

Sciences teacher training: theoretical aspects for developing programs

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ABSTRACT

Different countries have some specific orientations and ways of handling Physical Sciences teacher education to meet the needs pertaining to them as stipulated in their education policies, the baseline is that for teachers to perform effectively for the benefit of the learners, teachers require sound, organised and directed preparation. The preparation programmes essentially affords prospective teachers the opportunities for the acquisition and development of the required content knowledge, pedagogical knowledge and pedagogical content knowledge with its components, all constituting teacher professional knowledge. In their learning to teach, practice with the theoretical knowledge is deemed a crucial ingredient to develop into a professional teacher, the practice, the success of which has been proved to be continuing reflection. In the present paper, the discussion of research is aligned closer to this study still considering the identified concepts and underlying theories.

KEYWORDS

Science teacher, teacher training, Science Education, pedagogical content knowledge, didactic transposition

RÉSUMÉ

Les différents pays ont des orientations et des méthodes spécifiques pour gérer la formation des enseignants des Sciences Physiques afin de répondre aux besoins qui leur sont propres, comme le stipulent leurs politiques éducatives, mais le principe de base est que pour que les enseignants travaillent efficacement au profit des apprenants, ils ont besoin d'une préparation solide, organisée et dirigée. Les programmes de préparation offrent essentiellement aux futurs enseignants la possibilité d'acquérir et de développer les connaissances requises en matière de contenu, de pédagogie et de contenu pédagogique avec ses composantes, qui constituent toutes les connaissances professionnelles de l'enseignant. Dans leur apprentissage de l'enseignement, la pratique des connaissances théoriques est considérée comme un ingrédient crucial pour devenir un enseignant professionnel, la pratique, dont le succès a été prouvé, étant une réflexion continue. Dans le présent article, la discussion de la recherche est plus proche de cette étude, tout en tenant compte des concepts identifiés et des théories sous-jacentes.

MOTS-CLÉS

Professeur de science, formation de professeurs, didactique des sciences, pedagogical content knowledge, transposition didactique

INTRODUCTION

This paper sought to explore where the shortfall might lie that led to science student teachers' failure to competently employ in their classroom practice what they had been taught in the teacher preparation Curriculum Studies courses at the National University of Lesotho (NUL). The intention was to get the perceptions and opinions of teacher educators (TEs), student teachers (STs), teaching practice tutors' (TPTs) and Regular Practising Teachers (RPTs) based on their experiences about the preparation that the science pre-service teachers were afforded in learning to teach in specific science subject areas, and how the student teachers exhibited that professional knowledge during practice teaching. The focal concepts were teacher preparation, STs' learning to teach, development of their professional knowledge, teaching practice and participants' perspective of the whole situation. Basically, the focus was on two major aspects of science teachers' preparation in the practicalities of teaching. Firstly, the content offered in the identified Curriculum Studies courses that STs later drew from and used in their classroom practice. Secondly, the methodologies and pedagogies employed in order to develop STs' professional knowledge during face-to-face coursework training on campus and practice in schools.

CONCEPTUAL FRAMEWORK

The framework of this study was premised on the belief that the cornerstones of teacher's work were one's declarative and procedural knowledge (Gess-Newsome, 1999) comprising mainly of the subject matter/content knowledge (CK), general and specific pedagogical knowledge (PK) backed with educational theories, the blend of which manifested itself in actual classroom teaching. The blend of subject content and pedagogical knowledge is termed pedagogical content knowledge – PCK or didactic transposition, (Shulman, 1986, 1987; Ravanis, 2009; Vellopoulou & Ravanis, 2012). It is the form of knowledge that Shulman rightly considers the special knowledge specific to teachers.

I acknowledge the view taking it that without knowledge of blending the major domains, content and pedagogical knowledge, one might not execute teaching with informed mind for the effective learning of the students that are taught. I felt, with the content and pedagogies offered in the training courses of a programme, STs should be able, to a considerable level of competency, enact those knowledge domains hence why PCK has been identified as the main underpinning theory for this study. In the context of this study, since PCK blends the basic knowledge required by a teacher together with the directly involved factors in the teaching/learning scenario, in this case excluding the general school environment and teacher's role therein, I took both teacher knowledge and teacher professional knowledge to be implied in PCK.

I further concurred with the view of educators that the acquired theoretical teacher knowledge could best be manifested in practice where theory and practice join forces. In other words, what has been learned in a conventional setting where one is told the facts, principles, theories, practices and about them; their understanding and interpretation of all forms of knowledge could show up in the mode of practice and the reasoning underlying the decisions made for enacting in a certain manner. The belief was that if practice and theory could be dialectic (Kirk, 1986), that is, informing each other, the two should benefit the prospective teachers for their better performance as teachers. That being the case, practice and theory became yet another crucial theory for this study. For ongoing improvement of one's practice employing the acquired teacher knowledge, I felt a teacher ought to be constantly reflecting on

his/her practices hence the third theory for this study – reflective practice. According to Cohen, Manion and Morrison (2011) the context determines causes and effects and therefore the basis for the conviction that case study approach might make it possible to determine the possible cause(s) of the apparent limitations in STs' classroom performance which also employing the qualitative approach was hoped to have a potential of getting into understanding the root cause resulting in the concern. The discussion of the theoretical framework in relation to the conceptual framework follows in the next section.

