PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016
21

PHYSICAL SCIENCE TEACHERS' PERCEPTIONS OF AN ADVANCED CERTIFICATE IN EDUCATION

Sarah Bansilal, Angela James
University of KwaZulu-Natal, South Africa
E-mail: Bansilals@ukzn.ac.za, Jamesa1@ukzn.ac.za

Abstract

Advanced Certificate in Education programmes was offered by many South African universities to provide opportunities for teachers to upgrade their positions. The purpose of the study was to explore Physical Science teachers' perceptions of their professional development. In this study we considered three domains of professional development which are content knowledge, pedagogic content knowledge and teacher beliefs and attitudes. This study used a mixed method approach using the form of an embedded design. The study was conducted with 156 students enrolled in an ACE Physical Science programme. The teachers stated that their content knowledge and pedagogic content knowledge had not only improved, but also their engagement with actual laboratories, and conducting experiments contributed to their teaching experiences. Hence, their self-confidence of physical science teaching evolved. The authors recommend that the ACE programme should also include a mentoring system with teaching practicum via school leadership and subject advisers.
Key words: *content knowledge, professional development, physical science teachers, pedagogic content knowledge, teacher beliefs, teacher confidence*.

Introduction

A sector of education that has been greatly affected by the series of closures, reconfigurations, mergers, curriculum revisions and other transformation exercises carried out in South Africa since 1994 is that of in-service teacher education. The planning and implementation of suitable programmes for underqualified teachers who were already in the system increased in urgency as many teacher training colleges were closed in the 1990s. Finding ways to enhance the professional development of practising science and mathematics teachers has been a focus of many studies in South Africa (Stears, Good and James 2012; Sibanda and Jawahar 2012; Bansilal and Rosenberg 2011; Kriek and Grayson 2009).

During the apartheid era teacher training was effected by the various separate education departments which were organised according to race. Initial teacher education preparation was segregated in that former black colleges offered a three-year diploma in Education while former white and a few other colleges offered a four-year higher diploma in education (Council for Higher Education 2010). In the 1990's a decision was taken to close all colleges of education, even those that offered opportunities for underqualified teachers to upgrade their positions. A teacher with a three-year qualification was and is currently regarded as underqualified and is required to complete a formal programme such as the Further Diploma in Education. On successful completion this would render a participant fully qualified who would then have the equivalent of a relative education qualification (REQV) of a four-year degree or diploma. The further diploma was later replaced by the Advanced Certificate in Education (ACE), which is the focus of this study.

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

The decision to close colleges, put pressure on the education department to provide upgrading opportunities for these teachers and the ACE programmes were commonly offered by many universities in response to the challenge. In fact in 2006 there were 69 different ACE's with over 290 specialisations (CHE, 2010).

The delivery of the programme was such that the general education modules were offered using a distance education model. Teachers completed various assignments based on the materials that were designed for self-study, but were complemented by teaching. The content modules were offered via face to face contact sessions that the teachers attended during Saturdays and school holidays. Tests and practical laboratory sessions were also conducted during these times. There were six content modules related to the teaching and learning of physics and chemistry and two generic education modules.

Literature Review

Avalos (2011) suggests that understanding teachers' professional development is complex in nature and requires both the cognitive and emotional commitment of teachers as individuals or as a group. It is also essential that these programmes are able to develop the necessary knowledge competence of the subject taught by the participants and the knowledge and skills of how to present the content to the learners (pedagogic content knowledge - PCK).

