AUTHOR:
Dr Jacques Verster[1]
Prof Yusuf Sayed[2]

AFFILIATION:
[1]Cape Peninsula University of Technology, South Africa
[1]Centre for International Teacher Education, Cape Peninsula University of Technology, South Africa

DOI: http://dx.doi.org/10.38140/pie.v40i4.6654

e-ISSN 2519-593X
Perspectives in Education
2022 40(4): 165-179

PUBLISHED:
23 December 2022

RECEIVED:
3 August 2022

ACCEPTED:
5 December 2022

Published by the UFS
http://journals.ufs.ac.za/index.php/pie

Development of teacher knowledge in an initial teacher education programme qualifying mathematics teachers

Abstract

South African teacher education policy expects initial teacher education programmes to introduce integrated and applied knowledge to underpin a teacher's practice in diverse classroom contexts. This paper explores how a one-year Postgraduate Certificate in Education responds to this expectation in terms of training prospective teachers to teach high school mathematics. Exploration involves a qualitative case study of semi-structured interviews with six teacher educators and five newly qualified teachers, supplemented with document analysis. The stages of research involved a literature review, piloting the semi-structured interview questions, conducting semi-structured interviews, and analysing all accessible documents linked to the Postgraduate Certificate. All collected data were merged into one document which was read to identify codes, themes and categories. The paper finds that the Postgraduate Certificate does equip individuals with professional teacher knowledge to function in diverse contexts, albeit unevenly and highly dependent on the quality of each teacher's past engagement with mathematics. The broad nature of policy knowledge type definitions and the lack of clarity in differentiating 'specific specialised subject matter' and 'specialised pedagogical content knowledge' are key contributing factors to uneven development in a Postgraduate Certificate. As a recommendation, we suggest that policy should differentiate 'specific specialised subject matter' and 'specialised pedagogical content knowledge' in more detail to promote the development of each as important types of knowledge needed by teachers.

Keywords: *initial teacher education, mathematics, pedagogical content knowledge, specialised subject matter*

1. Introduction

Initial teacher education (ITE) is tasked with producing the cohort of teachers needed now and in the future to assist countries in achieving inclusive economic growth and education quality (DHET, 2015). This paper aims to present insights into the process of training a mathematics teacher in relation to South Africa's national teacher education policy. Specifically, this article focuses on the development

of professional teacher knowledge in a Postgraduate Certificate in Education (PGCE) mathematics ITE programme. In South Africa, the most recent national teacher education policy notes the purpose and approach of teacher education qualifications as follows: "The approach adopted in the Minimum Requirements for Teacher Education Qualifications [MRTEQ] pays close attention to the various types of knowledge that underpin teachers' practice, while encapsulating all of these in the notion of integrated and applied knowledge" (DHET, 2015: 9).

ITE is governed by national policy. But even with this national policy, there are no absolute guarantees that a quality education will be realised in university education (DBE, 2011; Jansen, 2013; Taylor, 2014). This paper explores how one university approaches the delivery of a Postgraduate Certificate in relation to policy, reviewing one ITE programme and the overall approach for its delivery. The intent is to gain understanding of the holistic approach used to link policy and practice during ITE. The research gap being addressed is to offer contextual insights into a Postgraduate Certificate. This is done with the hope to enhance understanding of what a Postgraduate Certificate involves as an experience. Therefore, the research question is: What does a Postgraduate Certificate, as offered by a university of technology, involve as an experience?

Following a discussion to set the background and establish the context of the phenomenon under study, we present the knowledge types needed by a classroom teacher – as noted in the MRTEQ – as the paper's conceptual framework. The methodology introduces the data analysis section as guided by the parameters of the MRTEQ knowledge types. The paper concludes with a discussion of the findings related to policy vs practice.

2. Background

South Africa offers two routes for becoming a teacher; namely, a one-year Postgraduate Certificate in Education (PGCE) that follows a recognised diploma/degree linked to a school subject; or a Bachelor's in Education (B.Ed.) after completing Grade 12 (upper/senior secondary). Both routes are equal in status as they offer "entry-level initial professional knowledge and skills as classroom teachers in a chosen phase[s] and/or subject[s]" (DHET, 2015: 26). The key difference is that "PGCE curricula are largely concentrated versions of B.Ed. curricula, without subject content modules" (Taylor, 2014: 10).

There is international recognition that a one-year ITE route has challenges, specifically as far as the development of subject content knowledge is concerned. For example, some PGCE graduates struggled with subject content in the context of teaching diverse learners (CHE, 2010). More specifically, a major in a relevant subject at university level is unfortunately no guarantee that the desired subject matter knowledge needed to build professional teacher knowledge is in place (CHE, 2010).

It is a potential mistake to treat subject content as "already in place" at any stage of a teacher's career (Ellis, 2007: 450-452) because subject content needs continuous updating and must be linked to professional teacher knowledge (Loughran, 2010). This paper seeks to understand professional teacher knowledge within the context of "relationships between pedagogical knowledge and [disciplinary] knowledge" (Reeves & Robinson, 2010: 237). Although broadly applied, theorised and debated (Ellis, 2007), there is no one agreed-upon definition of professional teacher knowledge (Burn, 2007). However, there are two ways in which existing subject content is linked to pedagogical knowledge to influence the development of

professional teacher knowledge: 1) "pedagogical theory and skills [are] generic and applicable within and across subject domains"; and 2) pedagogical theory and skills are anchored "within a particular subject domain" (Reeves & Robinson, 2010: 244).

