

## CHAPTER FIVE

## RESEARCHER REFLECTIONS

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### ***5.1 Introduction***

In the previous chapter, a compilation of participants' reflections and experiences from their final portfolios was presented. This participant reflection described how each participant viewed the aim of education, their experiences of teaching and learning mathematics within the PGCE course, their insights during their two school-based education periods and their progress and development over the course of the year with regard to developing and implementing learning task designs. The reflections were written in the voice of the participants as they represented themselves in their final portfolios, in defending their professional development. The purpose of including these participant reflections was to give the reader insight into the participants through the eyes of the participants themselves, before presenting the researcher reflections in this chapter.

These researcher reflections are my experiences, views and assessments (and some assessments from the lecturer who assisted me) of each participant during their PGCE year. The approach I used in writing these reflections was to include comments on how the participant represented themselves in comparison to how I viewed them. In the mathematics profiles I then expound each participant's subject matter knowledge, pedagogical content knowledge, conceptions of mathematics and beliefs on the teaching and learning of mathematics through my own observations, conversations and encounters with the participants. Finally, the instructional behaviour profiles are outlined according to each participants' position on the continuum of reform versus traditional approaches to the teaching and learning of mathematics and the second continuum of providing learners with either autocratic versus democratic experiences of learning. I draw on the literature referenced in chapter 2 in guiding the development of these narratives.

My main sources of data for this chapter came from the learning task designs and video-recordings of lessons included in each participant's portfolio. I also draw on my reports of

their observed lessons and the baseline assessments (see Appendix D) they wrote on entering the mathematics specialisation module of the PGCE. This baseline assessment covers a variety of topics and learning outcomes up to a Grade 9 level (from the South African curriculum) and is made up of a number of TIMSS items that were released on their website for public distribution as well as other items taken from Grade 8 or 9 school assessments. The PGCE students are instructed to draw up a memo for the baseline assessment without consulting anyone else or their textbooks. The assessments help me as the specialisation lecturer to gain some insight into the level of conceptual understanding of basic mathematical principles with which students enter the course. While I do not wish to argue or prove the scientific validity and reliability of these baseline assessments, they have proved over the last four years to be a very good indicator of the level of mathematical conceptual understanding that students demonstrate in their teaching and learning of mathematics during the PGCE course.

## **5.2 Marge**

### **5.2.1 Mathematics profile narrative**

The way Marge has represented herself and reflected on her approach to the teaching and learning of mathematics is significantly in line with how I experienced Marge's growth and development throughout the year. Marge always displayed strong subject matter knowledge, with conceptual depth and an ability to think relationally. When she wrote the baseline mathematics assessment that I require all students to write on entering the course, Marge found some solutions that I had not even included in my memorandum. This strong subject matter knowledge and her passion for the subject appeared to put her in a position to develop her own mathematical problems for learners that were later presented in an appropriate and authentic context in her LTD's.

The first lesson of Marge's that I assessed was conventional, as she mentions. She initially expressed a deep concern of how she could not understand how things could be any different. However, Marge has an ability to persevere and she began reading, widely! Evidence of this is apparent in her portfolio and in the quotes from her assessment reports below. Marge especially enjoyed the literature on Realistic Mathematics Education to which I introduce all

the students as part of the course. She also did her own research and found the work of researchers at Stellenbosch University (Olivier, Human and Murray) on the problem-centred approach very helpful.

Marge began finding ideas on the internet, in textbooks and by looking for mathematics in her everyday life and working them into mathematical problems that could facilitate the construction of mathematical principles in her LTD's. She tried various forms of assessment in her learning tasks and worked exceptionally hard at changing her approach to and view of teaching and learning mathematics. She started viewing learners' errors as potential learning opportunities and began answering questions by asking another question to encourage learners to become more independent thinkers. Marge also successfully started using scaffolding in her lessons where she gave questions or hints to learners who were struggling while still trying to encourage them to think for themselves. The progress in her pedagogical content knowledge was evident throughout the year and is illustrated by the following quotes from assessment reports I sent her during the course of the year.

*I experienced the lesson as very teacher-centred, with the learners doing very little thinking of their own...The learners' role was to respond on occasion when requested and to copy the examples. It is difficult to see this then as facilitating of learning but rather as "copying" of the teacher's notes and thinking. Statements such as "Ek gaan vir julle wys hoe werk dit, en dan [I am going to show you how it works, and then....]" re-inforce for me a very teacher-led and teacher-centred style of teaching. (24 April 2006)*

*Think about what the learners gained mathematically from this lesson – they followed the rules given and the examples on the board but how has this enabled them to be more mathematically literate or to understand the concept of a mathematical function? One runs the risk of making mathematics out to be a set of rules that need to be memorized and applied at the right times or you can't do it. (24 April 2006)*

*Your passion for the subject and perseverance with challenging students are to be commended. (5 May 2006)*

*There was definitely a noticeable attempt at shifting to a more learner-centred approach in this lesson.  
(5 May 2006)*

*It was good to see that you “entertained” the incorrect answer of the learner about  $B + C - 180$ , by writing out exactly what she said and allowing her to realize her own mistake. This is a definite improvement in your pedagogy – keep it up! (1 June 2006)*

*Your questioning skills are certainly improving all the time. I experience that you are pushing the learners more and trying to make them more independent in their thinking – well done. (1 June 2006)*

*Your LTD's are of a high standard – both in design and execution. You have also maintained a good balance between context and mathematics. Continue to ensure that learners are given sufficient opportunities to practise and demonstrate their understanding. (7 August 2006)*

By the end of the course Marge had progressed from a predominantly instrumentalist view of mathematics to a Platonist view and eventually a problem-solving view. She successfully made the transition from a content-orientated approach to a more process-orientated one where she managed to explicitly demonstrate her changing beliefs through her attempts and ability to take on the role of explainer rather than that of instructor. She was able to design effective LTD's (up to a Level 5 of Mason's levels) that she had thought up herself, to monitor that actual learning was taking place through appropriate assessment and to reflect on ways to improve her classroom culture and pedagogical content knowledge. In my opinion her strong subject matter knowledge, her ability to reflect on herself and her lessons with critical insight and accuracy, the literature she read, tried and her own experiences during her school-based practice periods are the factors that enabled the positive changes that occurred in her conceptions, beliefs and practice.

## **5.2.2 Instructional behaviour narrative**

Initially I would classify Marge's instructional behaviour as very traditional. Her first few classes were characterised by a dominance of expository teaching, a focus on correct answers and correct mathematical methods as well as the efficient mastering of rules and algorithms.

As Marge began to engage more with the literature and review her own conceptions and beliefs with regard to mathematics and the teaching and learning thereof, her approach in the classroom began to change.

Marge started to value communication in the mathematics class more highly, design and implement learning tasks that reduced the emphasis on routine arithmetic computation and encouraged more guided (scaffolded) discovery methods, exploration and modelling. She began making more frequent use of alternative assessment methods such as journal entries and encouraged learners to compare and discuss their mathematical techniques. Marge's learning tasks became more problem-solving orientated and engaged learners in real-life, contextual problems where learners were first required to attempt their own informal solutions before seeking a more formal approach.

On commencing her first school-based experience, Marge displayed (and expressed) a need to always be in control of the learning and management of the classroom. She would tell the learners what they would be dealing with for the day, show them a few examples, explain the steps and get the learners to try some calculations themselves. Her approach was therefore formal, expository and did not allow for a lot of communication between the teacher and the learner, except for the odd question to ensure that learners "understood" or to see if they had any queries they wanted to express. Marge's listening was also more evaluative initially where she was focused on listening for the correct answer or mathematical explanation.

Late in her first school-based experience and into her second school-based experience, Marge began to become more aware of the classroom culture she was creating through her authoritative actions. She began to encourage learners to share their reasoning first, before she provided them with her formal, stylised approach. More group work was undertaken in her classes, while individual meta-learning was not disregarded. During this phase her listening also moved towards a more interpretive listening where the correct answer no longer became the focus. Marge asked learners to elaborate on their thinking and explanations behind incorrect answers and stimulated further discussions using these errors. Communication, especially relating to mathematical issues therefore became more of an integral part of her lessons, although Marge never reached a hermeneutic level of listening where the teacher and

learner become equal partners in jointly exploring mathematics. By the end of the year, Marge's instructional behaviour had therefore shifted from a traditional to a more reform approach and from a very autocratic to slightly more democratic position on the two continuums.

