

## CHAPTER SIX

## ANALYSES OF DATA SETS

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### ***6.1 Introduction***

This chapter draws on the reflections from chapters 4 and 5 in order to construct a visual representation of each participant's mathematics and instructional behaviour profiles. The visual representations were borne out of my need to be able to visualise what the textual reflections "looked like" in order to better facilitate within and cross-case comparisons. The mathematics profile is represented by a facial profile of each individual with parts of the face (such as the eye, the ear, the mouth and the head) each depicting one of the four components of the mathematics profile (subject matter knowledge, pedagogical content knowledge, conceptions of mathematics and beliefs regarding the teaching and learning of mathematics) respectively as identified and discussed in chapter 2. The instructional behaviour profile is presented on a landscape grid. The idea of the landscape grid has been adapted from the mathematical Cartesian plane, but without any intention of displaying values in order to demonstrate measurement. In this landscape the traditional to reform teaching continuum is represented on the horizontal axis and the autocratic to democratic learning continuum is presented on the vertical axis. These visual representations are then used as the basis for the cross-case comparison and discussion also included in this chapter.

### ***6.2 Visual representations of profiles***

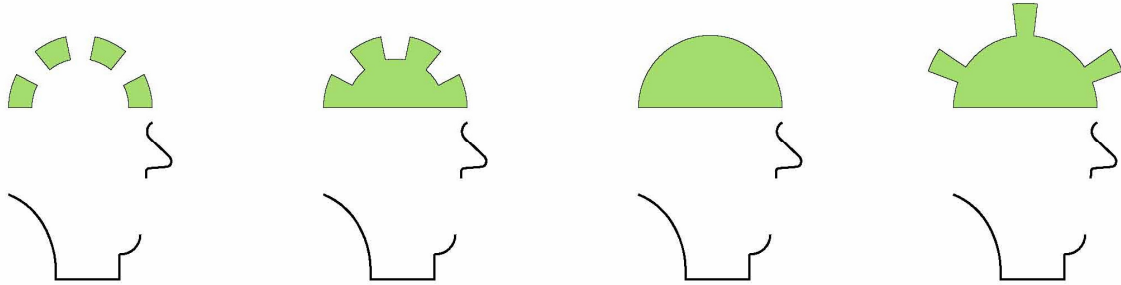
As the narratives have been presented over two chapters, I wanted to find a way to simplify and optimize the cross-case comparison without continually drawing on quotes from the narratives. My quantitative mathematics background also found me wanting some sort of symbolic representation without getting into actual quantitative measurement, such as graphs or tables. These visual representations are the resulting output. Owing to the confidentiality of the participants that I wished to honour in this study, I could not include photographs of each participant. However, each participant is a person and when I introduced them in chapter 3, I wanted to also present a picture of them. A friend suggested I include caricatures of each participant and this developed into the idea of the visual mathematics profiles that are included

in this chapter. As explained in chapter 2, the word profile indicates a side view of a face. I therefore decided to make the mathematics profile a side view of each participant's 'mathematics' face according to the four components of subject matter knowledge, pedagogical content knowledge, conceptions of mathematics and beliefs regarding the teaching and learning of mathematics.

I have divided each of the components into four categories. I chose an even number of categories to avoid continually picking the "middle" option while still allowing for suitable differentiation between the participants. Each category is depicted by a particular icon on the continuum and the four components were then put together to form the initial and later the final mathematics profile of each participant. Each part of the face and the icons used to represent the categories was chosen with a metaphorical meaning in mind. The categories presented in this report are not intended to be absolute and I am using them for a pre-service context and what our PGCE course requires from the students leaving our programme with the expectation that they will still continually improve as they enter and gain experience in the teaching profession. For example, the fourth pedagogical content knowledge category shows the ear as "full" (see Figure 6.2) indicating more complete pedagogical content knowledge than the first category. However, this does not suggest that the participant's pedagogical content knowledge is totally complete but that it is at a high level in the pre-service context in order for the participant to enter the profession.

The *head* of the face represents the *subject matter knowledge*. Firstly this is due to my assumption that this is the "head" component. Without any knowledge of mathematics one cannot teach the subject. Secondly I view subject matter knowledge as something that one cannot easily see completely. We can see parts of it as the student begins to teach or do mathematical calculations but I do not think research is at a point yet where we can see or evaluate this component completely. In the visual representation, the category on the extreme left in Figure 6.1 below indicates obvious and fundamental conceptual gaps in the participant's subject matter knowledge. In the second category, less fundamental conceptual gaps were evident with some relational coherence of the content. The third category indicates that the subject matter knowledge appeared sufficient with no gaps evident in terms of errors or lack of mathematical understanding observed during the course of the year. The final category on the

right depicts subject matter knowledge that is not only relational but also able to extend into other learning areas where necessary.