To make best use of the allocated PGCE year, a common practice in South Africa is to approach pedagogical knowledge as generic and applicable within all subject domains (Reeves & Robinson, 2010: 244). This is most likely why various PGCE programmes are delivered within a view that development of desired skills and knowledge occurs "in a general (often abstract) form first" and becomes engrained into an individual as experience is gained in a classroom context (Philpott, 2006: 300). Treating pedagogical knowledge as applicable across subject domains assumes that prospective teachers, with little guidance, are able to link existing disciplinary knowledge with newly introduced pedagogical knowledge. This approach leads to a perception that *how to teach* (pedagogy) is more important than the *what* (subject content) (Reeves & Robinson, 2010). To the contrary, approaching pedagogical knowledge as anchored within a specific subject domain treats disciplinary knowledge as the core knowledge needed by a teacher, leading to the perception that *what to teach* is more important than the *how* (Adler, Slonimsky & Reed, 2002).

National policy in South Africa balances approaches by focusing on both the *what* (disciplinary knowledge) and the *how* (pedagogical knowledge) as equally important (DHET, 2015). This ensures that a qualified classroom teacher is able to "organise systematic learning in … whatever the context and conditions are" (Morrow, 2007: 20). To balance both approaches, national policy argues that the PGCE should include eight to 12 weeks supervised and formally assessed school-based experience (Nomlomo & Sosibo, 2016; Zeichner, 2010) to introduce prospective teachers to the "groundwork" of teaching as a profession (Walkington, 2005: 57) by exposure to "classroom situations that exist in reality, and not just … with ideal situations" (DBE, 2011: 109).

The practicalities of school-based experiences are governed by policy written by an ITE service provider, referred to as 'institutional policy' in this paper, which stipulates roles and responsibilities of involved university and host-school staff to promote quality engagements and links between theory and practice. An institutional school-based experience policy, according to the findings of Samuel (2009: 751-752), assumes three factors: 1) a culture of collaboration and partnership between all involved; 2) training workshops and contracts to clarify roles and responsibilities of all involved; and 3) learning and development that emphasises school-based experience as an "initial step in a lifelong journey of professional growth and development". Such a policy is essential in promoting an extensive and well-planned school-based experience to serve as the pinnacle of learning *how to teach* (Matoti, Junqueria & Odora, 2011).

3. Conceptual framework

We argue that learning to teach through a PGCE involves tacit and explicit teacher knowledge presented in a general, often abstract manner to develop professional teacher knowledge. The introduced teacher knowledge is potentially assumed to be integrated and applied by PGCE graduates as they gain experience as a classroom teacher. This might explain why there is no common national PGCE curriculum in South Africa beyond the MRTEQ knowledge types applicable to all ITE programmes, as learning to teach is seemingly an individual experience. To explore this more deeply, the paper focuses on professional teacher knowledge developed

in institutional settings in relation to national policy, specifically on the *types* of knowledge stipulated in policy (DHET, 2015: 10-11) that offer a "basis for a common, accepted curriculum that a program would cover in terms of knowledge and practice, leaving it up to the providers as to how to realise this in program terms" (Sayed et al., 2018:33), meaning that the types of knowledge are to serve as guidelines to develop the institution offering the PGCE's specific curriculum to address these knowledge types. This paper, through an examination of pedagogical and disciplinary knowledge gained by prospective teachers, explores how types of knowledge in policy are enacted in a PGCE programme. See Figure 1 for the organisation of the types of knowledge associated with the acquisition, integration and application of knowledge for teaching purposes.