## **5.3 Lena**

### **5.3.1 Mathematics profile narrative**

In the baseline assessment Lena performed well, only making one or two careless omissions and one general solution where she could not find the specific values required. She never made any overt fundamental errors during the lessons I observed her teach or in her learning task designs. While I would not regard her subject matter knowledge as strong as that of Marge or Toni, I am of the opinion that it was still conceptually sound.

Lena was given a Grade 12 class to teach at her first school-based experience and right from the start she confidently presented the content to them without faltering. As she explains in her reflections, what she struggled with initially was finding more ways to try and explain to learners when they did not initially understand. This was more a feature of her pedagogical content knowledge which was also often highlighted in my comments in reports sent to Lena during her first school-based experience. Another focus was on trying to encourage Lena to make more use of contextual problems, rather than her preferred model of showing examples to the learners before getting them to try some calculations of their own. A few quotes are provided below from a range of reports during the first semester that illustrate these comments.

*Think of ways to move your teaching towards a more learner-centred approach. Remember that this has to do with the amount of thinking and learning they are doing, rather than whether they are just active in the lesson. (24 April 2007)*

*Listening to the answers learners propose and investigating their correct as well as incorrect responses can be very helpful in identifying for you what they understand, rather than simply what they can do. Actually asking learners whether or not they understand is not as useful. (24 April 2007)*

*I think these learners are afraid of making mistakes. This is probably due to many years of mathematics experience for them where mathematics has been about getting the right answer. They therefore begin to think that if they can't get the right answer, they shouldn't even bother. This is something for you to consider in your own practice-theory and how you can change this in your classroom culture once you have your own class. (10 May 2007)*

*Although your lesson involved the learners, I want to challenge you to consider how you could have more engaged and challenged them with this particular content. Try to think of where this applies in real life (for example painting versus filling a swimming pool) and how an actual box of ice-cream cones is packed. Beyond just the pure mathematics embedded in this learning outcome, I think there is a lot of scope for more use of context. (30 May 2007)*

During the second school-based experience, Lena started showing more creativity in designing her learning tasks and making effective use of challenging learners with problems in authentic contexts. She was able to design learning tasks that I would classify as Level 5 on Mason's levels. She was continually working at and reworking her personal practice-theory on the teaching and learning of mathematics, especially in terms of working in the use of urgent problems that would engage learners on a horizontal and then vertical mathematisation level. During this time Lena also showed good development in terms of her pedagogical content knowledge specifically with reference to her planning, ideas, posing of questions and use of scaffolding. The comments below from reports issued to Lena (by the lecturer who relieved me) during the second school-based experience substantiate this.

*The problem about the homework was relevant to learners' lives and their context. Learners had the opportunity to solve the problem in an informal manner (horizontal level). Some of the learners generalised the solution to a formal, vertical level. (24 July 2007)*

*The idea to show snippets of a film to learners was outstanding. This put the problem that they needed to solve into context and I believe you were successful in immediately getting the attention of the learners.*

*(6 August 2007)*

*Your use of questions such as, “Are you sure?” and “what do you think?” are effective questions during learning task feedback.* (6 August 2007)

*Your reference to the sketch of the hyperbola was a good way to make use of scaffolding for the learners.* (6 August 2007)

*I was excited about the consensus that some of the learners reached. One group was convinced that the formula was  $y = 3^a$  while another group reckoned that it was  $y = 3 \times a$ . The resulting discussion was educationally very beneficial.* (6 August 2007)

Similar to Marge and Toni, Lena took a methodical approach to writing her reflections and to developing her practice-theory. Lena’s reflections mostly foreground what she thought had worked and what could be done to improve her practice. With regard to her conceptions of mathematics, she demonstrated an instrumentalist view of mathematics throughout the year. During her expository teaching she conveyed mathematics as a bounded system of rules and algorithms. Lena had creative ideas and made effective use of media and context. Although she did design problems that encouraged learners to think about and engage with the mathematics, her focus remained largely on mathematics content and the mastering thereof. Initially she did not indicate that she required the learners to be anything more than passive receivers of her teaching. Later in the year though she began to ask more questions that encouraged communication from the learners.

My perception of Lena throughout the PGCE was that she will always strive to improve her practice. This appears to be part of her nature. However, I did see the conflict she continually seemed to be experiencing between the way she was taught mathematics and how she was being challenged to teach it. Initially she battled to see any fault with the traditional approach to the teaching and learning of mathematics. It was only when she started to successfully apply

a more constructivist approach that she became excited about the prospect of working this into her practice. While students make some radical changes to their beliefs during the PGCE year, Lena appeared to be one of those students who took time to reflect and internalise change in her practice. I suspect though that when she does, the change is deep and sustaining.

### 5.3.2 Instructional behaviour narrative

The most striking characteristic in all of the observation and recorded lessons of Lena is what I have called “the teacher pause”. As I commented in one of her reports,

*Think about your questions and the pauses you allow. If it is not really a case of you requiring an answer from them, then rather make a statement. Otherwise it is good to wait for them to provide an answer to avoid encouraging a classroom culture where they know you will answer if they just wait long enough. (25 April 2007)*

Lena had a tendency from the beginning to start a sentence (not necessarily a question) and then pause for the learners to “fill in the blank”. For example, she would say, “...and the third term is.....four”. She did not necessarily wait for an answer to come from the class. After approximately a second she would fill in the blank herself. Unfortunately she tended to also do this with questions that she posed to the class. If the correct answer was not forthcoming from a learner very quickly, she would immediately proceed with her expository explanation. This is an important aspect of Lena’s instructional behaviour. This was one of the influential factors that kept her lessons predominantly authoritative for the entire year.

The learners seemed to quickly pick up on this culture of not having to answer too quickly as the answer would then come from the teacher anyway. This therefore did not encourage a lot of mathematical discussions or communication in the classroom. When Lena did start her expository explanations, they required little more than surface involvement from the learners with questions such as, “...who joined the points?” or “what was the value for  $a$  that you got?” However, in the actual learning tasks that Lena designed she managed to make use of problem solving and effective scaffolding within the tasks. Towards the end, the problems were also real-life and in context. During such a lesson though, her standard approach was to introduce

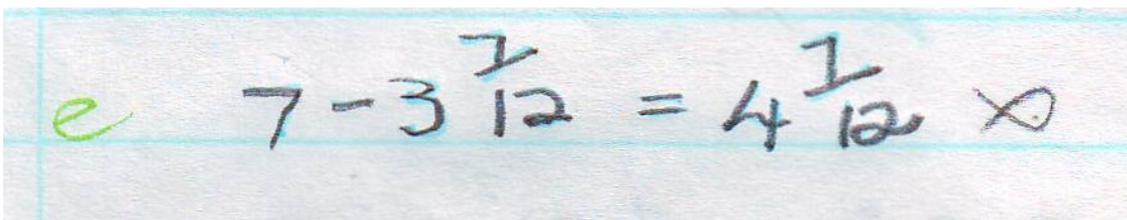
the problem to the learners (either verbally or with assistance from media such as video clips). Lena would then distribute the written problems and instruct the learners to work on their own before moving them into groups for further discussion between themselves. After some time in their groups, Lena would move to the front of the class and begin going through the problem in her usual expository approach. I could not find any examples of where she invited learners to share their solutions to the problems or where she facilitated a class discussion on the problem. Her listening skills also remained evaluative, rather than interpretive although she did towards the end start asking individual learners higher level thinking questions as she moved about the class.

In terms of instructional behaviour, this meant more of a movement occurred for Lena on the traditional/reform continuum than on the autocratic/democratic continuum.

## 5.4 Peta

### 5.4.1 Mathematics profile narrative

Peta's reflections are accurately representative of her frustrations and challenges throughout her PGCE year. Peta is a soft-spoken and gentle individual and discipline issues feature often in her reflections. I suspect, however, that Peta's personality is not the only factor that may have aggravated her negative experience of discipline issues with learners. As Peta mentions in her reflections, she initially lacked confidence, was very nervous she would make a mistake and struggled to explain the content to learners. She was also overtly aware of potential weaknesses in her pedagogical content knowledge. Much of this was due to the gaps in Peta's subject matter knowledge, some of which became evident in her baseline assessment through fundamental errors as demonstrated in the examples below.