GENERAL THEORETICAL DISCUSSION

The observed pervasive incompetence with both pre-service and in-service teachers in classroom teaching still abounds despite the various efforts made in many countries to improve teacher representations about scientific and/or school knowledge, teacher education and teacher preparation programmes (Ball, 2000; Darling-Hammond, 2000; Zeichner, 2010). It has thus been a concern over the years why teachers fail to connect the learned theory with their practice hence the “perennial” gap expressed by Korthagen (2010) enduring. In this section we discuss the literature related to the concepts of teacher education and teaching, teacher preparation, learning to teach, teacher knowledge, teaching practices and the theories underpinning this study.

Teacher education and teaching

Talking of teacher education, clearly is talking about educating teachers in order for them to effectively and efficiently do their work of teaching. In other words, they are taught so that their teaching should serve the purposes of education for those taught. Hence, at the heart of teacher education is the learners and their successful, beneficial and meaningful learning. The prospective teacher's successful learning would reflect itself in teaching, which might have to start with the effective and meaningful learning for the teacher herself/himself. Teacher education is thus a means for teacher professional development. Of the many definitions given by various sources, Wikipedia defines teacher education as referring to: “... *the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviours and skills they require to perform their tasks effectively in the classroom, school and wider community ... often divided into stages ...*” (http://en.wikipedia.org/wiki/Teacher_education).

Although this definition captures important aspects of teacher education considering a wide spectrum of teacher's work, the mention of prospective teachers yet further talking of three stages of teacher professional development – continuum comprising initial teacher education (ITE), induction and continuing professional development, presents a distorted picture of it by omitting the serving regular teachers (in-service). If the professional development of teachers should be guided by policies and procedures, it is obvious that although the basic issues for teacher education would be the same, there would be some distinct peculiar differences for the countries as teacher education would then be designed and run to serve the specific needs of individual countries. But at the heart of teacher professional development are teaching and learning for both pre- and in-service teacher for the benefit of the students that s/he would be teaching. For teacher education to be of benefit to teachers, students and ultimately the nation, the continuum approach that ensures cooperation and dialogue between stakeholders (Caena, 2014) seems relevant.

With the growing research in teacher education, the analysis of the journal articles in *Teaching and Teacher Education* for ten years (2000 to 2010), the main focal issues had been “*teachers learning, learning how to learn, and transforming their knowledge into practice for the benefit of their students' growth*” (Avalos, 2011, p. 10). However, most of the research had

been done in the USA. I take these research issues to be basically about a teacher as a learner and her/his work of teaching. The breaking down of the issues within teacher education for research might be driven by the complexity of the involved processes. In this study the focus was on the initial stage of teacher professional development, pre-service.

Teaching is a complex and multidimensional process (Ball & Cohen, 1999; Donovan, Bransford & Pellegrino, 2000; Kirk, 1986; McCarthy & Quinn, 2010) that requires deep knowledge and understanding in a wide range of areas. The complexity of teacher education is not only with ITE, but rather transects all levels (Freese, 2006; Morine-Dersheimer & Kent, 1999; Perrot, 1982; Pollard, 2002; Sandra & Boohan, 2002). This certainly calls for a sound foundation in the training of prospective teachers looking into various aspects that would produce a teacher with aspired abilities and qualities. It thus requires one to be able to synthesise, integrate, and apply the acquired in different situations, under varying conditions handling diverse learners (Hollins, 2011). It therefore becomes inevitable that such a process requires ongoing reflection on one's knowledge and practices for one to develop competency and ultimately growing into an expert. The section that follows discusses what researchers say about how teachers are prepared for the seemingly challenging work.

Teacher Training and Preparation

In this study, the preparation of prospective teachers is mainly referred to as training simply taking it that it is done by teacher training institutions despite the expressed view of the deficiency of the term considering what is actually involved in learning to become a teacher. The initial stage on teacher professional development continuum, pre-service training, usually has a face-to-face component complimented with teaching practice in schools (Lewin, 2004; Mtika, Robson, & Fitzpatrick, 2014; Ozdemir & Yildirim, 2012; Shuls & Ritter, 2013). This mode of teacher training according to the perspectives discussed by Kirk (1986, p. 58 is "*traditionalist perspective which sees teacher education primarily as a process of professional socialization and induction...*" which to a significant extent holds. Teaching is a social interaction that targets specific goals, hence for the novice teacher to achieve them, s/he needs guidance from the veterans with the appropriate expertise in the field. The on-campus training phase is basically theory laden with some practice in the form of micro and/or peer teaching that gets trainees ready for actual practice in the school setting. With some countries, even though towards the end of training STs do practice teaching in schools for a relatively prolonged period of time, the practice referred to as field or professional experience, the STs are exposed to the school situations and classroom observations and short practices throughout the years of training, providing repeated opportunities for practice in context (Ball & Forzani, 2009).