Morrow (2007) considers two important questions when designing and implementing teacher professional development programmes: what work is expected of teachers and what are the contexts in which they work? Johnson, Hodges and Monk (2000) criticize the reflection of research about effective in-service provision, on the dominant concerns of teachers from Northern/Western contexts. These authors contend that teachers who work in developing countries such as South Africa are constrained by different sets of circumstances, work in different contexts and, as such, need different in-service provisions to those from developed countries. Hence the models underpinning the professional development of teachers need to be evaluated in terms of the perspectives and contexts of the participating teachers. With the emphasis of the government on developing quality science and mathematics teachers, various international and South African agencies have partnered with the national government to deliver interventions aimed at improving the state of school mathematics and science by focusing on improving teachers' subject content knowledge. One such example is the Mpumalanga Secondary Science Initiative (MSSI) which was a school-based system of professional development to improve the teaching of mathematics and science at the junior secondary level (Ono and Ferreira 2010). This intervention used the Japanese model of professional development through lesson study. This model with its clear focus on supporting teacher development within communities of practice in their specific school contexts experienced disruptions that arose mainly from the constraint of time. Teachers struggled to find time for the necessary participatory planning and evaluating of lessons that are integral to the lesson study approach. Teachers' time was occupied by demands to attend training workshops for revisions to the school curriculum. Kriek and Grayson's (2009) (HPD) model for physical science teachers in South Africa explicitly integrated the development of teachers along the three dimensions of content knowledge, teaching approaches, and professional attitudes. The authors argue that teacher professionalism is about the quality of practice that a teacher demonstrates and it was because of the integration of the three dimensions of professional development that refer to their model as holistic. Their study found that the application of the HPD model with practising physical science teachers supported their development along the three desired dimensions. It was found that the improvement of teachers' content knowledge increases teachers' confidence, which, in turn, stimulates them to use a variety of teaching strategies, in particular, more learner-centred and activity-based approaches. The authors suggest that the use of more innovative teaching

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

approaches makes science classes more interesting and will lead to better understanding and a more positive attitude towards science among learners.

Stears, Good and James (2012) conducted research with six physical science teachers enrolled in the ACE programme that is under scrutiny in this study. The purpose of the research was to explore the factors that shape the professional identities of teachers, including their engagement in the ACE programme. The study found that the teachers' pedagogic knowledge as well as didactic knowledge are not valued as highly as content knowledge. The findings of this study emphasise the value placed on subject knowledge. To these teachers the quality of subject knowledge held by a teacher, determined the quality of the teacher. Their identities are strongly shaped by their view of themselves as subject specialists as defined by their subject knowledge. Pedagogic knowledge contributes very little to the identities of these teachers. The teachers did not appear to be sensitive to the changes in didactical approach required by the NCS (DoE, 2003) or the CAPS document (DoBE, 2011). Stears et al. (2012) recommend that the ACE programme should include the mentoring of teachers so that the teachers can understand their roles as more than mere deliverers of information.

Research into the professional development of South African teachers has focussed on the different methods used and the impact of this on their development in terms of their content knowledge and pedagogic practices. A focus on the emotional development of teachers is lacking and this is the gap that we sought to investigate and add literature about.

A Framework for Understanding the Professional Development of Physical Science Teachers

Many studies focusing on professional development include aspects of content knowledge, pedagogic content knowledge and attitudes or identity or beliefs (Peressini et al. 2004; Kriek and Grayson 2009; Bansilal and Rosenberg 2011; Brijlal 2014). Stears et al. (2012) used a framework of teacher professional identity comprising the facets of teacher as a subject matter specialist and pedagogical expert and didactical expert. In this study we consider three domains of professional development which are content knowledge, pedagogic content knowledge and teacher beliefs and attitudes and these are now elaborated on.

Content Knowledge for Teaching

Many research studies highlight the important role played by teachers' conceptual knowledge in developing students' understanding (e.g., Ball and Bass 2000; Perressini et al. 2004; Adler et al. 2009; Kriek and Grayson 2009). In South Africa Kriek and Grayson (2009) note that in order to develop a deep understanding of physics, teachers need to not only acquire knowledge of central concepts and principles, but also develop various thinking and reasoning skills. Content knowledge for teaching includes both school level content knowledge as well as knowledge of concepts on the horizon. Ball, Thames and Phelps (2008) speak about *horizon knowledge* for teaching mathematics. This model is adapted and used to describe it more generally as an awareness of how science topics are related over the span of science included in the curriculum (adapted from Ball et al. 2008, 403). Knowledge of school level topics is what Ball et al., refer to as common content knowledge. Hence, content knowledge for teaching includes both common content knowledge as well as horizon knowledge of physical science concepts.