The image shows a handwritten mathematical expression on lined paper. On the left, a green letter 'e' is written. To its right, the expression is written in blue ink:  $7 - 3\frac{7}{12} = 4\frac{1}{12} \times$ . The expression is incorrect because  $7 - 3\frac{7}{12}$  should equal  $3\frac{5}{12}$ , not  $4\frac{1}{12}$ . The final result is followed by a circled 'x' indicating it is wrong.

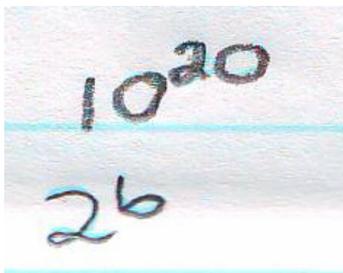
*Figure 5.1 Example of a fundamental error from Peta's baseline assessment*

This first error is particularly disconcerting with regard to Peta’s conceptual understanding of fractions and working with rational numbers. This is further confirmed by the errors in Figure 5.2 below where she appears to incorrectly apply exponential laws. When students are doing this assessment, they will often complain that they have “forgotten” the exponential laws after not having used them for a few years. My response is always that if one understands the notation and has a conceptual understanding of the concept of an exponent, that there is no need to have any memory of the laws. The notational and conceptual understanding should be sufficient to allow one to find the answer without applying any laws, although this may make one’s calculation slightly longer. Peta’s responses to the questions below indicate her inability to demonstrate either a notational or conceptual understanding of exponents.

*Question 2b*

(4)  $10^4 + 10^4 + 10^4 + 10^4 + 10^4$  (2)

(5)  $2^3 \times 2^2$  (1)



***Figure 5.2 Further examples of fundamental errors from Peta’s baseline assessment***

Even after a few difficult incidences exposing some gaps in her subject matter knowledge, Peta continued to persevere in working at designing learning tasks that were more learner-centred and constructivist in their approach. The following quotes are taken from reports I sent Peta.

*Consider in your practice-theory the effects on your classroom culture of showing learners how to do the first one. Does this help you see who understands? Who ends up doing the thinking? Is this more learner or teacher-centred? What are (if there are) the benefits of telling and showing learners how to*

*do the mathematics? These are questions that you will need to think about as you reflect on your practice. (11 May 2007)*

*You are still telling too much, rather than getting the learners to think. You need to work more on designing questions you can ask learners when interacting with them. These can be written down in your planning already.(11 May 2007)*

*I am still concerned that your teaching is still too teacher-led and that you make too much use of whole-class teaching. On this video it again looked like groups already finished had to wait for you to finish attending to other groups, and your next instruction, before they could continue. I wasn't sure why you had chosen this above a self-led worksheet. Perhaps this is in your reflections, or feel free to comment on it in your reflections to me. (30 May 2007)*

*Although this improved as the lesson progressed, learners did not seem to be engaged for parts of the lesson, although they were involved. My next challenge to you is to get them solving problems that challenge and engage them to think as mathematicians. There is a difference between them being mathematically engaged and them supplying answers on demand or following your instructions. Remember that we can involve learners and still not have a learner-centred lesson. I am sure that you will take up the challenge in the second semester to work on this, now that you are more confident in front of the class. (30 May 2007)*

During her second school-based experience, Peta did take up the challenge by applying herself to improve her planning. Her pedagogical content knowledge appeared to improve despite the deficits in her subject matter knowledge. Her planning, assessment and classroom management advanced to a sufficient proficiency in my opinion over the course of the year. She made use of hints to try and get learners to think more independently and her questioning technique improved. This is substantiated by the following quotes taken from the assessment reports written by the specialisation lecturer relieving me while I was on study leave during the second SBE of the students.

*It is very positive that you introduced the new topic with an example in an authentic context...The problem in a real context was solved by learners on a horizontal level. This was a good decision. You could have made the learning experience even more learner-centred by asking the learners to do a journal entry about their observations. (31 July 2007)*

*Your skill in setting questions has developed well. (31 July 2007)*

*I enjoyed it very much that some of the learners do not want hints from you anymore. This is a positive change in the classroom culture. (14 August 2007)*

*The Chinese proverb that you used to present the learning task was a lovely idea, something different and definitely effective...I liked the fact that you asked the learners to “tell the proverb graphically...” (29 August 2007)*

The final task that Peta reflects on in her participant narrative is also indicative of the highest level she achieved in designing a learning task according to Mason’s (1989) differentiation. This was a level 3 in my opinion. Her conception of mathematics appeared to remain rigid and bounded by rules and formulae throughout the course of the year. I make this deduction mainly from the way she portrayed the mathematics in her learning task designs and from her low frequency of engaging with the actual mathematics content in her reflections. Peta definitely felt more secure when dealing with mathematics as a set of rules and algorithms, therefore predominantly teaching in a content-orientated manner. This may again be a function of the gaps in her subject matter knowledge, which possibly also led to her mostly taking on the role of instructor in the classroom, where her strongest focus was on mastery and correct performance.

#### **5.4.2 Instructional behaviour narrative**

All the lessons I observed Peta teaching and the videos she included in her portfolio follow much the same order of events. A worksheet was handed out to learners at the start of the lesson. On one occasion, the learners immediately just started working on the worksheet but the other times Peta either read through and explained the instructions or problem to the

learners or presented a verbal presentation of the problem. Peta would then move between the learners and respond to questions as requested while the learners worked on the problem or calculations. If a question seemed to be repeated by a few learners Peta would go to the front of the class and present an explanation to the class. The learners would then continue with their work, which they would either hand in to be marked or mark themselves from an explanation presented by Peta.

There were some positive changes though within this order of events. The quality of the worksheets improved from a set of calculations to more contextual type problems, although there was never actually a problem I would deem as relevant to the real life of the learners. Initially Peta would read through the problem and instructions of the written presentation with the learners and explain to them what they needed to do. In one of the lessons she showed them how to construct the table they would need to complete in order to draw the graph they were being required to draw. However, in her final learning task design, Peta presented the verbal presentation (of a Chinese proverb) to introduce the problem (rather than reading through the problem and instructions with the learners) and then turned the learners' attention to the problem of representing the Chinese proverb graphically.

During expository explanations, Peta mostly focused on the explanation and the correctness of the learners' responses. Towards the end of her second school-based experience, Peta did begin to ask more questions in response to learners' answers and questions, but these did not necessarily elicit high level mathematical reasoning processes. I suggest that, even by the end of the year, Peta was still more comfortable with a step by step development of ideas and following rules and algorithms. Her discussions with the class did not encourage them to find patterns of thinking or make connections between various concepts, but rather to guide them to the correct solution of the problem. She also seldom made use of authentic or alternative assessment. I would therefore classify Peta's instructional behaviour as dominantly traditional throughout the year.

The issue of an autocratic versus democratic learning experience for the learners is an interesting one in Peta's case. Unlike many of the other students, Peta never started off trying to be in "control" of the class. At times we actually commented on how much say the learners

had in her classes, to the extent that she would ask them when she could carry on with the next worksheet or problem. However, at times she would feel that the discipline was getting out of control, get very angry with learners and attempt to then “take control” from a discipline point of view. Mostly though, Peta learnt to move around the class and interact with the learners working on their problems individually or in groups. In this interaction she appeared to show signs of somewhat more interpretive listening rather than the evaluative listening she demonstrated during the whole class teaching discussions.

## **5.5 Kapinda**

### **5.5.1 Mathematics profile narrative**

As I worked through Kapinda’s portfolio again, analysing her learning task designs and reflections, the aspect that stood out most was Kapinda’s tremendous creativity in designing learning task designs. From the beginning of the year Kapinda seemed to enjoy this part of the training and worked hard at continually improving her learning task designs. She did not seem to struggle with any sort of cognitive or belief conflict regarding the new paradigm of thinking she was confronted with in the PGCE course in comparison to the way she was taught as a learner. She never showed any resistance towards a more problem-based approach and seemed to embrace the challenge with great enthusiasm. Her learning task designs always actively engaged the learners and learners appeared to enjoy Kapinda’s lessons very much. The following quotes from assessment reports we sent to her illustrate this.