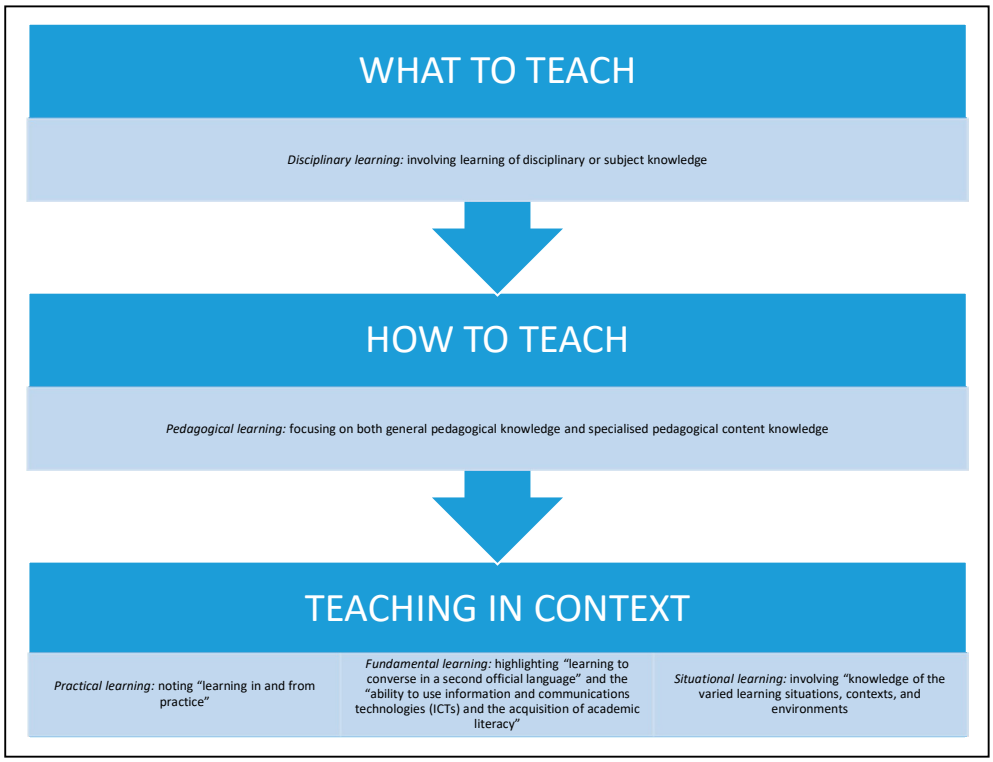

Figure 1: The organisation of the types of learning associated with the acquisition, integration and application of knowledge for teaching purposes (DHET, 2015: 10-11)

We argue that the above guides ITE delivery by directing the core focus of engagements to involve the development of disciplinary and/or pedagogical learning. The three remaining types of knowledge are to focus on teaching in context and therefore, it is argued, are to form part and parcel of engagements influencing disciplinary and/or pedagogical knowledge.

4. Empirical research

This paper is based on a qualitative case study of a PGCE with mathematics as one major offered in 2014 by a university of technology located in the Western Cape of South Africa. This university is one of the larger providers of teacher education qualifications in the province.

Data collection involved semi-structured interviews (six teacher educators interviewed during the latter part of 2014 and five NQTs during their first NQT term in 2015) and document analysis (study guides, PGCE service provider policies, programme guide, faculty handbook, university website, and prospective teacher portfolios of assessment retained for moderation). All documents made available via the university website, teacher educators or from administrators at the campus offering the PGCE were included. All documents were read keeping the interview questions presented below in mind and using the following question as an overall analysis guide: Is what I am reading highlighting an insight revealing an aspect of the PGCE as an experience for a prospective teacher?

Interview questions posed to the six teacher educators included:

- Is it possible to reveal your contribution in the design of the PGCE programme you are involved in?
- What is the department's philosophy concerning the PGCE FET programme?
- How would you define and describe your teaching approach?
- Considering the PGCE programme you are involved in, please explain how it develops a prospective trainee's pedagogical knowledge.
- Based on your experience, what subject content knowledge do you believe prospective teachers acquire from participating in the PGCE programme you are a part of?
- Is it possible to reveal specific experiences that was aimed at developing the mathematics beliefs of prospective teachers?

Interview questions posed to the five NQTs included:

- Is it possible to reveal your thoughts concerning the overall design of the PGCE programme you have successfully completed?
- What do you believe was the department's overall goal concerning the PGCE FET programme?
- How would you define and describe the teaching approaches of the teacher educators (lecturers) in the PGCE?
- Considering the PGCE programme you successfully completed, please explain how it developed your pedagogical knowledge.
- Based on your experience, what subject content knowledge do you believe you acquired from participating in the PGCE programme you successfully completed?
- Is it possible to reveal specific experiences that was aimed at developing your mathematics (or potentially teaching-learning) beliefs?

Sampling of participants were done purposefully to explore experiences comprising a PGCE which would have been experiences by a prospective teacher who registered for a PGCE with mathematics as one of their majors. An interpretivist paradigm guided data analysis, examining the interrelationship between ITE policy framework and institutional practices. All collected data were merged onto one document and printed. Different colour highlighters were used to identify codes, themes and categories. Specific codes, themes and categories were noted in pencil on the original document. Linked data were then merged into tables to organise the data and serve as reference point for the presentation of data. The original

printed document with original notes were re-read after analysis to identify any overlooked data to bring analysis to a close.

Ethical requirements attached to a qualitative case study were followed, and ethical clearance was granted by the relevant university ethics committee.

5. Research findings

Key research findings focus on the relationship between what national policy expects in relation to teacher knowledge and how this is realised in the programme. The argument presented is that in the PGCE programme, the studies of 'specialised pedagogical content knowledge' mentioned under 'pedagogical knowledge' and 'specific specialised subject matter' under 'disciplinary knowledge' in policy are exact duplicates. This approach to addressing policy stipulations, it is argued, overemphasises subject administration at the cost of developing 'specific specialised subject matter'. This approach also rests on the assumption that prospective teachers in the PGCE are subject content experts, primarily in need of pedagogical skills to be effective classroom teachers in South Africa. To present the rationale for the above argument, the two main themes discussed are disciplinary and pedagogical knowledge.

5.1 Disciplinary knowledge

5.1.1 Disciplinary knowledge acquired and developed in an ITE programme

We begin exploring policy versus practice by presenting the way policy defines *disciplinary knowledge*. The MRTEQ policy states:

> *Disciplinary or subject matter knowledge ... can be presented in two components within a teaching curriculum. Firstly, it is represented in the study of education and its foundations, including but not limited to the philosophy, psychology, politics, economics, sociology and history of education. Secondly it includes the study of specific specialised subject matter relevant to the academic disciplines underpinning teaching subjects or specialisations. Professional ethics and issues related to knowledge of, and relationships between the self and others are cross cutting themes that are theoretically located in the study of education and its foundations* (DHET, 2015: 10).