In Korthagen and Kessels (1999), Goodlad is said to have expressed dissatisfaction with teacher preparation programmes for their failure to prepare prospective teachers for the realities of the classroom. The situation that Korthagen (1999) attests might be the one that has led to some countries such as UK to embark on teacher preparation in schools by the schools. I take this gesture by UK to imply the necessity for and the anticipated positive effect of actual practice in the classroom for teachers' professional development. The same sentiment shared by Ball (2000) who asserts that preparation of teachers in content should be grounded in practice. That could therefore require the teacher training programmes to create opportunities that afford the teacher trainees to learn in the "meaningful and supportive contexts" (Magnusson, Krajcik, & Borko, 1999, p. 124). Despite the concern about teacher inefficiency and other criticisms (Grossman, 2008), other researchers find teacher training programmes still important and acknowledge that there is a dire need to improve them such that the content offered and the pedagogies employed are aligned with classroom practice (Bransford, Brown, & Cockling, 2000; Thomas 2013). Furthermore, there are those researchers who re-enkindle the hope that

teacher training programmes impact positively on prospective teachers' professional knowledge and practice (Wilson, Floden, & Ferrini-Mundy, 2001).

On the basis of these views, I maintained that teacher training was important and of course concurred with the view that it needed to be improved. One of the possible and probably most viable means of improvement being through different forms of research (Darling-Hammond, 2000). Some countries have teacher training oriented towards research also referred to as evidence-based practice (Pollard, 2002). This could be taken as a shift from the view that teachers are mere practitioners and not researchers, the view that is seen to perpetuate the gulf between theory and practice in education (Gordon, 2009). The USA mainly bases teacher education reforms and teacher preparation models on research findings, probably addressing the "rationalist" perspective (Kirk, 1986, pp. 158-159) that stresses the importance of basing educational activities on scientific research findings which in the cases where there was such research there should not be a concern raised by the researchers in education noting disregard of their efforts by teacher practitioners.

In echoing the need for research as an anchoring pillar and reference point in education, Connelly, Clandinin & He (1997, p. 665) assert that *"It is not enough to teach students and it is not enough to teach teachers. There must, as well, be a research and inquiry tradition accompanying educational practices"*. However, Kirk contends that consideration of scientific research findings should not boil down to thinking, as rationalist assumption goes, that, "it is possible to learn more about teaching in a rigorous, systematic, and objective fashion and apply this knowledge in a beneficial way to the process of teacher education", asserting that teaching involves human minds and therefore could not be equated to dealing with innate entities. The unpredictable nature of the teaching-learning situation (Ball & Cohen, 1999) also might render the feasibility of this perspective to a certain degree. Both traditionalist and rationalist views do have a ground in teacher education. With the effort put into the training programmes to make them serve their purpose, the next section looks into what the training affords prospective teachers to learn to teach.

Learning to Teach

Despite the longstanding criticisms that teacher education does not seem to serve its purpose in producing effective teachers, research has shown that *"fully prepared and certified teachers are better and effective"* (Darling-Hammond, 2000) in comparison to those prepared through alternative routes that have been tried in the USA. However models focusing on preservice teachers' learning to teach seem few. The scarcity of research on student teachers' learning to teach could probably among other factors be due to the fact pointed out by Kirk (1986) who argues that teaching and learning are made complex because they involve human interactions which are influenced by what goes on in the mind which is different with the cases where innate phenomena are dealt with as in objective quantitative research common in areas such as engineering and medicine. On the same note Feiman-Nemser (2001) highlight the four attributes involved in learning to teach; thinking, knowing, feeling and enacting. These involved factors make learning to teach a process in itself.

Wideen, Mayer-Smith, and Moon (1998) cited in Feiman-Nemser (2001) present three traditions in teacher education each tradition bringing a different view of learning to teach process. These are: 1) positivist tradition in which teacher education provides teachers with pre-determined knowledge about teaching and learning; 2) progressive tradition in which student teachers' learning starts from their prior knowledge gradually changing through the process of teacher education; and 3) social critique tradition in which student teachers' preparation includes consideration of a wider spectrum of social issues. I perceive no impervious boundaries between the traditions which could prevent the blend of their aspects as might be necessary in any one case of teacher education. For instance, guiding a teacher training programme with pre-

determined knowledge as might be borne in a standard course content could still build on student teachers' pre-existing knowledge in relation to the form of knowledge identified as essential for teacher knowledge base which could be extended to the related issues in the community which would thus contextualise the knowledge which could make learning more meaningful and beneficial to the learner. Especially because the STs have been exposed to teaching and learning before engaging in teacher education and also being part of the communities in which and for which they would be working. A lot of research has been done on student teachers' prior beliefs about and experiences with teaching and learning which influence their acquisition and interpretation of what they learn in teacher training courses. Feiman-Nemser (2001) express that as they learn to teach, preservice teachers take their past learning experiences into the present and use these as a reflective mirror for evaluating their current learning.

