Title: Pre-service science teachers' preparedness for classroom teaching: Exploring aspects of self-efficacy and pedagogical content knowledge

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Context/purpose

The purpose of this project was to determine pre-service science teachers' preparedness for classroom teaching by exploring their teaching efficacy beliefs and pedagogical content knowledge (PCK). This is in pursuit to match the standards intended to create a fundamental shift in what learners learn and how they are taught.

Why teaching efficacy beliefs, pedagogical content knowledge and classroom preparedness?

Research (Omolara, 2008; Arends & Phurutsi, 2009; Chen & Usher, 2015) has shown that poor performance of learners in science is primarily influenced by among other factors, teachers' low levels of self-efficacy beliefs. Learners' performance is linked to teachers' beliefs in their capability to teach the subject. Accordingly, initial teacher education (ITE) programmes should promote instructional strategies that enhance science teaching efficacy beliefs in support of teaching science with confidence.

It is also important to note that teaching science doesn't only require knowledge of the content, but also an understanding of how to teach the concepts, that is, student teachers need sufficient pedagogical content knowledge (PCK) to be effective practitioners. PCK development includes learning about instructional strategies and approaches for improved classroom practice (Bartholomew, Moeed, & Anderson, 2011). This project, therefore, sought to explore how pre-service teachers' science teaching efficacy beliefs influence their PCK and how these inform their preparedness for classroom teaching. Information generated here will be used to develop a strategy post TAU that will support pre-service teachers' confidence in teaching the subject. This is aimed at producing breed of teachers that are better prepared to teach science and consequently can influence performance in science.

This project sought to address the following questions:

- What are pre-service teachers' perceived personal science teaching efficacy beliefs?
- How do teacher educators evaluate pre-service teachers' PCK?
- What are the implications of such perceptions for teacher education?

To further understand the role of teacher preparedness, the ineffective teaching of science has been attributed to many factors including; a lack of a strong background in science content, under-preparedness in science content, inadequate facilities and equipment, poor instructional leadership, and teacher attitude (De Laat & Watters, 1995). The element of teaching efficacy needs to be taken into consideration during teacher training as teachers' self-efficacy has a strong influence on teachers' attitude towards science. Therefore, the role of teacher training programmes is to respond to changes and demands by offering training programmes aimed at producing effective teachers who can meet the challenges of the day, including among others employability and competence (Taole, 2013; Ono & Ferreira, 2010). These attributes form part of the requirements needed in preparing effective science teachers to meet the environmental, social and economic challenges of the 21st Century. These include adapting to climate change (sustainability), education, economy, technology and communication, natural resources (water, energy and food security), natural hazards.

Conceptual framework and literature review

This project is grounded on Bandura's Self-efficacy beliefs and Shulman's (1987) PCK theories. Through these, came up a conceptual framework focusing on the relationship between aspects of teacher competence, i.e. sources of teaching efficacy, the aspects of knowledge, with special focus on PCK and facets of knowledge relating to PCK. Cochran (1997), refers to PCK as a type of knowledge that is unique to teachers, and is based on the way they relate their pedagogical knowledge (what they know about teaching) to their subject matter knowledge (what they know about what they teach).

Inevitably, understanding and promoting the development of teacher self-efficacy beliefs may well be important for reducing the current attrition rate in teaching. For this reason, teacher educators need to understand the key points in teacher development where teacher self-efficacy beliefs are affected by each of the four sources of efficacy; namely; mastery experience, vicarious experience, verbal persuasions/feedback and psychological factors or emotional arousal (Bandura, 1986), as explained below:

Mastery: perception that a performance has been successful can raise efficacy beliefs

Vicarious: self-efficacy when observing people performing challenging tasks.

Verbal persuasions: exhorting teachers for excellence focusing on teacher's skills

Psychological: competent teachers are more likely to have confidence in themselves and less likely to look uncertain to their learners.

Methods / process

The table below shows the instruments and process used, their focus and how they were used to gather data

Instrument	Its focus	How it was used
Questionnaire: Science Teaching Efficacy Belief Instrument for pre-service teachers (STEBI-B)	Designed by Enochs and Riggs in 1990 (modified by Bleicher in 2004). Used to gather quantitative data on perceived self-efficacy.	It is a five-point Likert type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The median for this scale is 3. A mean which falls between 3 and 4 was taken as moderate to high, while above 4 considered as very high or positive perception.
Evaluation forms for observations of lessons	Focus on evaluation of pre-service teachers' PCK	To evaluate skills such as lesson planning, set induction, skill of explaining, skill of stimulus variation etc
Class group discussions	Aspirations and challenges for pre-service teachers' preparation towards classroom teaching	To probe the findings of questionnaire and observations further by establishing pre-service teachers' preparedness for classroom teaching

Findings and discussions

Questionnaires: *Pre-service science teachers' perceived efficacy beliefs*

The subscale average mean was 4.01 which is perceived as very high. Item 2 (I will continually find better ways to teach science) was scored the highest at 4.7, this is a positive sign indicating the students' preparedness to learn. In addition, understanding that science is a very dynamic subject and even after qualifying as teachers, continuing professional development is a necessity.

Observations: *Pre-service science teachers' pedagogical content knowledge*

Data was also collected through pre-service teachers' participation in micro-teaching and teaching practice evaluations. This is a developmental process with constructive feedback to improve on their performance. Themes emerging from evaluators' comments addressing PCK were categorised in terms of formulation of lesson objectives, chalkboard summary, pace of lesson (i.e. hurried or slow), teacher-learner interaction, enthusiasm and confidence. At a smaller scale, micro-lesson just like teaching practice, provides an opportunity for student teachers to put into practice the theoretical knowledge they have studied in different courses in their programmes (Mpofu & Maphalala, 2018).