This paper explores the categories of 'subject matter knowledge' and 'specific specialised subject matter' acquired in an ITE programme to guide the discussion of the first main theme, 'disciplinary knowledge'. It is noted that 'specific specialised subject matter' is only mentioned by name in policy, leaving details open to individual interpretation.

5.1.2 Subject matter knowledge approached as 'already acquired' in delivering the teaching programme

The ITE programme as delivered assumes that 'subject matter knowledge' is in place (prospective teachers having completed Grade 12 and a diploma/degree) prior to prospective teachers entering the programme. During the module 'Mathematics Didactics', prospective teachers were given an opportunity to voice the specific 'subject matter knowledge' which they wished to include during contact sessions. If none was mentioned, none was specifically developed, as noted during the interviews: "*No one had a problem with the content in maths so we didn't do any content with maths"* (Mathematics Didactics, Teacher Educator interview). This practice was confirmed by teacher educators and NQTs during interviews: "*[T]here is no mathematical knowledge introduced only needed to be known by a mathematics teacher*"

(Mathematics Didactics, Teacher Educator interview) and, "*The content knowledge, you can't find it on the PGCE"* (NQT2 interview).

These remarks suggest that 'subject matter knowledge' is not core to this ITE programme. 'Subject matter knowledge' is assumed to already be developed, based on the understanding that at admission, a prospective teacher has both a Grade 12 certificate and a recognised "three-year diploma or four-year degree" (university website). The Programme Co-ordinator emphasised this:

> *I explain to them how they got in and warn them that they are subject matter specialists. If a person stands in class and says I don't know [how to work with data sets] then they have no right to be here* (Professional Studies, Teacher Educator & Programme Co-ordinator interview).

Teacher educators in the PGCE programme admitted they did not teach 'subject matter knowledge' as this was already in place: "*Within the first term, before [the school-based experiences component], you will be introduced to the school curriculum in its entirety. All you as a person should be able to do is say. I know that, I know that. Oops. I do not know that. Let me go and study"* (Professional Studies, Teacher Educator & Programme Co-ordinator interview). In support, teacher educator for the module 'Perspectives on Education' clarified how prospective teachers were approached as 'subject matter knowledge' experts:

> *There is a topic we do… we deal with differentiation. We talk about problems and learning. I try to draw examples from as many subjects as possible and of course I am not a mathematician. So, I have to believe what [prospective teachers] tell me is true. Somebody will have to stand up and tell us how I would differentiate this task for a learner who is at a lower level of understanding* (Perspectives on Education, Teacher Educator interview).

Based on the above, the PGCE approaches 'subject matter knowledge' as essentially "already in place" (Ellis, 2007: 450-452), but if inadequate, then the prospective teacher is responsible to self-study to close gaps (Loughran, 2010). This process was perceived by the interviewed NQTs as suitable based on the following statements: "*The things you did in Grade 12, Grade 10 and Grade 11. So, you always have to rephrase and go back on how to. But as you are somebody who did you immediately see that you will be just okay. That is how it is supposed to happen"* (NQT2 interview) and, "*Understanding that when you open the year plan it is Grade 10 then after that a new thing will start with Grade 11 all the way. That is something that I did not know. I only know it when I came to PGCE and that was Math Didactics"* (NQT5 interview).

In summary, the PGCE was designed to make no attempt to develop 'subject matter knowledge', resting on the assumption that this knowledge is already in place. If 'subject matter knowledge' is inadequate, as discovered while perusing the prescribed school subject curriculum documents, then ostensibly the prospective teacher self-studies to close personal knowledge gaps. The level of existing 'subject matter knowledge' is not verified in the PGCE beyond the entrance requirements linked to admission. Although self-study is promoted when gaps in 'subject matter knowledge' are self-diagnosed, this practice could result in prospective teachers holding vastly different levels of 'subject matter knowledge' when entering (and hence, when leaving) the PGCE. The quality of the PGCE as a whole, then, is dependent on the quality of past engagements each admitted individual has had with the 'subject matter knowledge' expected to be delivered in the classroom.

5.2 Pedagogical knowledge

5.2.1 Specific specialised subject matter influenced by linking existing 'subject matter knowledge' to newly introduced pedagogical knowledge

Linking pedagogical knowledge to existing subject matter knowledge was the primary approach in the PGCE programme: "*All we really do is we introduce the pedagogical knowledge skills and values which they then attach to their content knowledge"* (Professional Studies, Teacher Educator & Programme Co-ordinator interview). The common approach followed in a PGCE is to introduce pedagogy (Naylor & Sayed, 2014; Reeves & Robinson, 2010) which prospective teachers are then responsible to integrate with their existing 'subject matter' and 'specific specialised subject matter'. The process followed in the studied PGCE was summarised by the Programme Co-ordinator: "*Your two didactics [school curriculum modules] look specifically at the application of your subject matter expertise … So, we develop your subject specific pedagogical knowledge within the didactics"* (Professional Studies, Teacher Educator & Programme Co-ordinator interview). More specifically, 'Mathematics Didactics' included "advanced studies of theories" (study guide) to begin the development of subject pedagogy seemingly with the assumption that 'subject matter' and 'specific specialised subject matter' was already held. The approach was summarised as follows:

> *So, what we would do is we would focus on the theory of pedagogy. How do we teach mathematics? What is mathematics anxiety? We let them familiarise themselves with that – how do we deal with learners with mathematics anxiety. Different teaching strategies of teaching mathematics. Not all teaching strategies can be applied to mathematics. We look at the theoretical aspects of pedagogy: theories of learning, theories of constructivism, Piaget, Vygotsky. So that they could understand how do learners learn and do they actually learn. Is it about teaching or is it about learning?* (Mathematics Didactics, Teacher Educator interview).

This highlights how the PGCE approached the introduction of pedagogical knowledge which prospective teachers then linked to their existing disciplinary knowledge ('subject matter knowledge' and 'specific specialised subject matter'). It seems that 'specific specialised subject matter' as noted in policy is interpreted as a component of pedagogic knowledge as introduced in the PGCE programme. To support this argument, all interviewed NQTs perceived that 'Mathematics Didactics' overemphasised subject administration and pedagogical components which were likewise covered in other PGCE modules. This occurred at the cost of developing 'specific specialised subject matter knowledge' in the field of mathematics. The NQTs noted that they felt "*there was something more that needs to be taught*" (NQT1 interview) in 'Mathematics Didactics' as it was "*not maths, [it was] just arranging the file, all the lesson plans like, that is where [they] got the marks*" (NQT2 interview). In addition, PGCE contact sessions prior to the first school-based experience component for 'Mathematics Didactics' introduced theories. After and "*concurrent with the [school-based experiences component] focus [was] on: subject administration; assessment; [and] lesson planning*" (study guide). How 'specific specialised subject matter' was perceived as part of 'pedagogical knowledge' in the PGCE context is evident by looking at the summary of "advanced studies of theories" (study guide):

> *We would look at what is required to be taught according to the policy document and then look at how we align it. So that when a student leaves here they are familiar with the policy document. So that they don't come there, at their school and say okay. I have just started teaching but I don't know what to teach* (Mathematics Didactics, Teacher Educator interview).

We now understand that the studied PGCE overemphasised subject administration (meaning classroom administration) while neglecting 'specific specialised subject matter knowledge' because this was treated as a component of 'pedagogical knowledge'. This practice, it is argued, could have emerged because the difference between 'disciplinary knowledge' and 'pedagogical knowledge', as defined in national policy, is not adequately specific. The overemphasis on subject administration was further encouraged by the assumption that all those granted admittance into the PGCE are subject matter experts (which includes 'specific specialised subject matter knowledge') and knowledge gaps are closed by means of self-study. Building on the above argument, we explore the policy definition of 'pedagogical knowledge' in relation to the development that occurred in the PGCE programme.

5.2.2 Pedagogical knowledge acquired and developed in an ITE programme

Within the context that 'specific specialised subject matter' could be interpreted as a component of 'pedagogical knowledge', we present the policy definition of *pedagogical knowledge*:

> *Pedagogical knowledge incorporates general pedagogical knowledge and refers to the study of the principles, practices and methods of teaching. Pedagogical learning includes knowledge of learners, learning, curriculum and general instruction and assessment strategies and specialised pedagogical content knowledge which includes knowing how to present the concepts, methods and rules of a specific discipline in order to create appropriate learning opportunities for diverse learners, as well as how to evaluate progress. Inclusive education forms an important aspect of both general and pedagogical knowledge and specialised pedagogical content knowledge* (DHET, 2015:10).

The concept *pedagogical learning* formed part of the discussion under the categories of the preceding theme *disciplinary knowledge*. This was because the PGCE did not specifically develop *disciplinary knowledge*. The PGCE expected prospective teachers to link their existing *disciplinary knowledge* to newly introduced *pedagogical learning*. To extend this understanding, this section explores how 'specialised pedagogical content knowledge' is developed in the PGCE programme in relation to 'presenting mathematical concepts, methods and rules', evaluating learner progress and assessing programme methodology.

5.2.3 Limited focus on using a 'whiteboard/chalkboard' in teaching mathematics in the programme

Concerning theory and discussions on how to present mathematical concepts, methods and rules, the module 'Professional Studies' required prospective teachers to rank the teaching media based on suitability for teaching mathematics (or any other Didactics Module): chalkboard/whiteboard, bulletin board/posters, flipchart/flash cards, photo copies/handouts, PowerPoint presentations, textbooks/books, computer/internet, video clips/demonstrations, movies/television, multimedia/visual audio media, interactive/video camera, data projector, exam question papers, graphs/newspapers, smartboard, and mimeo classroom media kit (Professional Studies, portfolio of assessment). These teaching media were introduced in the PGCE to teach school mathematics during the related Didactics Module engagements. 'Chalkboard/whiteboard' was indicated as the most suitable to teach mathematics from the perspective of those who completed the programme, because "*mathematics … requires a lot of demonstrations and calculation on the whiteboard or chalkboard [and] mathematics … requires lots of teacher learner interaction* (NQT4 Professional Studies, portfolio of assessment). Practical tips on using a 'chalkboard/whiteboard' also influenced its rank as the most suitable teaching media. Examples of practical tips include, "*Write from the left to the*

right" (NQT5 interview); *"Utilise all available space on the whiteboard*" (NQT1 Mathematics Didactics, portfolio of assessment); and *"Face the learners when you talk to them…. Write keywords with definitions on the board"* (NQT3 Mathematics Didactics, portfolio of assessment).