There is a strong feeling that what prospective teachers ought to know and be able to do is crucial in enabling them to be able to act as professionals in their teaching (Brandsford et al., 2000; Darling-Hammond, 2005). Valid as the view might be, it might also be worth noting the problems facing teacher education programmes in offering STs what is suitable for them to learn for teaching. Ball (2000, p. 242) in talking of these problems, attests, "*The first problem concerns identifying the content knowledge that matters for teaching, the second regards understanding how such knowledge needs to be held, and the third centers on what it takes to learn to use such knowledge in practice*". In other words, it is not just a matter for teachers knowing what to teach as may be given in course synopsis (for TE) or the school syllabus (for ST) and how to teach it, but it should be teaching what should be taught and how to beneficially handle that very knowledge in learning and in practice. If the problems mentioned could be considered, then the content knowledge, teaching skills and educational theories acquired and developed during training might form a solid knowledge base from which teachers could resort to and work out what they require to create a suitable amalgam for good and effective teaching. First and foremost, however, their studies in the teaching of science must focus on the very important issue of the real difficulties and obstacles of students which are mainly due to the mental representations that impose reasoning and interpretations on children and adolescents (Kokologiannaki & Ravanis, 2013; Ravanis, 2013). That therefore, calls for a potent training programme/course.

With discussed issues pointing out to the complexity of learning to teach, it might be taken to suffice to study the attributes of teacher education and teaching piecemeal and progressively to have a manageable piece of work that contributes to the ongoing research work in teacher education. This study considered the learning of the prospective teachers in the initial stage of professional development who in the process of their learning are acting as learners and teachers in the making. Their learning according to Caena (2014, p. 2) being "*an intensive experience that requires student teachers to be both learners and teachers simultaneously*". On the other hand the content they learn is in itself also complex in that it comprises theoretical and practical knowledge that needs to be thought about, learned to be known and understood for personal benefit and for the students they would be teaching thereafter, so that it could be used in teaching leading one to feel that s/he is and performing as a teacher. The pinnacle of teacher learning is the acquisition of the knowledge required for teaching which turns to be the subject of discussion in the section that follows.

Teacher Knowledge

Although there is relatively a long history of research on teaching, that on teacher knowledge became apparent in the 1980s and 1990s (Connelly et al., 1997). The main content domains of the knowledge required by the teacher have been identified as subject content knowledge (CK), pedagogical knowledge (PK) and their blend, pedagogical content knowledge (PCK) with its

components which constitute the basic factors in the teaching-learning scenario. The general and specific subject content knowledge base acts as a pillar (McConnell, Parker, & Eberhardt, 2013; Shuls & Ritter, 2013) and a driving force around which the other knowledge domains are developed. The pedagogical knowledge embodies issues of classroom organization and management, instructional models and strategies, classroom communication and discourse (Morine-Dershimer & Kent, 1999), lesson planning, student assessment, addressing students' differences (Youngs & Qian, 2013), and principles and theories of instruction and collaborative group work (Boyd & Markarian, 2009).

Although the basic work of a teacher is teaching, there are more facets to it since it is a social undertaking hence involving personal and social aspects as well as the environmental factors all creating the context. The context in which teaching takes place determines the what to teach and how to teach it hence influencing the kind of knowledge required for such teachers for their effective performance. This study focuses on the knowledge required for classroom teaching, not specifically considering the other areas, not undermining their significant impact on the work of a teacher. That would not reject any issue though, that emerges from the research undertaken. In essence, this knowledge comprises three main domains; subject matter (content), pedagogies (methods) which cannot be divorced from each other in teaching due to their intricate, interrelated and entangled nature. Therefore, in the context of this study, they are all taken as teacher knowledge.

Basically for the student teachers, the content knowledge they learn comprises subject matter which the schools in most cases worldwide still teach to students and the pedagogies to teach those subjects coupled with practice in order to have a feel and experience of teaching such subjects before the normal full-time teaching. The practice element of the initial teacher training stage is the subject of the ensuing section.

Practice Teaching

Taking it that the gist of teacher knowledge is in practice (Ball, 2000; Mtika et al., 2014; Shuls & Ritter, 2013) teacher training programmes afford STs the opportunities to have this practice in different ways and different times in the course of training with varying duration as deemed necessary and feasible. It is believed that STs' knowledge and understanding of what has been learned should be reflected in their practice. That is why in the process of learning, practice comes in both theoretically mainly in the general methods courses and also in subject specific Curriculum Studies courses and practically in micro/peer teaching later followed by lengthy classroom practice in schools. The need for and importance of practice teaching as part of teacher education programmes has been emphasized in literature (Abell, 2007; Ball, 2000; Ben-Peretz, 2011; Ben-Peretz & Rumney, 1991; Boilevin & Ravanis, 2007; Sigauke et al., 1993). I take it then that the programmes are affording the necessities for STs to learn to become a professional teacher despite the shortcomings that might be observed. However, it has been proved to have challenges (Ozdemir & Yildirim, 2012).

Since practice with professional teacher knowledge is done in schools, it is inevitable that there are interactions between teacher training institutions and such practice schools the collaboration of which has been observed to have both benefits and challenges (Avalos, 2011). Teacher trainees out in schools have special needs and requirements that could be met if there could be some evident and strong support and supervisory systems which keep the trainees and trainers close together even at the distance through the use of some support systems (Nonyongo & Ngengebule, 1998). The mechanisms of the support, range from print material to advanced technologies. With the support systems in place there could be a possibility to avoid the situation described by Lewin (2004, p. 13) where he says, "*Often, however, trainees are faced with many confusing situations which they do not knowhow to deal with, and they have access to very limited support to help them solve problems*". The interventions to support and guide

student teachers during practice in schools have proved to be effective in helping them to learn to teach through various instruments. Pedagogical content knowledge, theory and practice, and reflective practice are taken as the theories that form the core of this study and their discussion follow in the subsequent section.