*Again I want to compliment you on a lovely idea and a more learner-centred lesson. I think it could have been even more real-life though if you considered an everyday context such as packaging for supermarkets, and how companies try to optimise volume and minimise cost in order to produce better profits. (6 May 2008)*

*I liked the way you engaged the learners in a short discussion on personal appearance, weight issues and peer expectations as part of the verbal presentation. The topic ensured natural integration with other learning areas like Life Orientation. (27 May 2008)*

*Although the learning did not take place with a central problem as focus, the issue was exceptionally relevant to the particular group. (27 May 2008)*

*All learners were involved and actively engaged. (27 May 2008)*

*This was a good way to handle the test. It made good use of differentiation and engaged learners far more than going through the whole test with the whole class would have. (18 August 2008)*

*A great video clip and introduction to this lesson. Really appropriate and this would be a good tool to use at the start of year when setting classroom culture. (11 September 2008)*

Overall I would classify Kapinda's subject matter knowledge as good. There was no evidence of any overt fundamental errors in her learning task designs or observed lessons. In the baseline assessment Kapinda made one careless error and did not find complete solutions to two of the problems. What I did observe though was that Kapinda seldom, if ever, approached the teaching and learning mathematics in ways that demonstrated a deeper relational understanding of general principles of the domain as shown by Marge for example. During the course of the year, she learnt to design and present interesting and engaging problems to the learners. However, the mathematically focused class discussions, feedback and consolidation of her lessons lacked evidence that she was aware of or intent on facilitating the learners' understanding of the mathematical processes involved. She seldom, if ever in the lessons I observed, questioned or delved deeper into learners' errors or thinking and appeared to remain more content orientated in her enacted beliefs towards the teaching and learning of mathematics. The following quotes from a range of assessment reports to Kapinda support the above claims.

*Be careful not to enforce narrow perceptions learners may have, e.g. that the perpendicular height of a right-angled triangle will be the vertical dimension and the base the horizontal dimension! Any of the perpendicular sides can be regarded as the base and vice versa. (24 April 2008)*

*Be careful not to respond to wrong answers too quickly. Probe into wrong answers in order to get clarity on learners' thinking. Instead of answering that the AREA of the circle was subtracted from the*

*area of the square, a learner answered that the CIRCUMFERENCE was subtracted from the area. She did, however, get the correct answer. She understood the solution, but only used the wrong TERMINOLOGY. Your response was to say “You cannot do that”. (24 April 2008)*

*I am concerned about your decision to order the BMI [body mass index] ratio's in the table from smallest to largest. This can lead to the misconception that the median will always be in the middle of any list, or that all given lists of observations will necessarily be ordered. It is my opinion that learners should have the responsibility to order the observations. The group of learners close to me blindly found the middle number without first checking whether the list was in fact in ascending order. (27 May 2008)*

*To counteract apparent narrow understandings like the one mentioned under the previous point, assess their understanding of the formulas or strategies for median, average, mode, etc. by asking the learners to explain in words, in writing what the formulas or strategies entail. Another strategy they need to apply is to determine whether there is an even or an uneven number of observations. That is impacting on the approach in finding the median. The learners close to me did not take that into consideration. (27 May 2008)*

*I think you could have a bit more of a discussion (asking the learners) why it is important, especially in mathematics, to understand why we do certain procedures and apply certain laws. (11 September 2008)*

*Investigating numbers helps us to see and establish patterns which we think may be true (called conjectures). In order to prove the conjectures so that we can accept them as rules, laws and theorems, we use algebraic proofs to test and prove their generalisability. These proofs are based on the conjectures we established in the patterns. (11 September 2008)*

*The presentation on why dividing by 0 is undefined was too long and also not clear or correct. But you didn't make any comments. Be careful of letting such mistakes go without clarifying them or asking the class about them. (11 September 2008)*

Kapinda's reflections are accurately aligned with how I experienced her lessons. Her focus in the reflections was mostly on pedagogical issues though, such as her planning, ordering groups, handing out worksheets, interaction with the learners, assessment, questioning and discipline. She seldom made any reference to the actual mathematics processes or understanding learners should gain from the lesson. Kapinda never made any reference to literature in the mathematics domain or to articles they had been given to read in class. However, she did demonstrate an outstanding knowledge of the context of her learners and this enabled her to select and design learning tasks with authentic contexts to which the learners could easily relate. Although, as mentioned, her ideas were very creative and the problems she set engaged the learners, in my opinion she elicited up to a Level 2 from her learners according to Mason's (1989) levels.

Kapinda's conceptions of mathematics are not as obvious from her portfolio as some of the other participants. Her lack of identifying mathematical processes, the nature of the worksheets she compiled and her continued focus on mastering content led me (in consultation with the lecturer who sometimes assisted with lesson observations) to conclude that her view of mathematics remained instrumentalist during the year. Based on the above-mentioned reasons I would also define the role she mostly played in the classroom as that of an instructor.

Kapinda displayed a very natural tendency to design creative learning tasks, interact well with her learners and to get their attention. She also seemed to agree with (verbally) and embrace the shift to a more constructivist paradigm. She was clearly passionate about her relationship with the learners, about encouraging and motivating them and about her chosen profession. The "silence" that comes through in her portfolio though relates to the actual subject of mathematics. When I asked her later about this, she made the comment that although she sees the value in teaching mathematics using a more problem-solving approach, she could not envision how this is possible considering her own experience of school and university mathematics.

### **5.5.2 Instructional behaviour narrative**

Kapinda's observed lessons were always enjoyable; both from a learner and observer perspective. She embraced group work in her first school-based experience and made extensive use of this type of collaborative learning where possible, sometimes allowing individual learning first, followed by groups then collaborating on the same problem. Kapinda varied her selection of groups well in terms of the number of learners per group and how they were organised into groups. Learners seldom had any part in this selection though and the group organisation was usually already written up on the board when learners entered the classroom.

Most of the observed or video-recorded lessons of Kapinda show her giving a verbal presentation of the problem and creating some context before handing out the problem or worksheet to the learners to work on individually or in their groups. Kapinda moved very effectively between groups, answering questions learners had and checking what they had done. She mostly answered learners' questions by posing another question to assist them in reaching the answer. However, even at the end of the year, the level of questions she was posing to them focused more on eliciting the correct response rather than investigating the learners' thinking processes. Her listening therefore remained evaluative throughout the year.

Kapinda made more use during the course of the year of alternative assessment methods such as journal entries, presentations and the use of rubrics to guide learners to be more independent. Her lesson task designs encouraged hands-on, guided discovery rather than expository teaching, but high level reasoning processes were not foregrounded. I never once observed her leading a discussion with the class where Kapinda required learners to verbalise their mathematical thinking or understanding or where investigative exploration and modelling were discussed. The problems given to learners were mainly designed to achieve the immediate curriculum outcomes and mathematical mastery required rather than afford the learners a more relational understanding of the domain.

## 5.6 Anabella

### 5.6.1 Mathematics profile narrative

Anabella's reflections are often refreshingly personal and honest. They are also mostly accurate with regard to the lessons I observed her teaching. I use the term "mostly" because there is one exception and that relates to the lesson she describes in chapter 4 as a "total disaster" where she was looking at the effects of the parameters of  $a$  and  $q$  on graphs with Grade 11 learners. The lesson was not a total disaster. The learners were not really proficient at drawing graphs though, so her lesson could not work out as planned. Relating to this I mainly gave her some pointers on how to consider achieving the desired outcomes differently. The main critique, however, in both my report as well as the colleague assisting me, related to her subject matter knowledge in relation to how she spoke about the mathematics content. The quotes below provide examples of this from more than one lesson.