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

Teaching Strategies

Kriek and Grayson's (2009) category of teaching approaches and Stears et al.'s (2012) notion of teacher as a didactic expert are closely aligned to the broader notion of pedagogical content knowledge, which is the: "… subject matter knowledge for teaching … the ways of representing and formulating the subject that make it comprehensible to others" (Shulman 1986, 9). Effective teachers have a repertoire of teaching strategies based on sound pedagogic content knowledge which they constantly draw upon to make the concepts and principles of science accessible to their learners.

One important facet of teaching physical science is that of conducting experiments as part of the practical work that is involved in the subject. The use of practicals in science can be used to demonstrate everyday phenomena as well as to investigate and discover laws that underpin many models in Physical Science. Conducting and designing practicals is an important teaching skill and is emphasised in the physical science curriculum documents, which stipulate that:

> Practical work must be integrated with theory to strengthen the concepts being taught. These may take the form of simple practical demonstrations or even an experiment or practical investigation (Department of Basic Education (DoBE) 2011, 11)

Hence this study takes cognizance of the ways in which teachers improved their teaching approaches and their development of skills in implementing practicals as well as integrating the practicals with the theory.

Teacher Attitudes and Beliefs

Teaching occurs in a sociocultural context (Van Huizen, van Oers and Wubbels 2005; Hughes 2006; Morrow 2007; Samuel 2008; James, 2009) where it "concentrates on the connections between individual functioning and development *and* the sociocultural practices in which individuals take part" (Van Huizen et al. 2005, 271). Hence professional development is influenced by the goals, values, commitment, beliefs, attitudes and other personal characteristics which create a sense of who the person is as a teacher. The need for the component of professional attitudes was acknowledged by Kriek and Grayson (2009) and James (2009). One of the important elements of teachers' attitudes is their confidence in their own knowledge and practice. Under this category, we looked at the confidence that the teachers displayed in their own ability to teach the subject.

Methodology of Research

General Background of the Research

In this study the researchers look at an ACE programme for upgrading Physical Science teachers in the province of KwaZulu-Natal. The teaching on the programme was carried out using a two-tier partnership model at four centres in KZN. Various modules were taught in the programme. The modules were designed and planned, and the materials and assessments were monitored by the permanent staff members of the university, also referred to as module coordinators. The teaching was undertaken by tutors who were employed on a contract basis, and were supervised by the module coordinators. The purpose of the study was to explore Physical Science teachers' perceptions of their professional development. The following research question guides the current study:

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

- What are the physical science teachers' perceptions of the ACE programme?
- Does a mixed mode delivery system/programme enhance or constrain their professional development?

Sample Selection

The ACE Physical Science programme at the University of KwaZulu-Natal was presented across four different teaching centres within the province of KwaZulu-Natal. A total of 273 teachers were students in this programme. Purposive sampling was used and 156 teachers were asked to volunteer to participate in the research and to respond to the questionnaire. Eight students, two from each of the four different UKZN ACE teaching centres consented to being interviewed, at times that were convenient to them.

Instruments and Procedures

In this study, a mixed method approach using the form of an *embedded design*, where the researcher collects quantitative and qualitative data simultaneously, but one form of data plays a supporting role to the other form of data (Creswell 2008). The quantitative data from the questionnaire played a supporting role to the qualitative data that were elicited from the questionnaires and interviews.

Since the purpose of the study focused on the teachers' confidence in their ability to teach the subject, an analysis of the teachers' lesson plans and the observation of their lessons were also conducted. This was done to triangulate the data, to portray consistency (Calik & Aytar, 2013). The contract lecturers were the field workers and were fully informed about the purpose of the research and their role in collecting data. The research questions and the use of the data collection instruments, including the data sought were discussed with the contract lecturers, to ensure trustworthiness. The teachers were asked to respond to a questionnaire on their confidence and ability to teach the subject – Physical Science. Some of the statements included in the questionnaire were: my content knowledge has improved; my teaching strategies have improved; my confidence as a Physical Science teacher has increased, and the Physical Science results of my learners have improved. The questionnaire used a five point Likert scale: the options (responses) were strongly agree, agree, neutral, disagree and strongly disagree and the teachers had to choose one option for each statement. Questions in the interview concerned teachers' improvement of their content knowledge, what impacted on this improvement, the nature of the impact, and on what they would like changed in the programme. Trustworthiness concept used by Guba and Lincoln (1994) for interpretivist research was adopted where credibility, dependability and confirmability were ensured. Credibility was enhanced during the data collection by using tape recorders to record the interviews word for word, before transcribing them and capturing them electronically, so as to improve accuracy. Dependability was achieved by the triangulation of the data generation process using questionnaires and interviews, and by asking the teachers the same questions in different ways. Also, the teachers were given assurance of anonymity of how the researcher will use pseudonyms so that their true identity would not be revealed, and they could therefore speak confidently and as honestly as possible.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

