

Enhancing Research Papers into Effective Teaching and Meaningful Learning in Mathematics, Science and Technology Education in Africa

Carmel McNaught ^{1*}

¹ Distinguished Visiting Professor, University of Johannesburg, SOUTH AFRICA

Ensuring the growth of effective science education across the African continent is of significant importance to addressing global issues in health, agriculture, economic development and environmental sustainability. There is now a significant number of researchers in science education for African contexts as universities proliferate across Africa and African postgraduate students study across the globe. While the challenges facing science education in Africa are many, an important strategy for supporting quality enhancement in teacher development and curriculum development is the provision of sound research into what works in the resource-restricted educational environments of Africa.

The ten papers in this Special Issue address a wide range of range of topics in Mathematics, Science and Technology Education (MSTE) in Africa. Several papers focus on teacher development so that teaching strategies can engage students in meaningful learning. As these studies show, learning activities for students of all ages need to be designed so that they immerse students in interactive, authentic scenarios. There can be no shortcuts. It is time that MSTe world-wide focused on this principle. Let me be quite clear: There is ample research evidence that a factory model of education is inefficient and minimally effective. If we want to use precious resources wisely, educational policy needs to focus on teacher development and curriculum development to produce learning environments where students are enthused by learning and can achieve the knowledge, skills and attitudes that will enable them to contribute to the myriad of problems facing countries in Africa and the entire globe. This requires a genuinely transformational approach to conceptualizing education systems, physical designs for schools, initial teacher education and ongoing teacher development. The world cannot afford to waste resources by perpetuating existing outmoded models for schooling and teacher education.

The small collection of papers in this Special Issue provides ample evidence that change is possible. These studies are on a micro scale; it is time to consider how to scale up our educational models so that all students can benefit from being in a meaningful and exciting educational environment. Let me briefly summarize some of the key contributions of these papers:

1. Clemence Chikiwa and Marc Schäfer explore the complex multilingual world that is ubiquitous across Africa. In multilingual mathematics classes, code-switching between English and local languages is common. In this complex linguistic environment, questions are often not phrased in higher-order cognitive terms. This highlights the need for close attention to language issues in teacher education.
2. Lydia Mavuru and Umesh Ramnarain tackle another complex aspect of African educational contexts. The interplay between socio-cultural beliefs and practices and conventional science is nicely illustrated in this study of three natural science teachers in township schools in South Africa. Recognizing and working with students' cultural beliefs about phenomena and practices can enhance student motivation and learning, and allow more active teaching strategies to take place.
3. Divan Jagals and Martie Van der Walt's paper focuses on how students can benefit from a design-based approach to planning their teaching. The paper highlights the need for teachers – both novices and experienced teachers – to consider theoretical principles in designing for learning. Iterative reflection on such design principles leads to better teaching strategies and a more nuanced theoretical understanding of teaching and learning.
4. James Ngugi and Leila Goosen's paper explores the complexity of individual innovative behaviour in undergraduate technology university students in Kenya, showing that both personal student attributes (exemplified in this study by self-regulated learning) and curriculum design contribute to the development of individual innovative behaviour. There is no 'one size fits all' recipe for higher education.
5. Vaughan van Appel and Rina Durandt focus on student attitudes in learning statistics. Student motivation in 'service' statistics courses is a global issue. This study provides clear evidence about this issue in higher

education in South Africa. In addition, there are attitudinal challenges with students who are in mainstream statistics courses. Indeed, food for thought and action.

