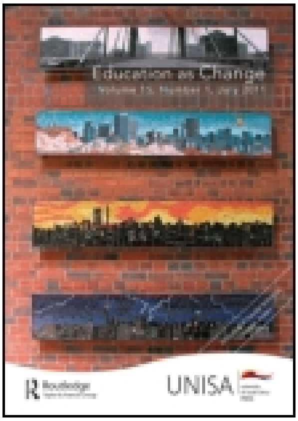

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Learning to teach argumentation: Facilitated reflection on a pre-service curriculum in South Africa

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Learning to teach argumentation: Facilitated reflection on a pre-service curriculum in South Africa

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Abstract

In South Africa, critical thinking is a prominent aim of education. Argumentation (the processes and products of arguing) is central to critical thinking and important in science and technology, but teachers have not been trained in classroom methods. This article reports an evaluation of the university-based part of a programme to train science and technology student teachers to teach argumentation. Observations of the university sessions produced detailed descriptions of the enacted curriculum with respect to argumentation and the teaching of argumentation. A model called SIMPL facilitated critical reflection by the programme's teacher educators. These reflections validated course structures, identified key assumptions made by teacher educators and clarified the interplay between student teachers as learners, and teachers' and teacher educators' instructional roles. The findings showed that while the curriculum provided student teachers with ample experience of argumentation and opportunities to plan for and teach peers, they needed more support in facilitating argumentation discussions and drawing on sufficient, relevant science in peer teaching. SIMPL allowed teacher educators to realise they had not identified or differentiated student teachers' learning of argumentation from learning to teach argumentation. Implications for future cohorts and the application of SIMPL to better understand the integration of aspects of training are discussed.

Key words: Argumentation, critical thinking, initial teacher education, science education

Introduction

Critical thinking was introduced as a cornerstone of a curriculum that emerged from post-apartheid democratic changes and priorities for education in South Africa. One intention was to engage a citizenry with decision making affecting peoples' lives, in response to the ideals of the country to 'produce independent, critical thinkers able to question, weigh evidence, make informed judgments and accept the incomplete nature of knowledge' (Republic of South Africa 1995:22). Putting a system in place to facilitate school students achieving these outcomes, required attention to curriculum development, instructional practices, and professional development for practising and prospective teachers.

There has been some research on teacher pedagogy in critical thinking, particularly as it concerns using argumentation (Erduran, Simon & Osborne 2004; Simon, Erduran & Osborne 2006), but so far studies on how teachers and student teachers develop their professional knowledge and learn to teach in this

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area have been limited (Zohar 2008). We are not aware of any studies in southern Africa that deal with how student teachers' knowledge and professional skills in this area develop.

This study is a facilitated critical reflection on a university-based component of a teacher education programme designed to help science and technology student teachers meet the needs of the curriculum in critical thinking and argumentation. The study took place at a university in the Western Cape province of South Africa. A particular model, the SCALE Immersion Model of Professional Learning (SIMPL) was used to facilitate reflection on programme design, student teacher outcomes and the roles of teacher educators (Lauffer & Lauffer 2009). The focus of research is on course design, implementation and improvement. First, we establish an educational justification for critical thinking in the curriculum, its links with argumentation and, more briefly, what is known of learners' abilities to engage in and teachers' efforts to teach science argumentation. This is followed by sections summarising the components of the university-based programme, and the SIMPL model used to analyse it. Two general questions are addressed, the first of which comprises two sub-questions:

(1) What are the elements of an argumentation curriculum for prospective science and technology teachers?
  a. What was the enacted curriculum with respect to student teachers' argumentation and teaching of argumentation?
  b. What insights on the enacted curriculum are provided by student teacher outcomes in argumentation and teaching of argumentation to peers?

(2) How does the SIMPL model facilitate reflection on an argumentation curriculum for prospective science and technology teachers?