Results of Research

The results are discussed under three headings linked to the research questions, content knowledge, teaching methods and attitudes and beliefs.

Content Knowledge

All the teachers agreed that their content knowledge improved as a result of the programme. The results from the questionnaire are given in percentage form in the table below, where the letters SD, D, N, A and SA represent strongly disagree, disagree, neutral, agree and strongly agree respectively.

Table 1. Teachers' responses about their teaching practice.

Teaching Practice	No response	SD	D	N	A	SA
My *content knowledge* has improved	0.64	0.00	0.00	1.92	46.79	50.64
My *teaching strategies* have improved	1.92	0.00	0.00	10.26	48.72	39.10
My *confidence as a PS teacher* has increased	2.56	0.00	0.00	7.69	44.87	44.87
The *PS results* of my learners have improved	5.77	0.00	1.28	28.85	52.56	11.54

This shows that all 97% of the students agreed (47%) or strongly agreed (50%) with the statement that their content knowledge improved. Similarly with teaching strategies, 88% of teachers felt that there was an improvement while 90% of the respondents felt that their confidence had improved. Of the group, 64% reported that even the results of their learners had improved.

From the interviews, all eight teachers agreed that their content knowledge for teaching had improved.

Teachers T_3 and T_4 felt that whereas previously there were school level concepts that they were uneasy about, this is no longer the case. Teacher 5 expressed views similar to teachers 3 and 4, but specifically mentioned a section that she used to avoid, an action which was no longer necessary.T_5 said "I had never done electrostatics with my learners before because I never knew it. I didn't even attempt it from the textbook because I never understood it … I became confident enough to do it on my own". T_2 said "we are currently doing some topics I've never done before such as Electricity and I found it helpful". Hence these teachers were pleased that exposure to topics in the school curriculum had improved their knowledge.

Some felt that they gained knowledge beyond the school curriculum. Teacher T_2 recounted that whereas before the course he had "been teaching the subject based on the content learnt in high school" … the "programme … exposed me to information that [he] did not have and validated what [he] had already known". T_2 explained that the programme exposed him to knowledge beyond school level content.

The ACE programme as a university level programme is required to present content equivalent to second year physics and chemistry at university. Subsequently, it seems as if some teachers were satisfied that they learnt school level concepts enabling them to be more confident about teaching those concepts to their learners. Some (for example T_2) were pleased that they developed knowledge beyond school level concepts. This type of knowledge is considered as

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

horizon knowledge because it serves as necessary background for the teaching of concepts at school level. T_1 expressed the notion of horizon knowledge as 'advanced knowledge' required when you teach a subject:

> When you present a topic to learners you need to have advance knowledge which requires a lot of research. Each time we are attending contact sessions it feels like doing research and we are able to go back to learners and explore with them.

Hence T_1 has expressed his opinion about learning horizon concepts as those which enable a teacher to know beyond what is required in the classroom and provides the teacher with the flexibility to allow his learners to explore the content.

However, the results from the programme showed that only 48% of the group completed the course. Only 39% of the group did so within the two-year period and the other 9% took three or more years to complete the course. This shows that half of the group (52%) were unable to meet the demands of the programme.