PERSPECTIVES: UNDERPINNING THEORIES

This discussion is underpinned by three notions:

- 1) PCK as a specialist knowledge for teachers - the effect of which has been underscored,
- 2) reflective practice - a goal for teacher preparation programmes (Hatton & Smith, 1995) and a vehicle for ongoing professional development (Zeichner & Liston, 1996) through the two phases within the initial teacher professional stage and
- 3) practice and theory - the associated features of teaching and learning and.

Pedagogical Content Knowledge (PCK) and/or Didactic Transposition

Pedagogical content knowledge (PCK) and Didactic Transposition are theoretical constructs that approach the issue of the creation of school-scientific knowledge: “...*that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding Pedagogical content knowledge... identifies the distinctive bodies of knowledge. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to diverse interests and abilities of learners, and presented for instruction*” (Shulman, 1987, p. 8).

This is saying to me that PCK as a blend of CK and PK is a specialised form of knowledge for a teacher. S/he needs this knowledge that ought to be used effectively and efficiently to perform her/his work of teaching students such that they understand what they are taught. Thus a teacher should be knowing what s/he has to teach and the best means of making it accessible for those taught. This in itself calls for a sound foundation in learning to teach in which a student teacher is enabled to think about teaching and learning, know well what is being learned, develop the essential feeling about her/his work and herself/himself in relation to her/his work and at the peak of it, enact and exhibit the acquired knowledge, skills and attitudes geared toward beneficial student learning. PCK is thus a domain of teacher knowledge that is crucial for teacher professional development (Aydin & Boz, 2012; Abell, 2007; Jang, Guan, & Hsieh, 2009; Magnusson et al., 1999; Mansor, Halin, & Osman, 2010; Van Driel & Berry, 2012; Vellopoulou & Ravanis, 2010) the development of which is embedded in classroom practice (Van Driel, Verloop, & De Vos, 1998).

The development of PCK is a complex process - highly specific to context, situation and an individual (Van Driel & Berry, 2012) probably the reason for researchers to consider its components at a time. In their analysis of the literature on teachers' use of PCK in Turkey (Aydin & Boz, 2007, p. 500), among their findings found that “*both pre-service and in-service teachers do not have adequate content knowledge; pedagogical knowledge of pre-service teachers is not sufficient and participants had lack of PCK and its components*”. To combat the probably contrived mystique about the obscured nature of PCK some efforts have been made to unravel it. For instance, Van Driel & Berry (2012) discuss the means to create opportunities for its enactment and reflection on enactment. Also, the development of the Resource Folios using Content Representations - “an overview of the particular content taught when teaching a topic” and Pedagogical and Professional Experiences Repertoires - “accounts of practice intended to illuminate aspects of the CoRe in a particular classroom context” by Mulhall, Berry,

and Loughran (2003) provides hope that PCK is an entity that can gradually be made understandable and accessible to those involved in education and the research into it.

Although widely accepted as a valid and useful construct despite the complexities of venturing into its research there are some uncertainties expressed about PCK. Settlage (2013) questions its authenticity arguing that it is more of the knowledge of information providing no tangible product. Gess-Newsome (1999) even though she identifies the limitations of PCK, she maintains its value in teacher education. I feel that the effort made to unpack PCK even if it has been done piecemeal by researching its components (Aydin & Boz, 2012; Abell, 2007; Jang, Guan, & Hsieh, 2009; Mansor et al., 2010) it is still a notion worth venturing into because long before Shulman coined the construct, pedagogical content knowledge, there had been observations made about this special form of knowledge which is needed and used by teachers in executing their work. In some way, PCK blends theoretical knowledge a teacher acquires and practices through its use in teaching. The issue of theory and practice is discussed in the next section.