Development linked to teaching media included observing and documenting how media was applied by practicing mathematics teachers in a classroom context. Observations noted that the teachers used very few extra notes beyond the prescribed textbook to present mathematical concepts, methods and rules: "*It is not common for teachers to supply extra handouts as most of the required work is in the textbooks"* (NQT4 Professional Studies, portfolio of assessment). To supplement the prescribed textbook, the observed teachers used a 'chalkboard/whiteboard' while learners used a scientific calculator to complete the activities and calculations in the prescribed textbook. Documented observations further revealed that while a school computer laboratory was dedicated to the teaching of the school subjects – 'computer applications technology' (CAT) and 'information technology' (IT) – these labs do not always include software specific for the teaching of mathematics. Teaching school mathematics with a computer was restricted to 'technology rich environments' where learners had access to tablets and laptops and the teacher had a Smartboard in the mathematics classroom.

In summary, although the PGCE introduced a variety of teaching media used by teachers, they primarily relied on a 'chalkboard/whiteboard' while the learners have prescribed textbooks and calculators.

5.2.4 Competence in assessing learners involves designing, delivering and reflecting on assessments given to mathematics learners in a classroom context

The module 'Mathematics Didactics' developed each prospective teacher's ability to assess learners, including a formal PGCE assignment requiring prospective teachers to design a variety of assessments for learners to test their competency in school mathematics. These assessments were then used during the school-based experience component of the PGCE by disseminating the assessments to learners as part of a planned lesson. This development included several activities:

> *The [prospective teachers] in a PGCE mathematics classroom were required to design a test that they will give to [learners] while they are on their [school-based experiences component]. The test that a [prospective teacher] has developed was to be handed in for evaluation and the [teacher educator] had the assessment criteria to check if the test has been designed according to assessment criteria of designing a test and marks were given to each test* (NQT5 Professional Studies, portfolio of assessment).

In addition, the following four questions were used to clarify details linked to the assessment presented as evidence in the 'portfolio of assessment' for the module 'Mathematics Didactics':

- *What were the desired outcomes the learners had to demonstrate in the assessment task?*
- *Which of the stated outcomes were met? Give reasons why you say this.*
- *Which of the stated outcomes were not met? Give reasons why you say this.*
- *How could the assessment be improved*?

The expectation in policy as per the definition of *pedagogical knowledge* is to know *how* to evaluate learners (DHET, 2015). This policy expectation was integrated into the PGCE

by means of designing, delivering and reflecting on specific assessments as part of the formal PGCE school-based experience component process. We argue that the process followed above serves as one example of how the PGCE approached the policy expectation that different types of teacher knowledge should be integrated and applied to influence teaching practice (DHET, 2015). This occurred in the designing, delivering and reflecting on assessments used for teaching mathematics to practically apply their burgeoning professional teacher knowledge. To explore additional examples of integrating and applying knowledge, understanding that the PGCE focused primarily on developing *pedagogical knowledge*, we close this analysis by discussing the programme methodology.

5.2.5 'Guided self-study' methodology used in the studied programme to link existing disciplinary knowledge with newly introduced pedagogical knowledge

The overall approach in the PGCE can best be described as '*guided self-study'* (study guide; Professional Studies, Teacher Educator & Programme Co-ordinator interview), intended to influence prospective teachers' ability to critically reflect on introduced pedagogical theories and practices to link to their existing '*disciplinary knowledge'*. This represents the core approach in the PGCE to meet the policy expectation of equipping individuals with professional teacher knowledge to influence their teaching practice in a classroom (DHET, 2015:9). In support of this argument, the Programme Co-ordinator clarified the '*guided self-study'* approach as follows:

> *It is not leaving students to do their own thing. It is providing them with the scope and parameters within which to operate. With the PGCE we need to give them the scope to be able to do.... Their minds flow [reflect] where it wants to go* (Professional Studies, Teacher Educator and Programme Co-ordinator interview).

To guide the delivery of the programme methodology, reflection skills influenced the integration and application of teacher knowledge in teaching practice. The ability to use reflective skills acquired during the year was formally assessed as follows: "*Use the reflective skills developed so far this year and reflect on each of the assignments for this subject. Use the attached reflection sheet for each assignment"* (Professional Studies, portfolio of assessment). The reflection sheet provided by the university, linked to the formal assessment programme during the school-based experience component, asked the following guiding questions:

- *Describe which aspect(s) was/were successful and explain why.*
- *Describe which aspect(s) was/were unsuccessful and explain why.*
- *Describe how this can be improved.*
- *Explain why you feel that the stated outcomes of the lesson were achieved or not achieved.*
- *Further remarks:* …. (Mathematics Didactics portfolio of assessment & Professional Studies portfolio of assessment).