Two issues with respect to the generic modules were also revealed. Firstly, teachers did not appreciate the delivery mode of the generic module as stated by three teachers who were interviewed. One teacher's comment was that it would have been preferable to have the modules assessed on a continuous assessment basis instead of having the summative examination, for which they did not feel sufficiently prepared. One written comment by T_{32} was that "there is too much work in the education modules". The comment suggests that the teacher was unhappy about having to do so much self-directed work. The generic education modules required the teachers to work with the written materials by themselves and to complete their assignments based on these materials. The discussion classes were not designed to teach the content covered in the materials, but were to highlight salient issues and provide guidance on the assignments.

The second issue about the generic modules was the content. One teacher T_{13} did not view the actual content as useful because "it does not show me how to teach". Twelve questionnaire responses indicated that the modules they felt were least useful were the generic education modules.

Teaching Methods

From Table 1, it is noted that of the 156 teachers, 88% of them said that their teaching strategies had improved on completion of the programme. The teachers who were interviewed were also positive about the improvement in their teaching methods.

T3 said: "The subject we are teaching is very complex and constantly requires new and better methods of delivery to the students. The programme has helped regarding that latter."

Some teachers such as T8 mentioned that they learnt different approaches for teaching certain topics:

> My teaching methods have improved. Through the programme I learnt different methods of delivering the content to learners. For example, calculation of equilibrium, I learnt new and simpler methods of calculating chemical equilibrium.

Some teachers (T6) found that they learnt new methods by watching their tutors while others (T7) mentioned that the course materials acted as a teaching resource.

> T6: I use some methods I learn from our lecturers when they teach us.
> T7: A good thing about the material is that we can re-use it in our teaching in the classroom

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

An important aspect of teaching physical science at school is practical work. The curriculum documents (DoBE, 2011) recommend that at least one practical activity is carried out each term. However, conducting practicals is a challenge for many teachers. The technical report on the National Senior Certificate examinations, recommended that "Learners need to conduct experiments and do other practical work in order to understand" the concepts (DoBE, p183). In South Africa the poor skills in practical work is an ongoing problem that the authorities have tried to address but are stymied by the fact that many schools do not have laboratories. In order to alleviate this problem, teachers on this programme were provided with science kits which could be used for many of the experiments required in the curriculum. All the teachers who were interviewed were pleased about the ways in which their exposure to actual laboratories and the experiences of conducting experiments, contributed to more effective teaching.

During the programme teachers conducted practical work in the laboratories. T2 reported that "I got more exposure to a laboratory setting and gained confidence in teaching practicals to my learners", showing that he developed confidence in carrying out practicals. T3 said that the practical sessions helped improve his knowledge and he found the science kits useful because he used these resources to conduct practicals in his class. T3 said that "because of the practicals provided by the programme, I now have a very clear picture of what is expected of the teacher when conducting an experiment to learners." T4 was also very grateful for the science kits. He responded:

> Before, we used to do a lot of theory in the classroom. Now we are able to do more practicals using the material and kits we received from the University. We now start with theory and the practicals and learners become very excited and you find that learners are able to remember what they've learnt because of the practicals. We feel happy about the equipment we receive and we put it in very good use.

T5 explained that the kits made it easier for him to teach:

> "For example if we are talking about Zinc powder and Zinc lumps, I can easily explain the difference between two to learners because they can physically see it"

T2 summarised the power offered by the science kits:

> When discussing topics in the classroom I'm able to take out the apparatus and show the learners what I am talking about. The learners don't have to imagine what I'm talking about they can physically see it. For example if I'm talking about a colour change, they can see the colour change

The preceding comments reveal that one of the concrete ways in which the programme helped the teachers was in conducting experiments while also providing necessary equipment that could be used. It also contributed to the development of practical skills, interest and positive attitude in science for the learners.

However, some teachers felt that they needed more help with approaches to teaching the subject. T5 explained:

> "Regarding teaching methods, we concentrated more on the content and very little on the teaching methods."

T1 felt that there were too few opportunities for interaction with other teachers and he would have preferred for separate modules on content and on the methods:

> I feel the course offered integration of content and method only during group works where we get a chance to interact with other colleagues and get different ideas of teaching

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

methods. There is no separate segment where there course focuses on methods.