Critical thinking

There are general justifications for developing critical thinking ability, going beyond South Africa's local needs. According to Pithers and Soden, increased economic competition demands that education and training, no matter in what discipline or at what level, should enable learners to think 'smarter' than in the past (Pithers & Soden 2000:237). Barnes (2005) argues that we find ourselves at a time when learners are inundated with information via the World Wide Web and other media, but have limited skills to decipher, question, validate and reason about the substantiality or validity of the information accessed. From these standpoints, teaching for critical thinking is a necessity for all learners (Lombard & Grosser 2004). If teaching is thought of as constructivist, in the sense of building on students' existing ideas (which is particularly important in science education) (Driver, Asoko & Leach et al. 1994), it is crucial to document the ways in which students cope with situations where critical thinking is required, so that newly encountered ideas and concepts are tested out and assimilated or rejected when reshaping mental frameworks. Taking this idea further, Kuhn (1999) draws attention to different levels of meta-knowing about the nature of assertions. Where assertions are considered to be judgements based on argument and evidence, and knowledge is subjective and uncertain, she sees critical thinking as a meta-cognitive tool to enhance domain-specific understanding. Kuhn's understanding of the nature of assertions as judgements coincides with components of the nature of science (see, for instance, Abd-El-Khalick, Lederman & Bell et al. 2002; Tsai & Liu 2005), making the development of critical thinking particularly relevant to science education.

In science education, considerable work has been done to survey the ideas of students at different ages about the relationship between data (or other types of evidence) and claims. For example, Leach, Driver and Millar et al. (1997) report that school students as old as 16 years of age do not differentiate between observations (the data) and conclusions (the theory). Only at undergraduate level (Dagher, Brickhouse & Shipman et al. 2004; Ryder, Leach & Driver 1999) do students explicitly use data to identify patterns and draw conclusions.

Argumentation as a component of critical thinking

In a Delphi study of prominent experts' views on critical thinking, Facione and Facione listed six components, each of which emphasises the need to examine assertions and claims in the light of the quality of evidence used to provide warrants and backings, through which the validity and integrity of claims and assertions are tested (Facione & Facione 1992). Thus argumentation, the process of resolving opinions and examining the cogency of premises and conclusions, is a major way of operationalising critical thinking in specific knowledge domains such as science (Kuhn 1993). The process of argumentation draws heavily on the critical thinking skills of analysing and evaluating evidence and drawing inferences. It includes the abilities to formulate an argument, using evidence to support the argument, and, even stronger, to counter the arguments of others. Argumentation has generated a considerable level of interest in the science education research community over the past decade (Driver, Newton & Osborne 2000; Erduran, Simon & Osborne 2004; Scholtz et al. 2008; Simon, Erduran & Osborne 2006). It is not surprising that argumentation has been recognised as a key component in school students coming to understand and reason about science topics (Driver et al. 1994). This is closely related to calls for an enhanced scientific literacy that allows science learners and the general public to participate in socially important debates, for example about environmental degradation (Osborne, Collins & Ratcliffe et al. 2003; Tao 2003; Tsai & Liu 2005). Dealing with evidence in a critical way is central in the teaching of school science, and is arguably a more intellectually honest representation of science, as it recognises the ways in which scientific knowledge has been constructed and validated (Duschl & Osborne 2002; Sandoval & Reiser 2004).

Learning and teaching argumentation

After reviewing the literature on the uses of argumentation in the practice of science classrooms, Driver, Newton and Osborne (2000) conclude that while there was evidence that, given the opportunity, learners were able to engage in argumentation from elementary school onwards, very few teachers had the skills or disposition to encourage argumentation in their classrooms. They conclude that this constitutes a major problem in that it limits progress in science education. Simon, Erduran and Osborne (2006) point out the complexities of teaching using argumentation, in that it requires significant role-switching for the teacher – from being an authority figure concerned with right answers, to more of a facilitator who values conflicting ideas and uncertainty. More generally, it is known that teachers' ability to promote and make clear higher-order critical thinking skills to their students is often absent (Paul, Elder & Bartlett 1997) and that teachers' metacognitive knowledge of higher-order thinking is lacking (Zohar 1999).

In science education research there has been considerable interest in investigating argumentation lessons in science classrooms (Jimenez-Aleixandre, Rodriguez & Duschl 2000; Schwarz, Neumann & Ilya 2003; Zohar & Nemet 2002). Four of the authors of this article have been involved in argumentation research and in-service training (INSET) for practising teachers in South Africa since 2004. So far, the nature of teachers' argumentation (Scholtz et al. 2008), learners' argumentation abilities before teaching (Lubben, Sadeck & Scholtz et al. 2010) and the different argumentation outcomes of scientific and socio-scientific contexts for lessons (Braund et al. 2007) have been reported. Taken together, these studies and our experiences of INSET showed the urgent need for teachers and school students to develop a better appreciation of what is meant by and required of good-quality argumentation in science; the inherent complexities and differences connected with using various contexts for argument; and the social, cultural, political, ethical and religious implications of argumentation that are particularly relevant in multi-racial classrooms in South Africa. Arising from these concerns is a need to better prepare future cohorts of teachers in this area of teaching science and technology.