6. Bernard Atsumbe, Samuel Owodunni, Emmanuel Raymond and Maxwell Uduafemhe compare scaffolding and collaborative teaching and learning strategies. They conclude that there is significant value in using collaborative work in teaching basic electronics in secondary schools in Nigeria. This is yet another study highlighting the need for students to discuss ideas and work together.
7. Hanti Kotze's study is in the area of mathematical modelling. Mathematics is often taught in an algorithmic fashion with an emphasis on set procedures and answers. In this study, the challenges that students have in applying mathematical models to real-world problems in biomedical technology are explored with obvious implications for classroom strategies and curriculum design.
8. Kgomotsego Samuel and Washington Dudu's paper offers a detailed look at the practice of four high-school science teachers as they begin to explore the value of role-playing in their classrooms. This is again evidence of the need for interactive and immersive teaching strategies.
9. Maria Catherine Kekana and Estelle Gaigher's study is another small-scale study exploring professional growth of four grade 7 science teachers, who need to negotiate challenges with resources and languages in their classrooms. For me, the key message is that a focus on teacher growth and development is more important than just decrying relatively poorly resourced environments.
10. Our final study by Sure Mupezeni and Jeanne Kriek has a poignant element. While out-of-school activities such as science fairs can motivate and enrich student learning and love of science, there is a stark contrast between support that urban and rural students receive in endeavouring to engage in such events. This finding is negative, but the positive aspect is that the infrastructure for science fairs exists and studies such as this one pinpoint strategies for the way forward.

It is of interest to explain how this Special Issue came into being. I have long been somewhat frustrated by the invisibility of the good work being done in Africa. MSTE research worldwide is dominated by research from the so-called developed nations, with the US, UK and Australasia being dominant players. My own background is varied with extended periods of time working in Africa, Asia and Australia, and several other shorter periods of time elsewhere. In many ways, my own career has straddled across the divide between the so-called developing and developed nations. I know there is significant MSTE research in Africa and this Special Issue highlights this nicely.

In collating the Special Issue, I took advantage of the ISTE International Conference on Mathematics, Science and Technology Education (MSTE) which provides a forum for practitioners from South Africa and other countries to interact and exchange ideas on issues relating to teaching and learning of mathematics, science and technology at all educational levels in South Africa and beyond. Since the inception of the conference in 2010, it has been hosted by the Institute for Science and Technology Education (ISTE) at the University of South Africa, the largest university on the African continent. The conference has hosted participants from all the continents of the world and has continued to reach out to a more diverse audience. Of the 200 abstracts received, about 100 are accepted for presentation (approximately 10% are from international participants), and about 50 papers are accepted after peer review for publication in the conference proceedings.

In selecting papers, I attended the 2017 ISTE conference. I went to the presentations of the papers that were ranked mostly highly during the peer-review process. I interviewed all the presenters, and finally selected ten papers on the understanding that authors would work with me to enhance their papers so that they would become a fresh contribution to the academic literature. All ten papers went through two rounds of review with me before they were sent out for peer review through the EJMSTE process. In several of the ten papers there is additional data, but all have much more strongly developed theoretical frameworks and discussion. Most are twice as long as the original conference paper. Eight of the studies are situated in South Africa; one in Nigeria and one in Kenya.

Many of the papers report research done during higher-degree studies, and hence one of the authors is an emerging scholar. One of my interests in the Special Issue relates to mentoring. How much investment is needed to support less-experienced academics gain skills in research and academic writing? I have had a long career as a Director of Teaching and Learning in universities in Australia and Hong Kong, during which time I have presented zillions of workshops on research, scholarship and academic writing that have been received well by participants. However, I have come to believe that much of my work has been 'edutainment' and I have seen insufficient evidence of follow-up in terms of real development in scholarship. The challenging and time-consuming process of individual mentoring does seem to have better pay-off.

I am grateful to colleagues world-wide who acted as peer reviewers for the Special Issue. This form of collegial service is often insufficiently recognized and yet it is the backbone of a global academic community. I am also deeply appreciative of the work of the editorial team of the *EURASIA Journal of Mathematics, Science and Technology Education* who have worked with the authors and myself to produce this Special Issue.

Finally, my heartfelt thanks to all the authors whose dedication to the refinement of their research has been done willingly and with diligence.

This collection is presented in the firm belief that it will be a useful resource for teachers, teacher educators and policy makers, as well as supporting further research on MSTE in Africa and elsewhere.

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