefitted him in significant ways in several areas, for e.g. in strategizing, problem-solving and project management.

Discussions explored a variety of experiences and themes.

The importance of managing the transition from primary to high school maths

The transition from primary to high school maths is difficult for many learners. Failure to grasp concepts in the early years of high school can negatively affect the remainder of one's schooling, and one's tertiary studies and career options.

This underlines the importance of schools correctly understanding learners' real abilities and their choices going forward, and giving them proper advice.

The importance of nurturing positive attitudes towards maths

Several contributors noted the importance of building confidence and creating environments in which children feel emotionally secure. When children start having trouble with maths they become anxious, and this anxiety can cause them to do badly in maths.

> "We must never underestimate the emotional effect that maths and science have on learners who struggle with them. They make children 'feel dumb'. To counter this, we need to teach in ways that encourage learners to use both sides of the brain, for e.g. by drawing pictures to explain concepts." (CoP participant)

The importance of teaching maths in context

Teaching maths in context helps learners to understand concepts and supports their capacity to apply them. Both the panellists and the audience highlighted the importance of knowing "why I am learning what I am learning". Tammy described her situation as "knowing the concepts but not knowing how to interpret the issues" and believes she would have benefitted from a greater awareness of "what you can do with maths and how it relates to life, so it would not just be about learning maths concepts and performing calculations in a vacuum".

> "People created maths to make sense of things in the world that they needed to make sense of. In our schools, do we teach maths that helps children to make sense of things in the world? Do we teach them maths as that thing that people do to make sense of things? Do we teach maths in context to facilitate this kind of learning? Or don't we?" (CoP participant)

The importance of subject and career information and guidance

The panellists' stories emphasised how important it is for schools to provide relevant information and guidance, particularly relating to the implications of maths for study and career choices. As Sydney explained, "I made those decisions and I learnt from them – but I wish that somebody could have guided me, and shown me where my decisions would lead."

Ways of bridging the gaps

Panellists related that they had learnt ways of accommodating maths content by dealing with it differently and asking for help. Data visualisation, which was about different ways of presenting data, was more user-friendly than traditional graphs and bar charts, and likely to be easier for children to relate to. Working collaboratively was essential for 'getting around' knowledge gaps, although it was still necessary to understand the requirements and to be able to explain them properly. YouTube and Excell were both useful resources. The message was that it was never too late to learn if one wanted to, and a variety of tools were available.

> "I have gone back to ABET level 1 and am learning some things for the first time – I missed all of this at school and am only getting it now, in ABET. (CoP participant)

Maths and science education for the future world-of-work

Maths and science education is well-placed to prepare young people for the future world-of-work, provided that the learning environment develops both their technical and their personal and social skills. This would mean, for example:

- Methodologies that facilitate learning and relate it to the practical environment, rather than just providing content
- A positive, accepting attitude, as well as the space to make and learn from mistakes – to build confidence and encourage creativity and innovation
- Methodologies that facilitate personal and social development – for e.g. learning to 'lead oneself', to strategize, to work collaboratively

While there are implications for the curriculum, for initial teacher education and for standards, teachers need not wait until changes have been made, as this comment shows:

> "Even though the CAPS structure is limiting, it is possible in the current situation to meet real learning needs. This means removing the emphasis on marks and instead placing it on learning. It means giving learners a context for what they are learning, and opportunities for higher order thinking – not just problem solving, but also reasoning, for e.g. by encouraging them to debate each other, or by giving the wrong answer and asking if they agree or not, and why." (CoP participant)

Facilitator's Summing Up

This session has begun to tease out many of the issues impacting on maths and science education and has articulated some of the questions that need to be asked. Hopefully this kind of engagement will crystallise out some of these issues into such stark questions that we can begin to solve them. Teacher education development stands out as an issue to be explored more deeply, especially the importance of teaching very consciously to develop learner confidence.

> "This Community of Practice – where people come together on a structured basis, with a certain agenda and a set of rules – is such a great idea. This could be something to take more effectively into the system." (Dr Ahmed Bawa, commenting on the BRIDGE Maths and Science CoP)

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