Reflective Practice

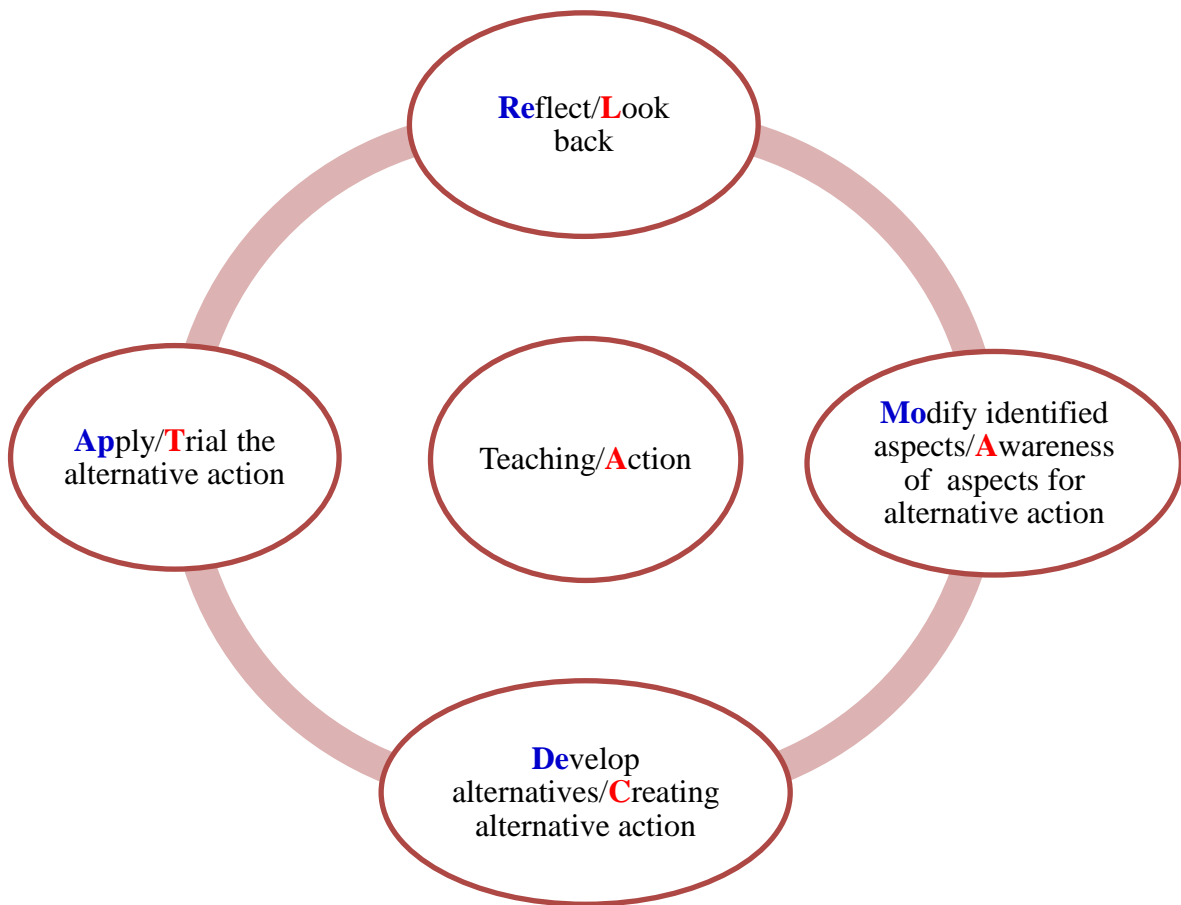
Reflection in teacher education is considered a key element for professional growth (Zeichner & Liston, 1997) and improved teaching and learning. In the development of the models for teacher reflection in teaching, authors such as Schön, 1983 and Kolb, 1984 cited in Feiman-Nemser (2001) base their models on Dewey's model. The notable fact about reflection is that it is a process that occurs in stages and different forms. Korthagen and Kessels, 2001 talk of reflection as embracing external and internal orientation. Externally oriented reflection focuses on other people and their actions while in internally oriented reflection one focuses on oneself.

In the whole teaching/learning scenario, the elements of PCK are involved and teachers should be aware of how they impinge on the undertaking for them to make appropriate decisions for effective teaching. This would be possible if teachers reflect on their teaching. Cathryn Chaney, a contributor in eHow website, considering ideas from education specialists declares the need to develop "versatile, reflective practitioners".

By reflecting, teachers would be able to identify how their teaching succeeds or fails to achieve the intent of their lessons. In this manner they would be learning what might be suitable to teach, in what manner and when, to differing groups and levels of students. Taking action on the basis of the results of their reflection, they would be practising a variety of ways to choose subject matter, transforming it to suit a specific context, and this practice leads to improvement. Reflection thus becomes a crucial attribute of effective teaching and learning which the STs need to be prepared and guided on throughout their training (Korthagen, 1999, 2010; Pollard, 2002; Marland, 1993).

In the process of teaching which is a learning platform as well I envisage a situation where a teacher ought to reflect on all that takes place in teaching and modify the identified thoughts, actions taken and teaching environmental factors accordingly, developing alternative versions of identified aspects which would then be applied either there and then or in an ensuing undertaking as might be appropriate (ReMoDeAp) – the model I used in the science teachers' and Induction Programme workshops (as Inspector for science and Induction Programme Coordinator). This model bears the elements of Korthagen's model of the action, looking back on the action, awareness of essential aspects upon which alternative action would be created and then trialled – ALACT (Korthagen, 1999), the relatedness is illustrated in Figure.

FIGURE



Interrelatedness of ReModeAp and ALACT models illustrating the reflective process in teaching

Theory and Practice

Teacher trainees’ failure to apply learned theories and employ the acquired teaching skills in actual classroom situation has been reported in other places in the world as well (Korthagen, 2005; Thomas, 2013; Yadin & Boz, 2012). This disparity between theory and practice which Korthagen (2010) considers “perennial” has been alluded to as far back as early 1900s, Dewey (1904, 1964) cited in Ball (2000). The chasm seems to have been there and it still persists even with so much research in teacher education but education still failing to meet its purpose. If teacher trainees show deficiencies in practice while still in the making, it might be equitable to anticipate chances of continuing incompetence especially in the case where there are no support structures for beginning teachers and continuing professional development programmes for regular teachers. The inadequacy in content, pedagogies, the blend of these domains of teacher knowledge and other vital elements embraced in teaching and learning has been reported in some studies with teachers beyond pre-service stage (UNESCO, 2013).