*Start to react to learners each time they refer to "take a term over to the other side" and "the sign changes". This is not mathematically correct and is definitely not what happens! They should understand the principles of the inverse for addition and the identity for addition. They do not have to write this down each time, but should quickly say e.g.  $+3x$  LHS and RHS. (23 April 2008)*

*Instead of saying "get  $x$  or  $y$  alone on the LHS", you can say "change the subject to  $x$  or to  $y$ ". Keep in mind that the subject does not have to be on the LHS! (23 April 2008)*

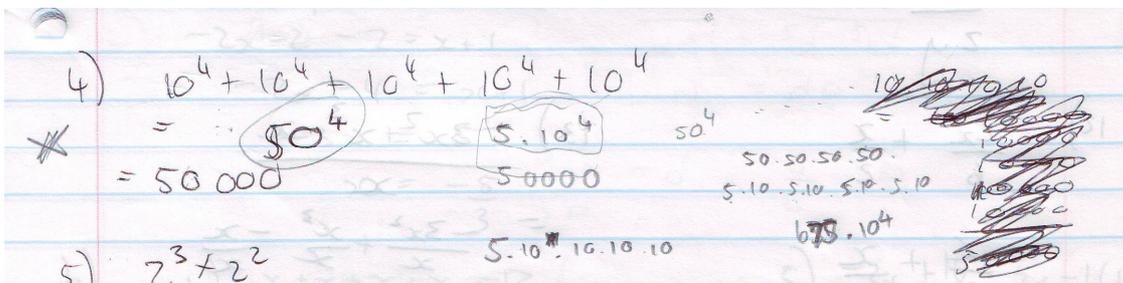
*Be careful to always balance equations. In other words, do not change an equation to an expression. If your equation is  $2x^2 + x - 3 = 0$ , do not suddenly write  $(2x + 3)(x - 1)$ . It is essential for learners to understand that the solution to a quadratic equation is the roots which are those  $x$ -values for which the function values will be zero. (23 April 2008)*

*Be careful of how you phrase mathematical ideas/concepts, e.g. "put a minus before the  $x$ "; a minus does not have meaning on its own – the term has a coefficient of  $-2$  and not of  $+2$ ; "the  $x$ -axis shifts", the graph has a vertical shift; "the slope moves down"; it is the gradient that is negative and the function that is decreasing; "plot graphs"; one plots points and joins the points to draw the graph; "a*

and  $q$  differ”;  $a$  and  $q$  change or take on different values; “how does the tan-graph differ from the other two?”; the tangent function does not only differ from the other two functions in terms of the asymptotes – there are other differences too, e.g. the fact that one cannot refer to an amplitude, the range differs, the period differs, the fact that one cannot identify a maximum or a minimum value, etc. You understand what you are trying to convey, but the learners hear these in a way that results in the construction of incorrect knowledge and misconceptions. (12 May 2008)

Anabella viewed this very much as an issue relating to her use of the English language rather than the conceptual understanding issues we were trying to highlight regarding her use of terminology. For example, in mathematics an axis on the Cartesian plane is fixed. A graph can shift if its equation changes but the  $x$ -axis does not move. If one talks about “shifting the  $x$ -axis” this demonstrates a lack of conceptual understanding regarding the properties of the Cartesian plane, rather than an incorrect use of the English language.

As Anabella correctly stated, I was concerned about her level of subject matter knowledge as displayed in the baseline assessment students wrote on entering the course. She omitted a few answers, made a range of careless errors as well as two fundamental errors. One of these fundamental errors is included as an example in the figure below. Here Anabella seems to get somewhat confused with her application of the exponential laws. I note this as a fundamental error because of her inability to see that  $50^4$  cannot possibly equal 50 000 and that there is a huge difference between  $5 \cdot 10^4$  and  $(5 \cdot 10)^4$ . This can also be argued as just an incorrect application of mathematical notation but a student with a strong conceptual understanding of the subject would have noted this discrepancy even if they had forgotten how to apply the exponential law.



4)  $10^4 + 10^4 + 10^4 + 10^4 + 10^4$   
 $= \dots 50^4$   
 $= 50\ 000$

$5 \cdot 10^4 = 50\ 000$

$50^4 = 50 \cdot 50 \cdot 50 \cdot 50$   
 $5 \cdot 10 \cdot 5 \cdot 10 \cdot 5 \cdot 10 \cdot 5 \cdot 10$

5)  $2^3 + 2^2$

Figure 5.3 Example of fundamental error made by Anabella in her baseline assessment

During the course of her school-based experiences, the gaps in Anabella's conceptual understanding of mathematics were also evident, for example, in the mistake she mentions in her reflections. Unlike the careless error that Toni made while doing a calculation on the board, Anabella had included a solution in her lesson plan that she had worked out prior to teaching the lesson and the errors were in my opinion not careless but of a conceptual nature. This is one aspect of her practice that I believe Anabella was unable to be honest with herself about. She noted my comments on her level of mathematics knowledge, the results of the brain profile, her mistake and an intention to work hard to improve this in her reflections, but she never actually acknowledged that the gaps in her subject matter knowledge could be what hampered her ability to design and operationalise LTD's in the FET phase.

On the other hand, Anabella did improve in the design of her lessons throughout the year. She was creative, made appropriate use of media and started to use scaffolding at a basic level in her lessons. She did not often engage with learners' errors, which I suspect is also due to her level of subject matter knowledge. Similar to Sophie, Anabella's reflections seldom provided insight into the mathematical content. The scaffolding questions she prepared for many of her lessons indicated that her pedagogical content knowledge was, in my opinion, of a higher level than her subject matter knowledge. Perhaps the deficit within her conceptual understanding enabled her to work at making the subject more accessible to the learners. Anabella also worked very hard at improving this aspect of her teaching. She engaged with the literature on Realistic Mathematics Education and attempted to use horizontal and vertical mathematisation at times.

Reflecting on the reading Anabella had done, she agreed that in the teaching and learning of mathematics "the focal point should not be on mathematics as a closed system but on the activity, on the process of mathematisation." During her second SBE Anabella had more success in actually making this belief noticeable in her learning task designs when she was given a Grade 8 class to teach. It was only when she was teaching at this level that I noticed Anabella was able to design tasks that indicated that she held a less rigid and limiting view of mathematics. This could have been due to the fact that her conception of mathematics had shifted during the course of the year, or that her subject matter knowledge had constrained her

view when she was required to teach mathematics at a higher level. A few examples of quotes from assessment reports are provided below depicting the changes discussed.

*Rather not teach learners a set of “steps” to solve certain kinds of problems. The status quo of regarding mathematics as a set of rules and algorithms is maintained by such practices. You can facilitate the development and recognition of certain strategies the learners can apply. (23 April 2008)*

*Your use of questions as scaffolding was a good pedagogical decision. I could see that you made an effort with your preparation. One needs to mentally go through the thought processes of the learners in order to effectively set up the questions one wants to use as scaffolding. (26 May 2008)*

*Although the problem was not urgent and did not originate from the learners’ personal context, it was realistic and the learning period was conducted in the transcendental paradigm. (26 May 2008)*

*You presented the problem verbally and the use of technology contributed to creating a conducive learning atmosphere. The learners were curious and their attention was definitely captured. The written presentations were of a good quality, were clear and served the purpose. (26 May 2008)*

*The fact that you prepared a second worksheet for learners, who needed less time to solve the problem, was a good strategy. (26 May 2008)*

*That was a good introduction to get them excited. (8 August 2008)*

*You seem more relaxed in front of the class - this is great! I am very happy to see the transition you are making to a more learner-centred approach. Well done. You also seem to be gaining confidence. (8 August 2008)*

I view Anabella’s belief of teaching as initially content-orientated, with evidence of a shift toward a slightly more process-orientated approach during her last few learning task designs. I would therefore classify her enacted beliefs regarding her role as a teacher as that of an

instructor moving more towards an explainer in the lower grades but reverting to the role of instructor for the higher grades.

### **5.6.2 Instructional behaviour narrative**

Anabella's lessons also reveal a common development trend. Initially her lessons were very traditional and teacher-centred with her showing the learners step by step examples on the board before giving them some calculations to try for themselves. During one of the lessons at her first school-based experience, Anabella began to move towards attempting a more problem-based approach in her lesson design. She showed the learners a problem using the data projector and required them to go about solving it. Learners were allowed to ask for hints if they were stuck and these were given in the form of a question to scaffold learners' thinking.