T2 asked for more exposure to teaching methods beyond the level of the current focus on content:

"I feel we should get more exposure in the methods and not more the content as the programme currently offers"

T6 commented "Including teaching methods in the programme would really help us". The teachers expressed a need for more direct help with the school level content: T3 said that "the most useful [modules] are the ones that cover content that we teach at schools with our learners, especially the ones covering Grade 11 and 12 contents that were most useful" showing that they felt they wanted direct help with the concepts they were going to teach. Another aspect of the programme that may have contributed to the teachers' professional development was the fact that the teaching methods are modelled by the tutors. As the tutors taught the teachers, their methods and presentation techniques would have helped the teachers develop their own repertoire of teaching skills. In terms of conducting practicals, the modelling of the teaching by the tutors would have been particularly useful because many teachers did not have the experience of previously working in laboratories.

Attitudes and Beliefs

As a result of their improvement in content knowledge and teaching approaches, the teachers' attitudes about teaching and beliefs in themselves improved. There was agreement by 90% of the questionnaire respondents that their confidence as a physical science teacher improved.

As asserted by T8: I am more confident now … After gaining more information on these topics from the course I realised how important they are. Now I am confident to teach these topics to great depth.

Comments by T_2 also conveyed that he was much more confident about practical work. T3 noted:

"I am more empowered now as I have more knowledge, content and methods of delivering the subject compared to before, I am very proud because we are now very respected out there".

This comment suggests that the participation in the programme improved his knowledge and teaching methods which seem to have been recognised by others who now respect him.

Discussion

This study revealed that the teachers perceived improvements in their content knowledge. Teachers mentioned that they improved their knowledge of school level concepts (common content knowledge) as well as topics beyond the curriculum (horizon knowledge) which provide insights into their teaching of the concepts. Teachers also noted improvements in their teaching approaches. They learnt new methods of teaching certain topics, some learnt from observing the tutors and others used their learning materials as teaching resources. They were particularly pleased with the provision of the kits which allowed them to carry out practicals in their classes as well as to demonstrate some physical properties of chemicals. The kits allowed them to bring together the theory and practical aspects in certain instances. Many South African teachers have limited exposure to practical work from their professional development degrees

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

and treated practical work as a theoretical exercise, but by actually conducting practicals served to enhance their practical skills and content knowledge as well. Also, it served to stimulate their attitudes and make the related knowledge more meaningful (Calik, Ozsevgec, Ebenezer, Artun, & Kucuk, 2014). Most teachers, therefore expressed a sense of confidence in themselves.

In trying to represent the findings of the study, we offer the following model in Figure 1 that is adapted from (Brijlal, 2014). As depicted in the figure, the study has shown that the professional development of the participant teachers was enhanced by participation in the programme. The component "confidence" emerged as a striking factor within this research. Their content knowledge and pedagogic content knowledge improved and this improvement led to an increasing amount of confidence about themselves as physical science teachers. Figure 1 shows the relationship that existed and was interpreted according to this research.

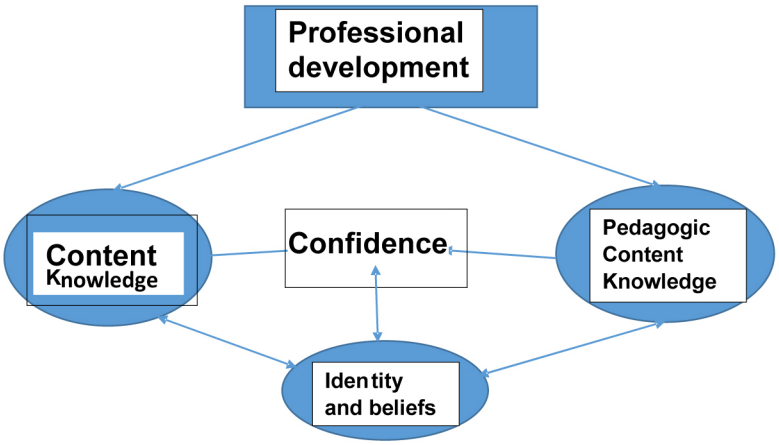

Figure 1. Diagram showing links between confidence and professional development (Brijlal 2014).