The university-based programme

Student teachers in life science, physical science and technology education, in their final year of a four-year BEd degree, were introduced to critical thinking in two components. During the first half of the year, students were on campus and were taught three successive programme modules on critical thinking. During the second half of the year, students were in schools on teaching practice, and each student was required to teach at least one argumentation lesson. Other components of the course remained unchanged from previous years.

The module addressed in this study is the third of three on-campus modules taught in the first half of the year. The first module outlined the philosophical, historical and sociological foundations of critical thinking in education. The second, on communications, focused on critical thinking discourse and introduced students to argumentation as one form of critical thinking. The final module, on subject didactics in life science, physical science and technology, was taught by a team of three teacher educators (authors, three, four and five), each teaching students from their respective disciplines. This final module had two phases: in the first, student teachers learned to argue by engaging in arguments about science or technology-related controversies, for example about whether animals should be kept in zoos, the cloning of animals and humans, and the development of nuclear power stations. During this phase the students were introduced to Toulmin's Argumentation Pattern (TAP) as an explicit way of structuring arguments (Toulmin 2003; see also Erduran, Simon & Osborne 2004). TAP displays the components of arguments and how they interrelate: the *claims*, and the *warrants* and *backings* used to support them; the conditions under which claims hold true (*qualifiers*); and the *rebuttals* used to argue against any of these components. Student teachers were expected to participate in, and reflect on, argumentation. In the second phase of the module, student teachers had several opportunities to engage in teaching argumentation. This involved planning argumentation lessons in small groups of four or five and teaching these lessons to their peers.

Data collection

The data reported in this article come from

- the observation of subject didactics sessions by the visiting sabbatical scholar;
- facilitated reflective discussion between the authors after completion of the programme using the SIMPL model.

The second author (a Fulbright scholar, on campus while on sabbatical) observed 11 classes of the science and technology didactics module. He wrote field notes, gathered handouts and held frequent discussions with the teacher educators, mostly at the conclusion of each class. Based on these data, he wrote reports of each class and shared them with the teacher educators. He coded the reports using a set of *a priori* coding categories. Examination of the coded segments – particularly when informed by post-observation discussions – helped develop a more robust definition of codes, thereby improving their content validity. In subsequent meetings, the authors reflected on these observation notes and on their experiences of the module, as instructors facilitated by the SIMPL model described in the following section.

The Scale Immersion Model of Professional Learning

The SCALE Immersion Model for Professional Learning (SIMPL) evolved from professional development practice supported by a National Science Foundation-funded Math and Science Partnership project in the

United States (US). This project was known as System-wide Change for All Educators (SCALE). Hence, SCALE constitutes the first letter of the SIMPL acronym.

SIMPL for science teachers is a model for informing design and instruction. It was developed to build greater coherence between the vision for both school students' and teachers' science learning experiences (Lauffer & Lauffer 2009). The hallmark of SIMPL, which sets it apart from instructional models designed for student learners, is that it is used to specifically apportion time for the different roles that adult learners (such as student teachers in higher education or practicing teachers in continuous professional development (CPD) play during the effective development of professional learning (for example, learning new science content or new ways to teach science content). In the SIMPL approach for (student) teachers as learners, participants are engaged in learning sessions that have particular intended science content and pedagogical learning outcomes. The model is shown

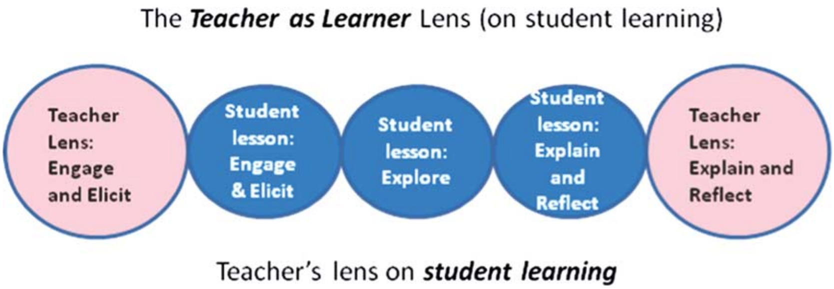

Figure 1: The SIMPL approach for teachers as learners

diagrammatically as Figure 1.