Focus group discussions: *Preparedness for classroom practice*

The following themes were generated from focus group discussions:

Aspirations

As aspiring agents of change, pre-service teachers' professional identity is aimed at promoting learning-centred inquiry-based learning. In enhancing their knowledge of science specific instructional strategies, meaningful learning should be encouraged by creating conducive learning environments where quality teaching will be prioritised. The findings resonated with the those of a Turkish study where student centred education methodology helped improve student teachers' cognitive skills via holding an active role and their affective skills through group work activities emphasizing its effect on permanent learning and learning how to learn (Zeki & Güneyli, 2014).

Experiences/challenges/concerns

ITE allows exposure to classroom teaching through micro-lessons where a variety of skills are being assessed. Even though micro-lessons simulate classroom teaching and promotes role-play, the experience in the actual classroom is a totally different setting as their fellow classmates act as learners.

No matter how prepared the students feel regarding the different skills learnt during microlessons, time will always be a constraint as it will become difficult to incorporate all the micro-lesson skills in one full lesson during teaching practice, and thus impacting negatively on their preparedness for classroom teaching. This is supported by the findings of Zeki and Güneyli (2014) where the inefficiency of some of the teaching-learning activities, physical characteristics of the classroom setting and duration of the allocated time for the activities were among the weak aspects of the approach. Focus should shift from assessment driven curriculum but should promote quality mastery learning of basic principles and concepts.

Implications to teacher education (TE)

The development of PCK therefore, requires teacher educators to understand the key points in teacher development where teacher self-efficacy beliefs are affected by each of the four sources of efficacy as previously mentioned. It is for this reason that this project examined pre-service teachers' preparedness to teach science content and how to teach the subject (pedagogy).

For effective micro-lesson evaluations, teacher education programmes should strengthen the school experience component through the development of teaching schools where pre-service teachers can engage in learning-from-practice. Due to poor mentorship in schools, students end up fending for themselves by learning on the job without proper supervision. Thus, mentor-the-mentor programmes should be facilitated by teacher education departments to promote collegiality.

Conclusion

The outlined implications for Teacher Education show the significance of this project. Teaching efficacy belief mediates between the teachers' knowledge of instructional strategies of science teaching and students' understanding of science knowledge. There seems to be a disjuncture between theory and practice, Therefore, pre-service teachers' knowledge of learners' science thinking, knowledge of science tasks and instructional strategies are key factors of PCK and should further be explored to enhance preparedness for classroom teaching.

Way-forward: post TAU activities

Post this project, strategies employed to support pre-service teachers' confidence by exploring the sources of efficacy and PCK will be established. Consequently, different pedagogic interventions may be explored where design-based research methodology will be employed. Design-based research is claimed to have the potential to bridge the gap between educational practice and theory, because it aims both at developing theories about domain-specific learning and the means that are designed to support that learning (Bakker & Van Eerde, 2015).

There is evidence that supports the view that new teachers have a positive impact on their students' learning when student teachers implement the practices they have learnt during their ITE programmes (Bartholomew et al, 2011). It is therefore imperative that after establishing pre-service teachers' PCK and teaching efficacy, new strategies will be introduced to enhance their science teaching efficacy during ITE, so that this can be one of the attributes they take into the profession.

References

Arends, F., & Phurutsi, M. (2009). Teacher education in South Africa series: Beginner teachers in South Africa: School readiness, knowledge and skills. HSRC.

Bakker, A. & van Eerde, H. (2015). An introduction to design-based research with an

example from statistics education. In A. Bikner-Ahsbahs, C. Knipping & N. Presmeg (Eds.), Doing qualitative research: Methodology and methods in mathematics education (pp. 429-466). Berlin: Springer.

Bartholomew, R., Moeed, A., & Anderson, D. (2011). Changing science teaching practice in early career secondary teaching graduates. *Eurasia Journal of Mathematics, Science and Technology Education, 7*(1), 53-61.

Chen, Jason A. and Usher, Ellen L., (2015). Profiles of the Sources of Science Self-Efficacy. Articles. 13. http://publish.wm.edu/articles/13

De Laat, J. & Watters, J. (1995). Science teaching self-efficacy in a primary school: A case study. Research in Science Education, 25(4), 453 - 464.

Mpofu, N., & Maphalala, M. (2018). A comprehensive model for assessing student teachers' professional competence through an integrated curriculum approach. The Journal for Transdisciplinary Research in Southern Africa, 14(2).

Omolara, B.E. (2008). Pedagogical approaches to the teaching and learning of school subjects in Africa in the 21st century. EABR & TLC Conference proceedings. Rothenburg. Germany. 2008.

Ono, Y. & Ferreira, J. (2010). A case study of continuing teacher professional development through lesson study in South Africa. *South African Journal of Education*, 30, 59 – 74

Riggs, I. & Enochs, L. (1990). Toward the development of an efficacy belief instrument for elementary teachers. *Science Education*.

Taole, M.J. (2013). Teachers' conceptions of the curriculum review process. *International Journal of Science Education*, 1, 39 - 46.

Wee-Loon, N. (2011). A study of Singapore female primary teachers self-efficacy for teaching science.

Zeki, C.P.,& Güneyli, A. (2014). Student teachers' perceptions about their experiences in a student-centred course. *South African Journal of Education,*34(3):1-11