The three lessons at Anabella's second school-based experience all followed a similar sequence. She would hand out the written presentation of the problem, do the verbal introduction and then walk around the class tending to questions from learners. The problems were always an application of work already handled in the class during the previous few lessons. Where there were recordings of Anabella going through the problems with the learners, these would be very expository with low-level cognitive questions posed to the learners every now and again. Anabella's presentations and contextual problems improved but the focus in her instructional approach remained on the content, such as the formulae and algorithms and on the final solution. When she walked around the class while learners were working on the problems, she mainly responded to questions posed rather than engaging with learners' thinking processes. There was no evidence of her investigating or probing learners' errors or incorrect thinking. Her instructional behaviour therefore certainly remained on the traditional side of the continuum.

I classify Anabella's instructional behaviour as mostly authoritative from the lessons and videos I observed. Her listening remained evaluative in all the lessons. Although Anabella's lessons became more problem-orientated and learner-centred, the learners always worked as individuals and were seldom (if ever) encouraged to elaborate on their thinking processes and understanding. As mentioned above, where questions were posed to the learners, it was clear

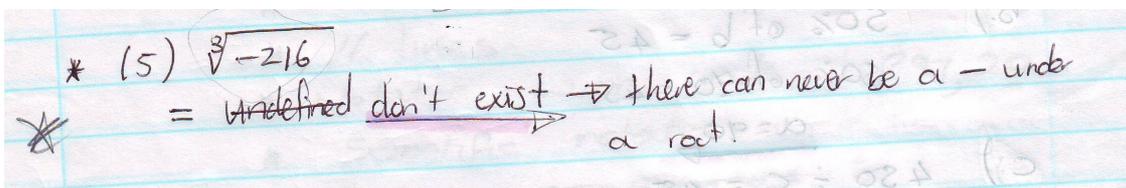
that the outcome of these was a solution. Anabella listened for the correct answer and when it was not forthcoming soon enough, she would provide it herself. Anabella also had the habit of using teacher pauses, but then inserting the answer if the class did not respond timeously.

Anabella’s body language was also a fascinating aspect of her teaching that necessitates a mention. She often walked around the class engaging with individual learners with her hands in her pockets or her arms folded. This could have been due to the cold weather in some of the lessons, but others were taped during summer. In one of the lessons she walked around with and used a metre long ruler to point to answers on the board that she could have reached from where she was standing. Anabella appeared to “play out” the role of a traditional teacher exceptionally well. As I replayed her lessons, I could not help but think how stereotypical of the traditional view of teachers her actions were. She was definitely in control, even when the learners were working on the problems. While her instructional behaviour did make a slight shift on the authoritative/democratic continuum, it still remained on the authoritative side throughout the year.

## 5.7 Sophie

### 5.7.1 Mathematics profile narrative

In the mathematics content baseline assessment test that Sophie completed on entering the course, she made a number of fundamental mathematical errors. Three of these are included in the figures below as examples.



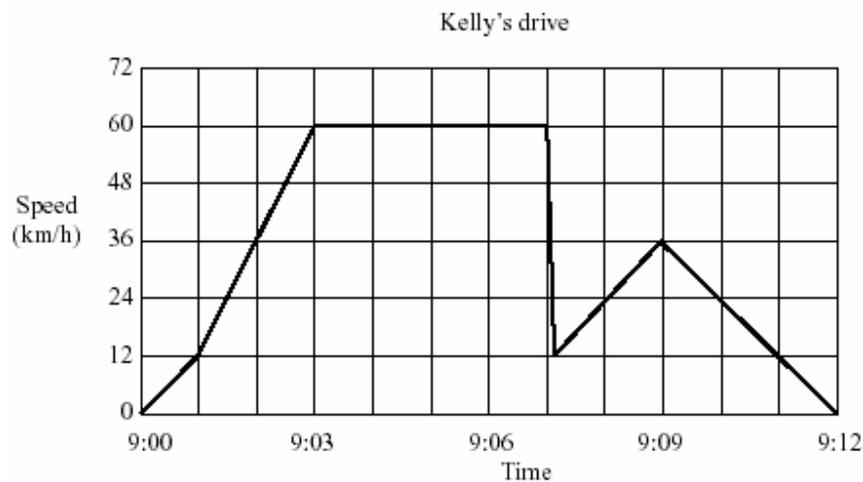
*Figure 5.4 Fundamental error from Sophie’s baseline assessment*

The above example illustrates Sophie’s dependency on rules and laws and her gap in being able to correctly apply conceptual understanding of the properties of numbers. Learners are often taught the “rule” that “you cannot have a minus under the square root sign” here she has

“applied” that rule even though it is the cube root that is being sought. Notice her use of the word “never”. The following example below is one of the TIMSS released items and I include it in the baseline assessment to gain insight into students’ understanding of gradient and interpretations of graphs. The conceptual gap in Sophie’s subject matter knowledge in this regard is evident from her solution below.

*Question 8*

*Kelly went for a drive in her car. During the drive a cat ran in front of the car. Kelly slammed on brakes and missed the cat. Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car’s speed during the drive.*



- a) *What time was it when Kelly slammed on the brakes to avoid the cat?* (1)
- a) *Explain what you think was happening between 9:03 and 9:07 according to the graph.* (2)
- [3]

Question 8

a.) 9:03 until 9:06

b.) From 9:03 and 9:06 Kelly stopped. After 9:06  
At 9:07 she drove back to return home by  
a shorter route.

**Figure 5.5** Second example of a fundamental error by Sophie

$$15.) \quad 4(y)^0 \times \left( \frac{y}{2} + \frac{y}{4} \right)^2$$

$$= 1 \times \left( \frac{y}{2} + \frac{y}{4} \right) \left( \frac{y}{2} + \frac{y}{4} \right)$$

**Figure 5.6** Third example of a fundamental error by Sophie

The error above is a common error that learners also make, mostly because they are applying an exponential law without understanding it. It can be argued that this was a careless error, but in the context of other similar errors, I would still classify this as a fundamental error which revealed further fundamental conceptual gaps in Sophie's subject matter knowledge.

As the lecturer of the mathematics specialisation module, I always have an individual meeting with each student concerning the results of their baseline tests. During the meeting with Sophie, I was honest with her about my concerns regarding the number of conceptual gaps in her subject matter knowledge of mathematics, especially in relation to her choice to teach at the FET phase. I indicated to her that she would have to work very hard at improving her own subject matter knowledge during the course of the year as this would impact heavily on her pedagogical content knowledge and the progress she would be required to demonstrate. On

more than one occasion I suggested and tried to encourage her to rather teach in the Senior Phase where I thought she would cope better with the level of mathematics. But she insisted that she wanted to stay in the FET phase for her PGCE year although she may consider teaching in the Senior Phase once she had qualified. I could not prevent her from continuing in the FET phase as she satisfied the necessary regulations. The PGCE regulations require a student to have mathematics on a third year level in their degree in order to teach in the FET phase. Sophie completed a general BA degree but did her mathematics on the education campus where she completed the third year level of mathematics.

Sophie's reflections mostly focused on discipline, general engagement issues with the learners, getting her learning task design "correct" according to the requirements of the course and issues relating to her position in the classroom as she experienced it. Her reflections tended to be mostly emotive, and she seemed to struggle to be self critical of her actions. She readily provided extrinsic factors as reasons for her lesson or any element thereof not working out. I could not find any examples where she reflects on the mathematics, her beliefs or her approach to the teaching and learning of mathematics. The mathematical processes elicited from her learners through her learning task designs can mostly be classified according to level 1 of Mason's levels (1989). This includes doing specific calculations, functioning with practical apparatus and recalling specific aspects of a topic and specific technical terms.

The course of Sophie's pedagogical content knowledge is an interesting mapping. There were initially many general as well as subject-related pedagogical issues to deal with as the comments from her first assessment report (written by my colleague after observing a Grade 9 class) indicate.