At the centre of SIMPL is nested an instructional model of Engage-Explore-Explain, that aligns with research-based practice in science learning (Bransford, Brown & Cocking 1999; Driver et al. 1994). This forms the 'teacher as learner' lens through which a student teacher plays the role of learner of science content. Either side of this central component sit spheres acting as the 'teachers' lens' on students' learning. An important part of SIMPL is that it recognises that the *explore* stage of the teacher's domain effectively consists of all three stages of the student learner's domain. A SIMPL session explicitly moves through a sequence of stages in which participants are facilitated to take on particular roles. The sequential progression in SIMPL (depicted in Figure 1) is made visible to participants by the facilitator (teacher educator or professional development leader) who physically moves a cardboard arrow, on a poster-sized version of the model, to designate which stage is active. The following sequence illustrates how SIMPL works.

Engage as teacher-learners. Participants (in this study, the student teachers) engage their prior conceptions about the session's teaching–learning outcome, in this case learning to teach argumentation.

Explore as teacher learners. Participants explore what it is like to learn the science that they will teach. Here they change roles, from that of *teacher learner* (of teaching) to *student learner* (of science). Thus, this stage is comprised of the three parts of the Engage-Explore-Explain instructional model for student learners. During this stage of the SIMPL session, participants are required to suspend 'teacher' thinking and questions, to experience the learning from the school student learner's perspective (frequently learning science content in ways never encountered before). For this part, therefore, it is expected that the student teachers would

- **engage as student learners of science**. Participants change roles and engage their prior conceptions about the session's science learning outcomes, e.g., learning to argue.
- **explore as student learners of science**. Participants explore, from a school student learner's perspective, a lesson that was selected because of its relevance to the intended session learning outcome (and relevant science content).
- **reflect (explain) as student learners of science**. Participants reflect on their common *explore* experience from a student learner perspective, to understand how and what they learned about the science content, e.g., learning to argue.

Explain as teacher learners. Participants revert back to their teacher learner roles, to explain the lesson's rationale with regard to the session's intended learning outcome. This time is intentionally designed for teacher-participants to reflect on their initial conceptions (from the teacher's *engage* experience) and to be metacognitive about their own learning of both science content and pedagogy (from the teachers' *explore* experience). A way of doing this is to examine the status of constructs from the point of view of conceptual change.

The SIMPL approach can be further extended to support reflection on the design of professional learning for professional developers (or, in this case, teachers of teachers). In this expanded version of the model, the learning sequence is extended on both ends to engage prior knowledge and provide time for reflection in participants' additional learning role as teacher educators (see Figure 2). Just as the SIMPL approach for teacher learners aligns with the pedagogical goals for student learners, so the SIMPL approach for professional developers and teachers of teachers parallels the pedagogical goals for both teacher and student learners.

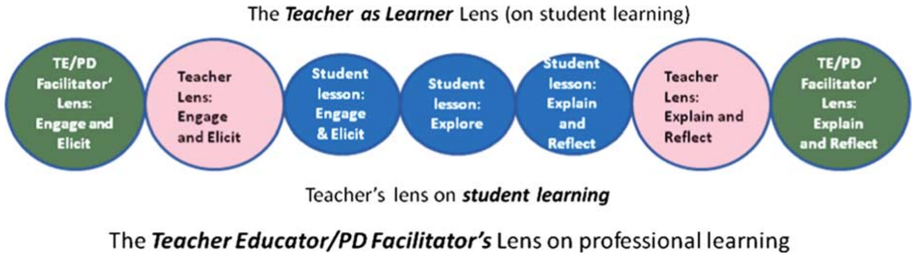

Figure 2: The SIMPL approach for PD facilitators (or teacher educators) as learners

Findings

In accordance with the two general questions of the study, findings are reported in two parts: the outcomes of observations of the didactics sessions of the final programme module; and reflections on module components, student teacher outcomes, and teacher educators' roles using the SIMPL model.