The teachers were more assured about the content they were required to teach and they had a repertoire of strategies that they had learnt. The development of their content knowledge and PCK also impacted on their own identities and beliefs about themselves as teachers of physical science.

The study also showed that some teachers were not yet fully confident. Four teachers said they would have welcomed more help in mediating the content with their learners - some asked that there should be separate modules focused on methods of teaching. These four teachers recognised that they required help in developing their teaching approaches. Since they had experienced teaching as a memorisation process, they used strategies to transmit content to learners, construction of knowledge by learners was not considered. Their misgivings are supported by a similar study conducted by Stears et al (2012) where they observed six teachers who were enrolled on the ACE programme and found that these participant teachers placed little value on the pedagogic aspects of teaching Physical Science. Stears et al. (2010, 251) comment that the programme "falls short on developing teachers who are competent to follow an inquiry approach".

This study also found that many teachers struggled with understanding school level concepts which was indicated by tutors as well as by the teachers themselves. This problem of poor knowledge of school level content is an underlying problem that constrains the professional development of teachers in a developing context such as South Africa. Those teachers who were

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

underqualified had only a three-year diploma from a teaching college during the apartheid era. Many studies have noted the poor preparation of teachers from most (not all) of these colleges. The ACE programme was offered by a university and as such had to offer content that was the equivalent of first year university level science content in the subjects. There was therefore a balancing equilibrium that the programme tried to achieve which was sometimes, but not always successful. Many teachers struggled as evidenced by the high drop-out rate and the fact that less than 50% of the group completed the programme within the stipulated time frame of two years. What the study reveals is that the upgrading of teacher qualifications requires a sound knowledge of school level content (common content knowledge) which can act as a foundation upon which the advanced concepts can be constructed. Without this, the gap can be too large as suggested by the large numbers who dropped out without completing the course. Consequently, there is the problem of helping teachers develop a sound understanding of the actual concepts they teach. Teachers were of the opinion that this was most important to them. However, research indicates that teachers need to know more than what they will teach and it is important that they are exposed to concepts at the horizon because this will help provide them with the insight that can help them plan and sequence their teaching as well as form links between the various topics and convey the significant ideas behind the teaching of science. The two year part-time programme failed to provide sufficient time for more than half the group to develop the necessary competence in the horizon concepts.

Stears et al. (2012) recommend that the ACE programme should also include a classroom support component of mentoring so that these teachers could be supported while trying to improve their practice. This could help in two ways. Firstly, mentorship would contribute to helping those teachers with poor school level content knowledge to improve. Secondly, it could help teachers develop inquiry oriented approaches which are more aligned with curriculum reform outcomes. Ideally, classroom support should be provided by school management and subject advisors. However, in the South African situation there has been much criticism about the limited role played by subject advisors in supporting teachers. Teachers often teach in isolation and have few avenues for support when they encounter conceptual difficulties. Providing support to teachers is a dilemma (Calik, 2012) as the appointment and monitoring of subject advisors is fraught with political problems between unions and the departments of education. The inclusion of a classroom support component in teacher development programmes presented by universities is a short term and limited solution. Ideally, the education department should focus on reconstructing the provision of quality classroom support for teachers at various levels of subject heads of departments, school management, district management and subject advisors.

Conclusions

The professional development of teachers in South Africa, a developing context, is faced by various challenges. The large number of unqualified teachers raised questions about possible models of professional development that could enhance both the content knowledge, the pedagogic content knowledge of teachers and in the process increase their beliefs and attitudes in teaching Physical Science. The implementation of an ACE programme was viewed as essential to achieving this end. Since teachers were expected to engage with horizon knowledge and to conduct practicals with the actual kits provided to schools, these served to instill in teachers a greater link between the theory and practical interest in what they were teaching.

Furthermore, the classroom support in any teacher professional development programme serves an important role as teachers are mentored in their presentation of teaching differently. It is at these times where a teacher may be regarded as a novice experienced teacher. Change is certainly difficult for most teachers to work with, so in their novice change state effective guidance, rich in motivation support should be implemented. Research into the models of

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

mentoring in-service teachers and the effect of this on the personal and professional development of teachers requires further research. The Department of Education as their organizational structure have designated persons to support teachers, but this support is lacking or absent in most instances, as finances are deciding what the role of these essential support persons is. Teaching is a highly "emotional affair" and in South Africa, there should be no risks with how teachers are supported but, clear, actionable practices should be identified and actioned.