*Your voice is not clear and you are not always audible. Focus on pronouncing every word clearly. You are speaking too fast. Focus on speaking slower. If you start pronouncing every word clearly, it will slow you down. (25 April 2008)*

*Maintain eye contact with the class while you are writing on the blackboard. Turn to the class often and never face the blackboard directly with your back to the learners. (25 April 2008)*

*It is a good habit to give learners an opportunity to solve problems in class. Do not, however, become so involved with one learner that you isolate yourself from the rest of the class. While you were attending to one learner, the other learners had nothing to do. If you do need to pay individual attention to a learner, ensure that the other learners have work to do. (25 April 2008)*

*Questions per se do not elicit higher order thinking. There were two expressions:  $a^2 - a$  and  $a^2 - 1$ . When referring to  $a^2 - a$ , you asked the learners “What is the highest common factor?”. When referring to  $a^2 - 1$ , you asked the learners “How do we factorise this?” You literally gave them the solutions. They need to develop strategies, e.g. (a) look at how many terms are in the expression, (b) look at the highest exponent in the expression, (c) look at whether terms are positive or negative, (d) look for a common factor, etc. Even the terms in a quadratic trinomial can have a common factor. (25 April 2008)*

*Give learners an opportunity to experiment and to make mistakes. Let them do all these incorrect things they are uncertain of. Then ask them to substitute simple values like 1 or 2 into the expressions and ask them to test their answers. (25 April 2008)*

The next learning task design that Sophie requested to be assessed was attended by both my colleague and I. The lesson was for a Grade 10 mathematical literacy class relating to representation of data. The nature of the content was such that it lent itself very well to an authentic context. Sophie made effective use of this opportunity and designed a creative problem with which the learners could identify (relating to their personal problems). This lesson engaged the learners far more than the previous lesson. However, my colleague and I still commented on a number of pedagogical issues that needed attention.

*This was a lovely idea for a task. It is relevant to this age group and is a good example of cross-curriculum design (for example with Life Skills). Well done! The lesson was predominantly learner-centred and this is commendable. (7 May 2008)*

*In reflecting on your practice-theory, consider the value of an explanation from you versus self-discovery on their part. Although self-discovery is not always possible, or practical, it can be practised in the mathematics classroom far more than it is. It does not mean that the learners are left alone to*

*discover everything, but that you guide them to an understanding through various questions and prompts – called scaffolding. Scaffolding would be a good term for you to read up on in the literature (theory) on mathematics education, and to try out in your own practice in order to feed into your practice-theory. (7 May 2008)*

*Allow for and encourage different approaches to solving a problem. It is not necessary to first determine the percentages for each category. One can determine the angles at the centre of the pie chart circle by using the ratios from the frequency tables. The percentages can then be determined from the magnitudes of the angles. (7 May 2008)*

*While you are designing a learning task, you should take care to solve the problem in as many ways as possible and “reflect” in anticipation on how the learning period could develop. Not only will that enable you to develop a set of appropriate questions to use during learning task execution/learning task feedback, but you will also recognize possible errors in the written presentation. (7 May 2008)*

*Ensure that learners understand what they are doing. To learn recipes/methods/algorithms without understanding them does not help learners. In finding an angle at the circle centre, the one learner got confused and thought it to be  $x 100 \div 3,6$  instead of  $\div 100 x 360$ , or  $x 3,6$  as they probably learned the algorithm. She got confused between writing a ratio as a percentage and finding the percentage of something. When learners understand what they are doing, one can even encourage them to deduce quicker ways of calculating values, but they need to discover these themselves. The same group got an answer of  $648^\circ$  for one of the angles at the circle centre. (7 May 2008)*

Sophie continued to teach mainly mathematical literacy classes and the comments above are representative of the rest of the assessment reports that were sent to Sophie during her first and second school-based experiences. Her ideas were usually relevant and creative. However, there often seemed to be an issue with either the memorandum or the written presentation of the problem given to the learners. I continually encouraged her to get her learning tasks checked by ourselves, her mentor or a colleague. We also consistently tried to motivate the

need to get learners to be more reflective and independent in their thinking. Examples from further assessment reports are included below.

*To call learners to the blackboard to solve problems can be an excellent learning opportunity, provided that they share their thinking with the rest of the class. A learner, who merely writes down a solution, does not necessarily contribute to better learning quality. (28 May 2008)*

*You cannot risk not being excellently prepared and not being able to solve the problems yourself. The serious mistakes you made in the memorandum you set up are of great concern to me. (25 May 2008)*

*Give learners, who make mistakes, an opportunity to explain their thinking. This can elicit contributions from the rest of the class. You lose valuable learning opportunities when you wipe such attempts out and ask for another learner to come to the front. (28 May 2008)*

*This was an “oulike” [lovely] idea and I can see that you had prepared well for the lesson. It was a good idea to use “google earth” for the map. This is relevant and applicable. (18 August 2008)*

*I would like to have seen a learning product emerging from the lesson. While it is good to use rubrics, I would like to have seen a product (such as a journal entry) being required from the learners – and the quality of this being assessed by a rubric. Without a learning product it is hard to know that learning has taken place and that your outcome(s) have been achieved. Please try to address this in the next lesson. (18 August 2008)*

*This was a nice task you designed – a good exercise to make them aware of the cost of living. Using the newspapers was an excellent idea. (9 September 2008)*

*Consider the effects of a pedagogy where you give instructions to the learners and then read through these with them. This does not encourage independent learning. I suggest you rather give them the instructions and five minutes to read through them on their own and then allow time for questions. (9 September 2008)*

*You please need to still work on getting a colleague/mentor to check the tasks you set to ensure that they are clear. For example, in this task, you wrote: “Sê vir my watter vertrekke jy wil hê” [Tell me which rooms you want...]. But actually you wanted them to draw the rooms. Clear instructions and a well-defined rubric will really help to ensure learners become more independent learners. (9 September 2008)*

My experience and assessments of Sophie’s mathematics lessons led me to the opinion that she viewed her role as the teacher (or facilitator) mainly in terms of organisation, discipline, motivating learners and being a role-model. Her conceptions of mathematics as they evolved out of her learning task designs and approach to her lessons appeared to indicate that she continually viewed mathematics in a very rigid and rule-bound manner. Even when she presented the learners with a “real-life” problem, her reasons for why they were doing the work were:

“You are writing a test about this next Tuesday and you must experience the practical part of that.”

“I can’t help you because in the future and in your tests I also cannot help you and you need to experience this assignment personally so that you will learn from it.”

“Those of you who want to become architects, engineers, builders, contractors, pilots or regional planners will use this one day.”

“If you don’t do it right now, you will not know what the surprise reward was.”

“If you don’t do this now, you will struggle in your test.”

In my opinion, Sophie tried to follow the guidelines of the PGCE course in her learning task designs, but she never really understood or took hold of the constructivist approach. I could also not find evidence in her final portfolio of explicit beliefs she expressed on how to approach the teaching and learning of mathematics specifically. From the data I have on her and from the assessment reports, my opinion is that although she initially did not require any active participation and communication from the learners, she later began to ask low level questions of the learners in response to their questions. However, the intended outcome remained skill mastery with correct performance.

### 5.7.2 Instructional behaviour narrative

The instructional behaviour Sophie demonstrated during her whole first school-based experience was very traditional. She would give the learners calculations to complete and then go through the solutions step by step with an expository explanation. Her explanation would usually proceed something along these lines: “So first you look for a common denominator. Then you take out the minus. The next step is to see if you can factorise further.” One of her video-recorded lessons showed Sophie calling a learner up to the board to complete the answer to one of the “warm-up test” questions on the board. The learner endured a lot of jeering and mocking from his classmates who laughed at him while he did the calculation. Sophie did not make any attempt to intervene other than to tell the learners to be quiet and to check if his answer was correct. She then went through the learner’s calculation step for step and failed to pick up an error. Various learners started shouting at her that there was still an error and she eventually invited a learner to come to the board to show her where it was. It was just a careless error in the final answer where the boy who originally did the calculation omitted a  $b^2$ .