Finding 1: From observations of the teaching of the didactics module

Students had a number of opportunities to engage in and practise argumentation. For example, they had to argue whether or not they agreed with the introduction of nuclear power as the sole source of electrical energy for South Africa – a topic in both the science and technology curricula. In another session, technology students had to argue around the most appropriate choice for a mechanical component to make a non-functioning mechanical card model work. In all examples student teachers were required to

- know Toulmin's model of argumentation using TAP to structure and analyse arguments, know about TAP-ordered levels of argumentation, and know about TAP as a model;
- develop reasoned arguments in support of an assigned position on a given topic, identify factors that qualified their position, anticipate counter-arguments to their position, and develop rebuttals to these counter-arguments. They had to present arguments to the whole class, discuss competing positions, come to closure and/or consensus on issues, and understand the complexity of issues.

Examples of topics selected by students in peer teaching included the advantages and disadvantages of cloning, whether surrogacy should be an accepted practice for infertile couples, the use of cell phones in schools and whether genetically modified (GM) crops should be grown. As students were in the fourth year of their studies, most relevant science content had been covered but, where this was not the case, tutors provided sources and references for students to use before planning lessons. Peer teaching required student teachers to

- plan argumentation lessons. This involved selecting a topic and locating it with curriculum statements from the South African national curriculum, knowing criteria for choosing a good argumentation topic, connecting the topic to learning outcomes and assessment standards, specifying claims, identifying content underlying claims, locating teaching resources, deciding whether to use TAP with learners and, if so, how to do so, and planning teaching strategies, such as how to organise the classroom for argumentation to take place.
- practise teaching argumentation lessons. This involved introducing the topic and using strategies to facilitate discussion, for example by probing learners' reasoning, providing learner prompts, re-voicing learners' responses, playing devil's advocate, and bringing closure to the argumentation and the lesson itself. The success of each of these aspects required effective time-management skills.

A first conclusion drawn from the observations was that in all observed sessions student teachers had frequent opportunities to *engage in argumentation* as participants, in sessions that were informed by TAP (Toulmin 2003; see also Erduran, Simon & Osborne 2004). Thus, in this respect, the observed and the *experienced* curriculum matched the *intended* planned curriculum.

Student teachers were able to engage effectively in arguments, but they sometimes struggled to formulate productive questions and claims. In one sense this was surprising, as two weeks before having to prepare their teaching lessons, they took on the same task in their own argumentation to produce topics, questions and claims that all seemed reasonable and fruitful. It seemed that taking the next step, namely translating a general issue into the specifics needed in planning lessons, created difficulties. For example, one group was considering water sources and phrased a possible claim as, 'It is good to use river water' with a counter claim 'It is good to use tap water'. While other possible water sources could have emerged in rebuttals to one of these claims, this rarely happened. It seemed clear that groups were spending a good deal of their time developing arguments in support of or against particular claims as positions, rather than treating arguments holistically. Thus, rebuttals incorporating challenges to claims or warrants and qualifiers were downplayed. The previous knowledge and understanding of TAP components of argument, as these all are, seemed to break down or were forgotten in some cases of peer teaching.

Some student teacher groups were unsure about whether to teach TAP first, before setting a context for argumentation, and about how much structure and support to provide. While all sessions observed included sufficient resources for peers, as learners, argumentation questions were often not clear enough to allow for the fruitful progress of the argument, or drew on insufficient science content. For example, in a session observed in the life sciences, one group chose to argue whether surrogacy should be allowed in the case of infertile couples and another whether there should be restrictions on immigration into an urban district. The class found the first topic relevant and it could be linked to curriculum topics and could also draw on some science content (about human reproduction). The second example, though relevant, was not easily related to the curriculum, nor could they use appropriate science content. In discussion, the second author advised the educators that these sociologically driven examples might be problematic to use in teaching practice, given that students in schools would be less mature and unable to engage sufficiently, compared to student teacher peers in the comparative safety of the university.