Overall, it is argued that the depth of professional teacher knowledge is highly dependent on prospective teachers taking charge of their own preparation for becoming a classroom teacher. The willingness and ability to reflect critically on professional teacher knowledge to improve future practices is integral to PGCE. This core aim is achieved by '*guided self-study'*, supported by reflection sheets to record reflections on theories and experiences, focusing on professional teacher knowledge comprising the PGCE. An example of the reflection skills developed during the PGCE is presented below, as noted in a formal assessment reflection:

> *When learning takes place in the classroom the educator needs to be aware of not just the overt curriculum that is the set objectives, outcomes. He/she needs to take into consideration the hidden messages we as educators send the learners through our comments, gestures and content covered in the class* (NQT Professional Studies, portfolio of assessment).

The depth of discussions pertaining to topics introduced in the programme with '*guided self-study'* was at the discretion of teacher educators and school-based mentor teachers, as indicated during the interviews:

> *Curriculum design is very flexible in the sense that there is no blueprint that says in PGCE you must… you know, like in schools… also use my discretion on how much students can process at a particular time… bring my own perspective in the [PGCE] curriculum* (Introduction to Research, Teacher Educator interview)

The benefits of the '*guided self-study'* methodology, from the perspective of those who completed it, is that the PGCE "*introduced [them] to what teaching is all about*" (NQT1 interview) and was *"brilliant [and] you know what is expected of you"* (NQT4 interview).

The following was noted by one who completed the PGCE to benefit fully from the methodology of '*guided self-study'*: "*PGCE is not there to teach you how to teach, for me. It puts more on what you can call embedded knowledge on what you already have*.... *So [the PGCE] kind of gives one pros and cons of being a teacher"* (NQT5 interview). The perception that the PGCE 'is not there to teach you *how to teach'* came from the practice of focusing on the "relationships between pedagogical knowledge and [disciplinary] knowledge" (Reeves & Robinson, 2010: 237) and "many PGCE courses are still organised in a way that suggests that skills and knowledge are to be acquired in a general (often abstract) form first before being deployed in specific circumstances at a later date" (Philpott, 2006: 300). The above perception is accentuated when prospective teachers compare their experiences during a PGCE with experiences of those completing a B.Ed. based on the practice that "PGCE curricula are largely concentrated versions of B.Ed. curricula, without subject content modules" (Taylor, 2014: 10).

'Learning to teach' is an individual journey which policy is expected to govern in a standardised format. The university relies on 'guided self-study' to encourage the individual journey of learning to teach within the confines of national and institutional policy stipulations.

6. Discussion

We now return to the issue of how a PGCE programme operationalises the MRTEQ policy which defines the required professional teacher knowledge in a one-year period within the context of learning to teach mathematics. This paper argues that that the PGCE programme is designed with limited opportunities to develop 'subject matter knowledge' or 'specific specialised subject matter'. The PGCE programme introduces 'pedagogical knowledge', which prospective teachers are to link to their existing 'disciplinary knowledge' to integrate into their teaching practice, approaching mathematical content knowledge ('subject matter knowledge' and 'specific specialised subject matter') as essentially 'already in place'. And if inadequate, the prospective teacher, it is assumed, will self-study to close identified gaps while in the process of completing the PGCE.

In terms of developing 'disciplinary knowledge', we argue that in the examined PGCE programme, 'specialised pedagogical content knowledge' mentioned under 'pedagogical knowledge' and 'specific specialised subject matter' under 'disciplinary knowledge' in policy is, by and large, considered the same thing. The rationale is the overemphasis on subject administration that occurred in the PGCE at the cost of developing 'specific specialised subject matter knowledge' during the module 'Mathematics Didactics', which was tasked with developing competence in mathematics teaching. Moreover, this indicates that the PGCE focuses on *how to teach* as the prospective teachers are assumed to have fully developed the *what* to teach within the context of school mathematics.

Concerning pedagogical knowledge in the programme, competence in assessing learners was gained by designing and delivering assessments and reflecting on the outcomes and processes involved when assessing learner mathematics competence (Purwoko, Nugraheni & Instanti, 2019). Pedagogical knowledge linked to teaching was influenced by introducing theories, observations and practical tips on how teaching media benefits the presentation of mathematical concepts, methods and rules. The overall methodology of the PGCE to meet policy expectations was 'guided-self-study' supported by a reflection sheet for critical reflections. This guidance involved answering questions to explore successful and unsuccessful aspects, the cause of such, and ways to improve future teaching practice. 'Guided self-study' and critical reflection served as the programme's core approach to equip each NQT with professional knowledge types as defined in the MRTEQ policy. This suggests that learning to teach mathematics in a PGCE involves general (often abstract) knowledge which is assumed to be integrated and applied as NQTs gain experience and conduct self-study as a classroom teacher.