*Instrumental*

*Relational*

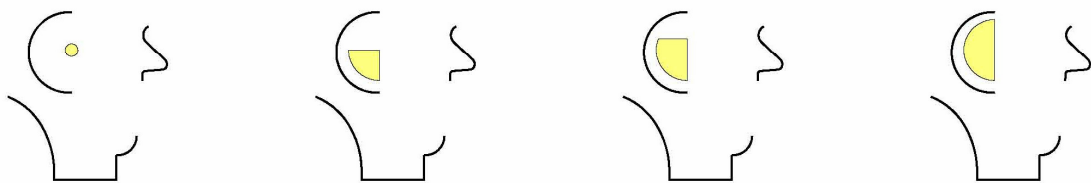
**Figure 6.1** *The four categories of the subject matter knowledge continuum*

The category of subject matter knowledge for each participant was decided on by drawing on data from the baseline assessment the participant completed at the beginning of the year and conceptual gaps stated in the participant’s reflections or observed in their lessons or learning task designs. These are summarised in Table 6-1 below. It was not possible to represent any change in the participants’ subject matter knowledge as this is not in any way a focus of our PGCE course. As the course does not directly address this subject matter knowledge aspect, and due to the nature of how I chose to represent this component (focusing on the conceptual gaps as an indicator of their mathematical understanding), I viewed this component as more of a constant, rather than changing component of the profile.

**Table 6-1** *Summary of data analysis for the subject matter category in mathematics profile*

<i>Section 2.3.1</i>	<i>Subject matter knowledge</i>
<i>Baseline assessment</i>	Careless or no errors, a few errors or solutions omitted, many errors, fundamental errors
<i>Errors in LTD’s</i>	Errors made in calculations in learning task designs
<i>Errors in observed lessons</i>	Errors participant made in lessons observed or recorded

The *ear* depicts the pedagogical content knowledge. Reasons for this include that much of the pedagogical content knowledge of a student teacher is taken in by what they hear in class at university and what they heard at school. A large part of this in their own teaching practice is their ability to hear the learners, their errors, their thinking and where they are at in their thinking. The category on the far left indicates an incomplete pedagogical content knowledge for a pre-service teacher. The categories towards the right of the continuum show varying levels increased pedagogical content knowledge.



*Less complete*

*More complete*

**Figure 6.2** *The four categories of the pedagogical content knowledge continuum*

Determining the *pedagogical content knowledge* category of each individual was slightly more complicated. The data I used came from the students' learning task designs, their reflections, assessment reports from the lecturer and observed or video-recorded lessons. As the students taught a range of different grades and mathematical topics during the year, it is only my intention to categorise their general pedagogical content knowledge and not refer at all to their domain or topic specific pedagogical content knowledge (Veal & MaKinster, 2001). The continuum used to determine the categories for this component is taken from Section 2.3.2.

**Table 6-2** *Summary of data analysis for pedagogical content knowledge category in mathematics profile*

**Section 2.3.2**

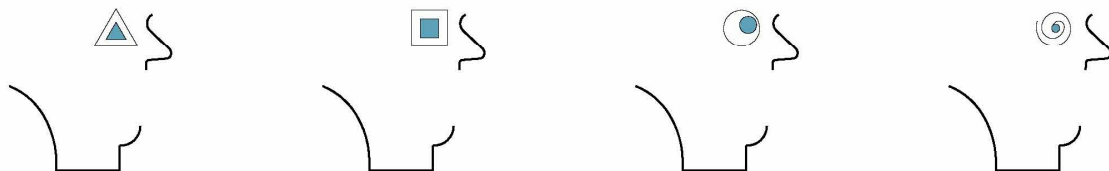
***Pedagogical content knowledge***

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<i>Mason's levels</i>	See Table 2-1
<i>Pedagogy</i>	Participant's handling of learner errors/misconceptions  Quality of planning
<i>Assessment</i>	Dominantly traditional or more alternative and authentic assessment and various forms thereof
<i>Context</i>	Participants' understanding of context of learners as viewed in LTD's and observed lessons
<i>Curriculum</i>	Knowledge of the curriculum according to LTD's and observed lessons
<i>Classroom management</i>	Issues such as discipline, handling classroom discussion, use of media, classroom culture

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The *eye* illustrates each participant's view or conceptions of mathematics (for obvious reasons). The varying shape of the eye in the four categories indicates a movement from seeing mathematics in its absolutist form as a limited, rigid, structured and rule-bound subject on the far left category to a more dynamic, interrelated and continually evolving subject that is more in line with the constructivist/problem-solving view as expressed by Ernest (1991), in the category on the far right.