Korthagen and Kessels (1999), point out that the traditional mode of training prospective teachers by teaching them the theories that are hoped to be transformed and incorporated effectively in classroom teaching, what Ball (2000) considers as linking propositional knowledge with practice does not help to connect practice and theory the probable drive for researching into the cause(s) and designing the intervention means to overcome the enduring chasm. Several studies suggest that teaching experience needs to be coupled with thoughtful reflection on instructional practice (Van Driel & Berry, 2012) the practice which is informed by the theoretical knowledge acquired. Marland (1993) declares that classroom

practice which I take to be the core of teacher's work can be "learnt, practiced and improved" for successful performance. Reflection is the issue discussed in the section that follows.

REFERENCES

- Abell, S. K. (2007). Research on science teacher knowledge. In S. Abell & N. Lederman (Eds.), *Handbook of research on Science Education* (pp. 1105-1149). Mahwah, NJ: Lawrence Erlbaum.
- Aydin, S., & Boz, Y. D. (2012). Review of studies related to pedagogical content knowledge in the context of science teacher education: Turkish case. *Education Sciences: Theory and Practice*, 12(1), 497-505.
- Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education*, 27, 10-20.
- Ball, D. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education*, 51(3), 241-247.
- Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3-32). San Francisco: Jossey-Bass.
- Ball, D. L., & Forzani, M. F. (2009). The work of teaching and the challenge for teacher education. *Journal of Teacher Education*, 60(5), 497-511.
- Ben-Peretz, M. (2011). Teacher knowledge: What is it? How do we uncover it? What are its implications for schooling? *Teaching and Teacher Education*, 27(1) 3-9.
- Ben-Peretz, M., & Rumney, S. (1991). Professional thinking in guided practice. *Teaching and Teacher Education*, 7(6/6), 517-530.
- Boilevin, J.-M., & Ravanis, K. (2007). L'éducation scientifique et technologique à l'école obligatoire face à la désaffectation: recherches en didactique, dispositifs et références. *Skholê, HS(1)*, 5-11.
- Boyd, M. P., & Markarian, W. C. (2009). Dialogic teaching and dialogic stance: Moving beyond interactional form. *Research in Teaching of English*, 49(3), 272-296.
- Brandsford, J., Brown, A., & Cockling, R. (2000). *How people learn: Brain, mind, experience, and school*. National Academies Press.
- Caena, F. (2014). Initial teacher education in Europe: An overview of policy issues. *European Commission. Directorate General for Education and Culture School Policy/Erasmus*.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education*. London: Routledge.
- Connelly, F. M., Clandinin, D. J., & He, M. F. (1997). Teachers' personal practical knowledge on professional knowledge landscape. *Teaching and Teacher Education*, 13(7), 665-674.
- Darling-Hammond, L. (2000). How teacher education matters. *Journal of Teacher Education*, 51(3), 166-173.
- Donovan, M. S., Bransford, J. D., & Pellegrino, J. W. (1999). *How people learn: Bridging research and practice*. Washington, DC: National Academy Press.
- Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, 103(6), 1013-1055.
- Freese, A. R. (1999). The role of reflection on preservice teachers' development in the context of a professional development school. *Teaching and Teacher Education*, 15(8), 895-999.

- Gess-Newsome, J. (1999). Secondary teachers' knowledge and beliefs about subject matter and their impact on instruction. In J. Gess-Newsome & N. G. Lederman (Eds), *Examining pedagogical content knowledge: The construct and its implications for science education*, (pp. 51-94). Boston: Kluwer.
- Gordon, M. (2009). Toward a pragmatic discourse of constructivism: Reflections on lessons from practice. *Educational Studies*, 45, 39-58.
- Grossman, P. (2008). Responding to our critics: From crisis to opportunity in research on teacher education. *Journal of Teacher Education*, 59(1), 10-23.
- Hatton, N., & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education*, 11, 33-49.
- Hollins, E. R. (2011). Teacher preparation for quality teaching. *Journal of Teacher Education*, 62(4), 395-407.
- Jang, S. J., Guan, S. Y., & Hsieh, H. F. (2009). Developing an instrument for assessing college students' perceptions of teachers' pedagogical content knowledge. *Procedia Journal of Social and Behavioral Sciences*, 1, 596-606.
- Kirk, D. (1986). Beyond the limits of theoretical discourse in teacher education: Towards a critical pedagogy. *Teaching and Teacher Education*, 2(2), 155-167.
- Kokologiannaki, V., & Ravanis, K. (2013). Greek sixth graders mental representations of the mechanism of vision. *New Educational Review*, 33(3), 167-184.
- Korthagen, F. A. (1999). Linking reflection and technical competences: The logbook as an instrument in teacher education. *European Journal of Teacher Education*, 2 (2/3), 191-207.
- Korthagen, F. A. (2010). Situated learning theory and the pedagogy of teacher education: Towards an integrative view of teacher behavior and teacher learning. *Teaching and Teacher Education*, 26(1), 980-106.
- Korthagen, F. A., & Kessels, J. (1999). Linking theory and practice: Changing the pedagogy of teacher education. *Educational Researcher*, 28(4), 4-17.
- Lewin, K. M. (2004). The pre-service training of teachers – Does it meet its objectives and how can it be improved? *Background Paper for EFA Global Monitoring Report*.
- McCarthy, J., & Quinn, L. F. (2010). Supervision in Teacher Education. *International Encyclopedia of Education (Third Edition)*, (pp. 757-763). Oxford: Elsevier.
- McConnell, T. J., Parker, J. M., & Eberhardt, J. (2013). Assessing teachers' science content knowledge: A strategy for assessing depth of understanding. *Journal of Science Teacher Education*, 24(4), 717-743.
- Magnusson, S., Krajcik, J., & Boriko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds), *Examining pedagogical content knowledge: The construct and its implications for science teaching* (pp. 95-132). Boston: Kluwer.
- Mansor, R., Halim, L., & Osman, K. (2010). Teachers' knowledge that promote conceptual understanding. *Procedia Social and Behavioral Sciences*, 9, 1835-1839.
- Marland, M. (1993). *The craft of the classroom: A survival guide*. Oxford: Heinemann Educational Publishers.
- Morine-Dersheimer, G., & Kent, T. (1999). The complex nature and sources of teachers' pedagogical knowledge. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education*, (pp. 21-50). Boston: Kluwer.