Finding 2: Reflections on using the SIMPL model

Introducing SIMPL into reflective conversations between the authors substantially broadened the focus of the teacher educators. Until that point conversations had largely focused on the structural, rather than the learning outcomes of the argumentation programme itself. The introduction of SIMPL, however, led to the inclusion of reflections about the effective learning structure of the programme, the roles of participants, and the reciprocal relationship between the model and practice. The qualitatively different nature of these reflections adds a dimension to professional practice in teacher education that, in our view, is significant and important. As such, it demonstrates the value of a model of professional practice (such as SIMPL for teacher educators) to clarify roles and dynamic aspects of learning that are often complex and difficult to analyse.

Reflections about the structure of the programme

SIMPL effectively provided a lens through which the components of the programme could be seen in new ways, treating student teachers as both learners and teachers of argumentation. As Figure 1 shows, SIMPL first focuses on the learning of science content and the teaching of science respectively. These are congruent with the programme structure which, as indicated in the preceding section, provided opportunities for prospective teachers to *engage in argumentation* and learn about the *teaching of argumentation*. The degree of congruence provided the reassurance that further analysis using SIMPL would be valuable. Second, SIMPL suggests a sequence of instruction in which there is an intentional focus on the differentiation of domains of learning, making it possible to understand their interrelationships more explicitly. For example, the student's domain focuses on the learning of science; questions about how to teach science are held in abeyance until instruction enters the teacher's domain. The comparison between this sequencing model and the programme showed that the teacher educators used a different pattern, in which they would frequently switch between questions of learning (what it means to engage in argumentation) and teaching (what implications this holds for how to teach argumentation). The recognition of these different patterns led to fruitful discussions about how best to differentiate between conversations with students in each domain, the purpose being to bring clarity rather than confusion to an understanding of the appropriate ways of integrating issues across domains. For example, in discussing the phase of the didactics module where student teachers were engaged in peer teaching, author five stated:

> *If you look at the model … it is interesting* [in peer teaching] *that you have two independent parties so to speak, the one practising* [the student teacher who is teaching] *the other one also, the student teacher as a learner. There's an overlap of some of the elements* [of the model] … *and I find it very interesting but also quite confusing!*

While these two aspects were an integral part of the programme, they had been, in one sense, taken for granted. Becoming aware of them and, as a result, seeing the match between model and programme did two things: first, it provided an assurance that looking more carefully at possible matches between SIMPL and the programme could identify other aspects of interest and importance. Second, awareness of an implicit, taken-for-granted aspect raised the possibility of taking more informed decisions about the way the programme is taught.

Reflections about the roles of the participants in the programme

Reflection using SIMPL improved awareness of the different roles that participants in the programme played. With respect to the student teachers in the programme, SIMPL illuminated that they played multiple roles. As the first group of findings (about the observed teaching of the argumentation module) detailed, these roles were as

- learners of argumentation – during the programme they had frequent opportunities to engage in socio-scientific and scientific arguments, i.e. they were learners in the student's domain;
- learners of the teaching of argumentation – they had opportunities to plan two to three argumentation lessons, i.e. they were learners in the teacher's domain;
- teachers of argumentation – in teams of four to five they taught the argumentation lessons they planned to their peers, i.e. they were teachers, albeit novices, in the student's domain.

Making these roles explicit had two notable consequences for the teacher educators. First they realised that their attention had primarily been focused on their students' roles as teachers, and that they had paid far less attention to their students' roles as learners. In other words, they recognised that they had not explicitly emphasised their students' own learning in the process of 'learning to teach argumentation'. In relation to this point, author four stated:

> *Our main focus was the teaching of argumentation and that's the role that we chose to highlight constantly, whether consciously or unconsciously. We didn't even think about them* [the student teachers] *as learners* [of argumentation].

A further consequence for the teacher educators is that the focus, in the SIMPL model, on their students' learning led them to reconsider their own roles. The outer spheres (domains) in Figure 2 identify different roles that could be played by teacher educators. In the teacher's and teacher educator's domains, they take on the roles, respectively, of teacher educator as teacher and teacher educator as learner. For the teacher educators in this study (authors three, four and five), on the one hand, they readily saw themselves as teacher educators concerned with teaching, but for the most part they had seldom reflected on their own paths of learning. Instead, most of their attention was directed to managerial aspects to improve the programme, in terms of the on-campus didactics module and during the following semester's teaching practice, where they would be working with student teachers and their mentors. A shift in thinking, raised by the SIMPL model, led author four to state:

> *When I look at the model now ... SIMPL kind of makes sense. You know ... here's this circle with this part of learning* [for the students] *and that part of learning* [for me as teacher educator]. *Your roles as a teacher educator ... were kind of integrated ... and now with this in mind we possibly would be rethinking what we do ... about not jumping in and out and changing roles all the time. Next year I can make the roles students play as learners, learners of teaching and teachers much clearer.*

Empathy with SIMPL provided a rare metacognitive space. As author four stated:

> *I mean … the thing for me is you never think about your own learning as a teacher educator. SIMPL forced me to think about my own understanding of the content* [of the course for student teachers] *and then … your own knowledge base, your own skills* [as a teacher educator] *and you know how much you knew*.

Discussion

The findings raise two important questions about teaching prospective teachers to teach argumentation. First, how can student teachers' learning be improved to make them more likely to be successful as teachers of argumentation? Second, how do insights on teaching teachers, gained from reflections using the SIMPL model, provide teacher educators with clearer insights on their roles in teaching future teachers of science?

While student teachers were relatively successful in understanding TAP and the contribution of its components (claims, warrants, backings and rebuttals) to a critical examination of science, they had more difficulties in translating that understanding into productive teaching contexts. For example, when argumentation was practised with peers, socio-cultural and socioeconomic contexts (ones already mentioned and others such as plans for local mining, medical treatments offered by traditional tribal practitioners, selling of organs for transplants) dominated student teachers' argumentation questions. There are positive and negative aspects to this.

On the positive side, Hamm and Adams (1992:83) point out the advantages of discussions about issues critical to the economy and welfare of the country as, 'maths and science move from a computational and factual base to a problem-solving emphasis'. In a teacher education context, Sandra Abell (2007:1113) takes the view that '[s]cience teacher education must honor not only formal teacher knowledge (curriculum, general pedagogical and subject content knowledge) but also the local and practical knowledge of teachers in the field and the sociocultural contexts that frame their work'.

However, on the more negative side, teaching science content using sociocultural contexts for argumentation can be more difficult than using more context-independent arguments about science concepts. Our research in South African classrooms and the results of other similar studies show that sociocultural argumentation contains complex science content which, if not learned or tackled before, results in lessons where superficial and emotive claims dominate and science plays a minor role (Braund et al. 2007; Dawson 2008; Simon, Erduran & Osborne 2006). In this study, although most student teachers' plans for their peer teaching sessions placed equal emphasis on science and argumentation content objectives, in their lessons, science learning was limited since claims and rebuttals, where warranted, most often drew on evidence from personally and culturally or politically embedded constructs. These are important matters of student content learning to bear in mind when working with future cohorts of student teachers, so as to encourage them to value, and operate in, both scientific and sociocultural aspects of argumentation.

Another limitation in student teachers' argumentation lessons was the extent to which they were able to facilitate, progress and sustain argument lines as well as the claims, warrants and rebuttals of their peers – in other words, to keep arguments going in fruitful directions. Two strategies, found to be useful in doing this, namely positioning and playing devil's advocate (Braund et al. 2007; Simon et al. 2006), were rarely used. This was partly due to their reluctance to intervene in discussions amongst their peers, so that decisions about when and how to contribute or challenge were absent. It was as if student teachers in this study were satisfied with the often enthusiastic engagement of their peers in argument they had prompted, but knowing what to do beyond this was not yet part of their teaching repertoires.

Student teachers often missed critical moments at which their interactions could have been productive. One reason could be student teachers' personal learning biographies, since most will have received very didactic teaching with little experience of interaction between learners, let alone any examples of argument or debate. The impact that previously experienced teaching has on student teachers' own practice is well known (Beck, Freese & Kosnick 2004; Berry 2004). In addition, it has been found that novice teachers who are least confident about their abilities – especially in managing and interacting with school students – are also least likely to engage with group work, and consequently can feel uncomfortable interacting in group situations (Helsing 2007; Wubbels & Brekelmans 1998). Furthermore, it seems that time and practice are needed for students and teachers to appreciate what is required in order to work productively in collaborative situations (Slavin 1996).