References

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education*, *27*, 10-20.

Adler, J., Pournara, C., Taylor, D., Thorne B., & Moletsane, G. (2009). Mathematics and science teacher education in South Africa: A review of research, policy and practice in times of change. *African Journal of Research in MST Education - Special Issue,* 28 – 46.

Bansilal, S., & Rosenberg, T. (2011). South African rural teachers' reflections on their problems of practice; taking modest steps in professional development. *Mathematics Education Research Journal*, *23* (2), 107 – 127.

Brijlal, P. (2014). An exploration of the contribution of the ACE in Mathematical Literacy programme towards the professional development of teachers in KwaZulu-Natal. *Unpublished M.Ed dissertation*, UKZN.

Calik, M. (2012). A dilemma in upper secondary teacher education. *Problems of Education in the 21st century*, *47*, 5-5.

Calik, M., & Aytar, A. (2013). Investigating prospective primary teachers' pedagogical content knowledge of "Effect of human on environment" subject in process of teaching practice. *Educational Science: Theory and Practice*, *13* (3), 1579-1605.

Calik, M., Ozsevgec, T., Ebenezer, J., Artun, H., & Kucuk, Z. (2014). Effects of 'Environmental chemistry' elective course via technology embedded scientific inquiry model on some variables. *Journal of Science Education and Technology*, *26* (3), 412-430.

Department of Education. (2003). National Curriculum Statement. Grades 10 – 12. Pretoria: South Africa.

Department of Basic Education. (2011). Curriculum and Assessment Policy Statement (CAPS). Grades 10 – 12. Physical Sciences. Pretoria: South Africa.

Hughes, J. A. (2006). Bridging the theory-practice divide: A creative approach to effective teacher preparation. *Journal of Scholarship and Teaching*, *6* (1), 110-117.

Johnson, S., Hodges M., & Monk, M. (2000). Teacher Development and Change in South Africa: A critique of the appropriateness of transfer of northern/western practice. *Compare: A Journal of Comparative and International Education, 30* (2), 179-192.

James, A. (2009). How student teachers construct and use practical wisdom to enhance their professional development. *Unpublished PhD thesis.* University of Pretoria.

Kriek, J., & Grayson, D. (2009). A holistic professional development model for South Africa physical science teachers. *South African Journal of Education, 29*, 185 – 203.

Morrow, W. (2007). *Learning to teach in South Africa*. Cape Town: HSRC Press.

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.

Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A Conceptual framework for learning to teach secondary Mathematics: A situative perspective. *Educational Studies in Mathematics*, *56* (1), 67 – 96.

Samuel, M. (2008). Accountability to whom? For what? Teacher identity and the Force Field Model of teacher development. *Perspectives in Education, 26* (2), 3-16.

Stears, M., Good, M. A., &. James, A. A. (2012). Exploring the professional identities of Physical Science teachers enrolled in an Advanced Certificate in Education programme. *Education as Change*, *16* (2), 241-253.

Van Huizen, P., van Oers, B., & Wubbels, T. (2005). A Vygotskian perspective on teacher education. *Curriculum Studies, 37* (3), 267-290.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 70, 2016

Advised by Laima Railienė, University of Šiauliai, Lithuania

Received: *December 16, 2015* Accepted: *April 02, 2016*

Sarah Bansilal	PhD., Associate Professor, School of Education, University of KwaZulu-Natal, Private Bag X03, Ashwood, 3605 Durban, South Africa. E-mail: Bansilals@fukzn.ac.za
Angela James	PhD., Senior Lecturer, Co-Faculty Advisor: ENACTUS, CU 139, Main Administration & Tutorial Building, University of KwaZulu-Natal, Edgewood Campus, Durban, South Africa. E-mail: jamesa1@ukzn.ac.za

ISSN 1822-7864