- Mtika, P., Robson, D., & Fitzpatrick, R. (2014). Joint observation of student teaching and related tripartite dialogue during field experience: Partner perspectives. *Teaching and Teacher Education, 39*, 66-76.
- Mulhall, P., Berry, A., & Loughran, J. (2003). Frameworks for representing science teachers' pedagogical content knowledge. *Asia-Pacific Forum on Science Learning and Teaching, 4*(2), 1-25.
- Nonyongo, E. P., & Ngengebule, A. T. (Eds.). (1998). *Learner support services: Case studies of DEASA member institutions*. Pretoria: University of South Africa Press.
- Ozdemir, A. A., & Yildirim, G. (2012). The effects of teaching practice course on professional development of student teachers. *Procedia Social and Behavioral Sciences, 89*, 31-39.
- Perrot, E. (1982). *Effective Teaching: A practical guide to improving your teaching*. London, & New York: Longman.
- Pollard, A. (2002). *Reflective teaching: Effective and evidence-informed professional practice*. London: Continuum.
- Ravanis, K. (2009). La transformación didáctica: de las materias académicas a las prácticas escolares. In G. Pappas (Ed.), *Actas de congreso "La lengua griega en América Latina"* (pp. 143-149). Buenos Aires-Patras: Universidad de Patras.
- Ravanis, K. (2013). Mental representations and obstacles in 10–11-year-old children's thought concerning the melting and coagulation of solid substances in everyday life. *Preschool and Primary Education, 1*(1), 130-137.
- Sandra, A., & Boohan, R. (2002). *Aspects of teaching Secondary Science: Perspectives on practice*. Routledge: Falmer Press.
- Settlage, J. (2013). On acknowledging PCK's shortcomings. *Journal of Teacher Education, 24*, 1-12.
- Shulman, L. (1986). Those who understand: Knowledge growth of teachers. *Educational Researcher, 15*(2), 4-14.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*, 1-22.
- Shuls, J. V., & Ritter, G. W. (2013). Teacher preparation is Not an either-or. *Phi Delta Kappan, 94*(7), 28-32.
- Sigauke, A., Mabejane, M., Shao, J., & Varghese, T. (1993). Exploring low cost materials: Low-cost practical science examinations for developing countries. In W. Patrick, G. Brian, H. Richard & M. Laurence (Eds.), *The Harare Generator: Innovative Ideas and Techniques for Science Educators in Africa* (pp. 154-163). Harare, Zimbabwe: International Council of Scientific Unions.
- Thomas, M. (2013). Teachers' beliefs about classroom teaching – Teachers' knowledge and teaching approaches. *Procedia Social and behavioral Sciences, 89*, 31-39.
- UNESCO (2013). *Investigating training needs of Primary and Secondary schools Teachers, Heads and Principals in Lesotho with respect to the Teaching and Learning of Mathematics, Science and Technology*. GEMS Study, Lesotho.
- Van Driel, J. H., & Berry, A. (2012). Teaching about teaching science: Aims, strategies, and backgrounds of science teacher educators. *Journal of Teacher Education, 64*(2), 117-128.
- Van Driel, J., Verloop, N., & Bell J. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching, 35*, 673-695.
- Vellopoulou, A., & Ravanis, K. (2010). A methodological tool for approaching the didactic transposition of the natural sciences in kindergarten school: the case of the "states and properties

of matter” in two Greek curricula. *Review of Science, Mathematics and ICT Education*, 4(2), 29-42.

Vellopoulou, A., & Ravanis, K. (2012). From the formal curriculum to the lesson planning: the didactic transposition kindergarten teachers’ carry out as they plan to teach dissolution. *Skholê*, 17, 71-76.

Wilson, S. M., Floden, R. E., & Ferrini-Mundy, J. (2001). *Teacher preparation research: Current knowledge, gaps, and recommendations*. Michigan State University: Center for the Study of Teaching and Policy.

Youngs, P., & Qian, H. (2013). The influence of university courses and field experiences on Chinese elementary candidates’ Mathematical knowledge for teaching. *Journal of Teacher Education*, 64(3), 244-261

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher education*, 61(1), 89-99.

Zeichner, K. M., & Liston, D. P. (1996). *Reflective teaching: An introduction*. Mahwah, NJ: Lawrence.