7. Conclusion

This study found that the PGCE programme under investigation linked practice with policy expectations by relying on 'guided self-study' and 'critical reflection' as programme methodology, albeit unevenly. Moreover, the linkage was crucially contingent on the quality of each student teacher's past engagement with mathematics and engagement with lecturers. The broad nature of policy expectations and lack of clarity in differentiating the concepts 'specific specialised subject matter' and 'specialised pedagogical content knowledge' are argued to be key contributing factors explaining the uneven development in the PGCE. The analysis of this paper suggests that the policy-practice gap in ITE is partly the result of how policy conceptualises knowledge, and specifically, how policy conceives specialised knowledge and its instantiation in ITE programmes. This suggests, as discussed, the need to revise ITE policies to ensure that 'specific specialised subject matter' and 'specialised pedagogical content knowledge' are clearly differentiated to promote the development of each as an independent type of knowledge. In so doing, the ITE could better prepare future teachers to teach effectively and ensure meaningful and equitable learning for all, particularly the marginalised, supporting inclusive economic growth in resource-constrained contexts. The paper argues for an effective bridging of the policy-practice gap in ITE as delivered in countries experiencing resource constrained contexts.

The limitations of this paper is anchored in the nature of a qualitative study which restricts generalisation. As a suggestion, it is urged to test the level of mathematical knowledge held by all prospective teachers enrolled for a PGCE with mathematics as a major.

References

Adler, J., Slonimsky, L. & Reed, Y. 2002. 'Challenges of teacher development: An investigation of take-up in South Africa. In: Y. Reed & J. Adler (Eds.). *Challenges of teacher development: An investigation of take-up in South Africa.* Pretoria: Van Schaik.

Burn, K. 2007. Professional knowledge and identity in a contested discipline: challenges for student teachers and teacher educators. *Oxford Review of Education,* 33(4): 445-467. https://doi.org/10.1080/03054980701450886

CHE (Council on Higher Education). 2010. Report on the national review of academic and professional programmes in education*. Higher Education Monitor 11*. Pretoria: Council on Higher Education.

DBE (Department of Basic Education). 2011. *Action plan to 2014: Towards the realisation of schooling 2025.* Pretoria: Government Printers.

DHET (Department of Higher Education and Training). 2015. Revised policy on the minimum requirements for teacher education qualifications. *Government Gazette*, 596(38487), February 19. Pretoria: Government Printers.

Ellis, V. 2007. Taking subject knowledge seriously: from professional knowledge recipes to complex conceptualizations of teacher development. *Curriculum Journal,* 18(4): 447-462. https://doi.org/10.1080/09585170701687902

Guyver, R. & Nichol, J. 2004. From novice to effective teacher: A study of postgraduate training and history pedagogy. *International Journal of Historical Learning, Teaching and Research,* 4(1): 1-66. https://doi.org/10.18546/HERJ.04.1.02

Jansen, J. 2013. Personal reflections on policy and school quality in South Africa: When the politics of disgust meets the politics of distrust. In: Y Sayed, A. Kanjee & M. Nkomo. (Eds.). *The Search for Quality Education in Post-Apartheid South Africa. Interventions to Improve Learning and Teaching.* Cape Town: HSRC Press.

Loughran, J. 2010. *What expert teachers do: Enhancing professional knowledge for classroom practice*. London: Routledge.

Matoti, S.N., Junqueria, K.E. & Odora, R.J. 2011. A comparative study of pre-service teachers' self-efficacy beliefs before and after work-integrated learning. *South African Journal of Higher Education*, 25(6): 1140-1177.

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

Naylor, R. & Sayed, Y. 2014. *Teacher quality: evidence review: Office of Development Effectiveness 2014*. Canberra (Australia): The Department of Foreign Affairs and Trade.

Nomlomo, V. & Sosibo, Z. 2016. From theory to practice: Beginner teachers' experiences of the rigour of the Postgraduate Certificate in Education programme. *Perspectives in Education,* 34(1): 199-215. https://doi.org/10.18820/2519593X/pie.v34i1.14

Purwoko, R.Y., Nugraheni, P. & Instanti, D. 2019. Implementation of Pedagogical Content Knowledge Model in Mathematics Learning for High School. *Journal of Physics: Conference Series* 1254 (2019): 012079: 1-6. https://doi.org/10.1088/1742-6596/1254/1/012079

Philpott, C. 2006. Transfer of learning between higher education institution and school-based components of PGCE courses of initial teacher education. *Journal of Vocational Education and Training,* 58(3): 283-302. https://doi.org/10.1080/13636820600955286

Reeves, C. & Robinson, M. 2010. Am I qualified to teach? The implications of a changing school system for criteria for teacher qualification. *Journal of Education,* 50: 7-33.

Sayed, Y., Carrim, N., Badroodien, A., McDonald, Z. & Singh, M. 2018. Policy and legislative context of initial teacher education. In: Y. Sayed, N. Carrim, A. Badroodien, Z. McDonald & M. Singh. (Eds.). *Learning to teach in post-apartheid South Africa: Student Teachers' Encounters with Initial Teacher Education (1st ed.).* Cape Town: African Sun Media. https://doi.org/10.18820/9781928357971

Taylor, N. 2014. *Initial teacher education research project: An examination of aspects of initial teacher education curricula at five higher education institutions. Summary report*. Johannesburg: JET Education Services.

Walkington, J. 2005. Becoming a teacher: encouraging development of teacher identity through reflective practice. *Asia-Pacific Journal of Teacher Education,* 33(1): 53-64. https://doi.org/10.1080/1359866052000341124

Zeichner, K. 2010. Rethinking the connections between campus courses and field experiences in college and university-based teacher education. *Journal of Teacher Education,* 35(3): 479-501. https://doi.org/10.5902/198464442362