Sophie then asked the class for the answers to the remaining six calculations and wrote them on the board herself owing to a lack of time. On completing the answer to question 4, one of the learners pointed out that the answer to question 3 ( $a^8 - 1$ ) could still be factorised further as it was a difference of two squares. Sophie revisited question 3 and as the answer she wrote on the board was  $(a^4 - 1)(a^4 + 1)$ , it could actually be factorised again more than once to yield a final answer of  $(a - 1)(a + 1)(a^2 + 1)(a^4 + 1)(a^8 + 1)$ . The point of this illustration above is to demonstrate an example of where Sophie seems to not to have engaged with the mathematics herself by evaluating the solutions from the learners. She never referred to any piece of paper or book to check on the answers and appeared to rely on and trust the learners for the correct answers. The answers and mastering of content were definitely her priority during this first school-based experience but the conceptual gaps in her own subject matter knowledge seemed to be a disadvantage in assisting her with this. However, Sophie also elected to complete her first school-based experience at an English school while her first language is Afrikaans. This also seemed to make her less confident and less comfortable in front of the learners.

During her second school-based experience Sophie began to show an ability to design more contextual learning tasks that attempted to engage the learners. However, mathematical reasoning was only required in one of these tasks where learners had to work out a distance between two points (using scale) on a google earth map of their school. Mostly the context seemed to dominate and the mathematics included was almost incidental at the end. For example, in one observed Grade 10 mathematical literacy lesson, the mathematical outcome was that learners learn how financial loans work. To achieve this outcome Sophie prepared a task where learners first individually had to draw a basic geometric design of a house (not to scale) for themselves and then get into groups and construct a big house for the whole group. Learners then had to calculate how much money they needed in order to build this house and what sort of loan they would need to apply for. The chosen context of drawing the houses took most of the time on this learning task, with the financial mathematics being a by-product at the end. The tasks can therefore not be classified as predominantly discovery type problems or ones that required higher levels of mathematical reasoning, exploration or modelling.

Sophie did make use of group work and mostly allowed the learners to select their own groups to work in. Something that stands out in all of her observed and video-recorded lessons is how she interacted with the groups and individuals while they were working on a task. She would usually stand in front of the class watching them work and responding to more social discussions, unless a learner called her over to ask a question. While communicating with one learner, she almost always re-directed her attention from the learner to another member or members of the class on a disciplining issue. Then she would turn back to the learner and usually tell them to just write down what they thought they should do. There were a few occasions where Sophie asked a learner a question in response to a question the learner posed. These were mainly very low level questions such as, “What is the formula for the area of a circle?” or “What is the value of the radius?” Sophie’s listening remained strictly evaluative throughout the year and with the exception of the learners choosing their own groups, her approach to the learning remained very authoritative.

## 5.8 Toni

### 5.8.1 Mathematics profile narrative

Toni's relational mathematics subject matter knowledge was evident throughout the year in his baseline assessment, reflections and the level of mathematics problems he constructed. In designing lessons, Toni managed to engage his learners in a level 5 according to Mason's levels of mathematical processes, which includes describing in general terms how a technique is carried out to account for anomalies, special cases and particular aspects of the technique. An example of this is provided in his reflection in chapter 4 on a lesson for Grade 10 learners on graphs and the functions of certain parameters within the functions. It is also interesting to note Toni's extensive and correct use of mathematics terminology even though English is his second language.

Toni's reflections are self-critical and very much in line with how I experienced him in a teaching role. His continual attempt to methodically analyse each lesson and try to improve is evident from his reflections. A strong desire and attempt to improve his pedagogical content knowledge was also always forthcoming from Toni. But he seemed to continually struggle throughout the year with letting go of his instrumentalist view of mathematics. Initially he also tended to "do and tell" most of the mathematics himself without engaging the learners through higher order questioning or enquiring further about their thinking or errors. These aspects of his pedagogical content knowledge improved throughout the year as the following quotes from assessment reports demonstrate.

*I know you are probably aware that you are still telling too much, rather than getting the learners to think. You need to work more on designing higher-level questions you can ask learners when interacting with them. These can be written down in your planning. (31 July 2008)*

*You handled the questions of the learner next to me well. You engaged well with her (and practised self restraint ☺) in answering her questions mostly with further questions. This aspect has certainly improved. (20 August 2008)*

*You dealt well with the errors in the whole class discussion. You encouraged learners, while still getting them to explain and extend themselves. (20 August 2008)*

Despite his natural tendency to think on his feet and design mathematics problems that encouraged relational understanding, Toni really struggled through the course of the year to make the transition from an absolutist to a more constructivist approach to his teaching. However, towards the end of his second school-based experience he was showing positive signs of competence in this regard. His early attempts to teach in a transcendental paradigm (see Section 3.4.1) found him feeling out of his comfort zone when the lesson did not work out as planned. In these circumstances, he would quickly revert to “taking control” and move to the front of the class where he would start explaining the mathematics.

*The idea you had was good and the problems you encountered were probably due to incomplete prior knowledge and to classroom culture. When you start reading up on something like classroom culture or views and beliefs on mathematics, you will begin to understand the reactions of the learners as well as your own. Understanding what happened is important in dealing with it. Do not be discouraged – rather be pro-active and think of strategies you can apply in order to wean the learners from their dependence on the educator. (9 May 2008)*

*When you decided to revert to a more traditional teacher-centred approach, I thought you could have first asked which learners would liked to have written their solution on the board and explained their thinking to the rest of the class. (9 May 2008)*

Although Toni seemed to have both strong subject matter knowledge and pedagogical content knowledge, it was only in his last few lessons where he really had a breakthrough in managing to teach in a more problem-solving, process-orientated approach. In doing so, he also began to demonstrate his view of mathematics as a static but unified body of certain knowledge. This is in line with Ernest’s (1988) Platonist view of mathematics. I have deduced this from his last few reflections where although he learnt to approach the lessons in a more problem-centred, process-orientated approach, the way he still talked about, used and interacted with the actual mathematics appeared to indicate that he still does not view the domain as a dynamic, continually evolving field of human creation, which is more in line with what Ernest (1988)

describes as the problem-solving view of mathematics. I suspect that this could have a lot to do with his background in studying mathematics through an actuarial science degree.

### **5.8.2 Instructional behaviour narrative**

The aspect of Toni's instructional behaviour that caught my attention most in analysing his lessons was how he interacted with the individual learners and groups as they worked on their tasks. From the start of the course Toni demonstrated a passion for the subject of mathematics and this came through in his teaching. He clearly wanted all his learners to share this passion and made a concerted effort to engage with learners about their mathematical thinking and reasoning. He quickly learnt to respond to learners' questions with a further question in order to clarify their thinking. But he also always affirmed the learner for correct thinking or calculations when required. He never rushed from one learner to the next but gave each learner his full attention as he worked individually with them. He was the student that made the quickest transition from evaluative to more interpretive listening.

Toni was also the only other student (along with Marge) who managed to progress to the point of facilitating a few (albeit brief) discussions with the learners that elicited higher level mathematical reasoning. The questions he posed to the learners did not only focus on an answer but required the learners to enter into mathematical reasoning. Even the hints he would give the learners in the scaffolding process were not just a set of small steps that would guide the learners straight to the answer, but rather a suggested comparison in similar reasoning or thinking that would assist them in solving the problem. For example if a learner was asking a question about the effect of a particular parameter within a function he would encourage the learner to compare a few graphs of different functions in order to identify the effect. Most of the other students would simply ask the learner what they remember the role of that parameter to be in the standard form.

During his first school-based experience Toni was very traditional in his approach and displayed a lot of expository teaching. He seemed to be much more comfortable in this role. However, as the year progressed and the demands of the course required him to implement a transcendental lesson, he began to try a more problem-oriented approach. In doing so, Toni's

learning task designs were always of a high standard mathematically and encouraged exploration, the identification of patterns and modelling. The consolidation he did with the whole class on completion of a task was more representative of a reform and investigative approach to mathematical discussions than any of the other participants demonstrated (with the exception of Marge). Toni's instructional behaviour therefore in my opinion made a substantial shift on both the traditional/reform and authoritative/democratic continuums.

## **5.9 Conclusion**

This chapter has presented my reflections on each of the participants in two parts; a reflection about their mathematics profiles and another foregrounding the trends in their instructional behaviour throughout the course of their PGCE year. The main function of these researcher reflections is to give the reader my view of each participant compared to the previous chapter where their own views about their experiences on the teaching and learning of mathematics were shared in their voices. The participant and researcher reflections provide the verbal view of the visual presentations depicted and compared in the following chapter. In chapter 6 each case is discussed individually before the cross-case comparison is presented.