Turning to insights from the reflection using SIMPL, Loughran sees teacher education as 'a place where challenging simplistic notions and practices should be normal, for it is where the seeds of change for the profession surely lie' (Loughran 2006:14). We have found SIMPL provides a way of operationalising Loughran's aim. In common with other countries, science and technology teacher educators in South Africa typically enter the role of teacher educators having been good classroom teachers and leaders in their respective subjects. Each of the authors who taught the argumentation module had previously taught one of the subjects in schools. But, as Ducharne (1993) warns, many struggle in the transition from school teacher to teacher educator. What makes being a teacher educator far more complex than most people who are engaged in it realise, is that practitioners deal simultaneously with what Russell (1997) calls the *content turn* of their teaching (such as knowledge of classroom management, wait time, higher-order questioning and so on) and the *pedagogical turn* (involving practices employed in presenting the subject matter). For teacher educators to understand their roles at this level of complexity requires what Loughran (2006:6) sees as a metacognitive element in pedagogy of teacher education. As he puts it, teaching teachers involves

> *unpacking teaching (of teachers) in ways that gives student teachers access to the pedagogical reasoning, uncertainties and dilemmas of practice that are inherent in understanding teaching as being problematic.*

SIMPL, with its explicit separation of emphasis on student learners' learning and teachers' learning provides moments in university teaching where these two domains can be better separated in the minds of the teacher educator. Whether the teacher educators in this case study wish to go so far as to use Lauffer and Lauffer's original intention – marking moments of teaching when their student teachers enter the student's or teacher's domains (with a pointer in their case) – remains to be seen, but at least using SIMPL as a reflective lens on practice has prompted deeper metacognition.

Conclusion and implications

A policy document for teacher education in South Africa (Department of Education [DoE] 2006) reinforces the importance of reflective analysis by student teachers, allowing for the integration of various strands of professional knowledge:

> Both conceptual and content knowledge and pedagogical knowledge are necessary for effective teaching, together with the teacher's willingness and ability to reflect on practice and learn from learners' own experiences of being taught. These attributes need to be integrated, so that teachers can confidently apply conceptual knowledge-in-practice. (DoE 2006, Para 45:16)

For this to be a reality in the case of teaching argumentation, requires student teachers to go well beyond merely what they learned at university. The facilitated reflection here, enabled using SIMPL, highlighted a number of ways in which first attempts to educate future teachers to teach, by using argumentation, can be improved. As a result of observation notes and the first meeting between the authors, where SIMPL was first used to facilitate reflection, the following steps to improve the programme were suggested by authors three, four and five:

- Restructure the programme so that student teachers gain more confidence by teaching an existing argumentation lesson (from resources supplied), before moving on to developing and teaching their own lessons;
- Tutors should model more argumentation lessons and the structuring of activities in such lessons in the subject didactics component, to make explicit links between teacher educators' teaching and student teachers' learning;
- Focus explicitly on classroom management and teaching techniques such as organisation and interactions in group discussions (positioning, playing devil's advocate);
- Identify opportunities for student teachers' and teacher educators' reflections on the suitability and efficacy of contexts for argumentation throughout the programme;
- Highlight the science and technology content of socio-scientific arguments.

Zeichner and Gore (1990) offer the idea that teacher education programmes often fail to impact pre-service teachers' beliefs and that the overall university teacher education experience may be inconsequential when teaching in real classrooms. Korthagen (2010) has criticised teacher education courses for teaching theory without student teachers having a sufficient practicum base on which to make sense of theory in practice. The influence of the university-based element of teacher education programmes has been found to be strong in cases where students and newly qualified teachers have shifted their views of how learners learn, as a result of their teaching (Braund 2001; Hand & Petersen 1995). On the other hand, Barone, Berliner and Blanchard et al. (1996) argue that the theory–practice divide in teacher education has resulted in programmes having isolated components in which theory is presented with hardly any connection to practice. We suspect this has commonly been the case in many programmes in South Africa. Tatto (1998) surveyed nine teacher education programmes and found that those which were more successful in getting graduates to adopt a university-advocated approach, had the following characteristics: a consistent philosophy promoted throughout the programme; faculty who maintained and espoused a consistent vision; and context-relevant experiences.

With refinements prompted by this study we believe the programme reported here will easily provide such characteristics and go on to help supply the kinds of new teachers that South Africa needs, to realise its democratising ambitions in science and technology education.

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