*Absolutist*

*Constructivist*

**Figure 6.3** *The four categories of the conceptions of mathematics continuum*

In order to decide on the category of the final two components (conceptions and beliefs), data from the reflections and observed and video-taped lessons of each participant were used. In differentiating between the categories for conceptions, I have drawn on Ernest's (1991) categories and added an additional category of absolutist (seeing the subject as even more limited and rigid than the instrumentalist view) to the conceptions of instrumentalist, Platonist and problem-solving views. These were determined from a summary of information as presented in Table 6-3 below taken from Section 2.3.3.

*Table 6-3 Summary of data analysis for the conceptions of mathematics category in mathematics profile*

<i>Section 2.3.3</i>	<i>Conceptions of mathematics</i>
<i>Orientation</i>	Content orientation or process orientation
<i>Thompson (1984)</i>	
<i>Orientation</i>	Computational, calculational or conceptually orientated
<i>Thompson et al. (1994)</i>	
<i>Ernest (1991) categories</i>	Absolutist, instrumentalist, Platonist or problem-solving

Finally, the *mouth* represents the beliefs about the teaching and learning of mathematics that each participant verbalised or expressed.



*Transmitter*

*Facilitator*

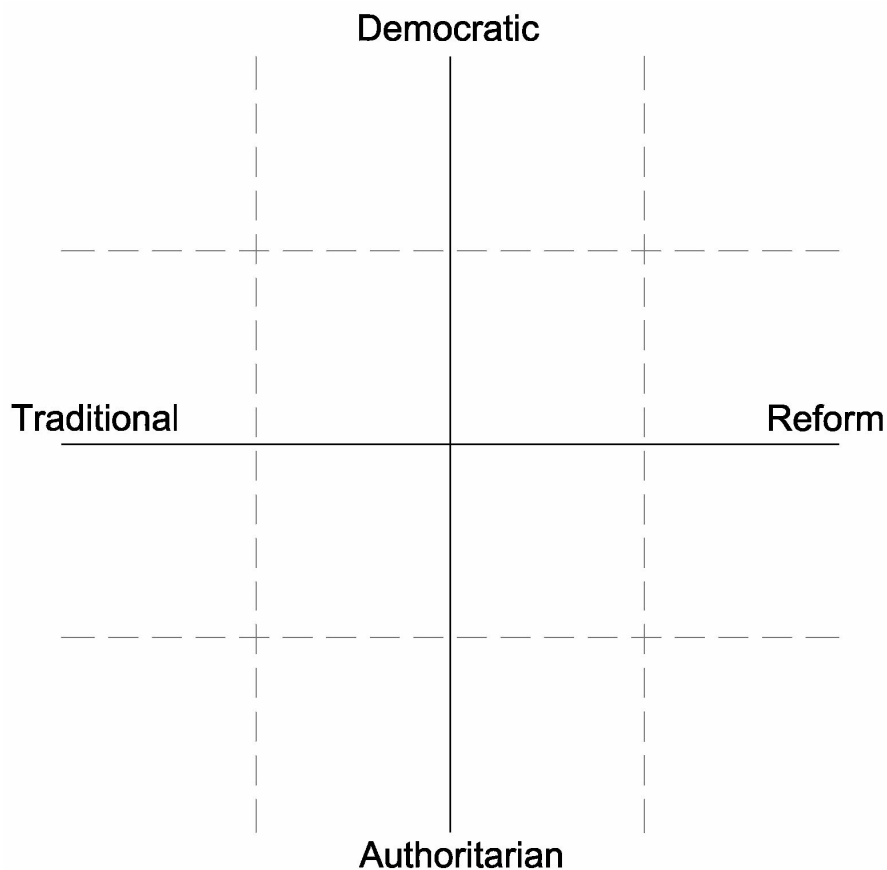
*Figure 6.4 The four categories of the beliefs about teaching and learning mathematics continuum*

In differentiating between these belief categories, the role of the teacher can be either a transmitter on the far left, instructor, explainer or a facilitator on the far right of the continuum. A transmitter is a device that transmits specific information or signals to “passive receptors” or receivers that receive the signal but do not transmit back. When a transmitter sends out a signal to a transceiver though, the transceiver sends back information. In my view the teacher in the role of the transmitter believes the teacher is an expositor and although they are aware of the learners in the classroom, they talk to them as passive receptors without expecting input. The instructor and the explainer, however, both view the learner as a transceiver that they expect to be more active and communicate with them. The difference though is that the instructor demands a much lower level of input and response from the learner than the explainer, who tends to require responses that demonstrate understanding. Finally, the facilitator has the fuller, closed lips indicating that, similar to the explainer, they also expect learners to communicate their understanding and in my view, they see learners not only as transceivers but as decoders. Facilitators therefore tend to continually demand more high-level mathematical reasoning and facilitate discussions that elicit this. In such cases, the learners are supported to do more of the thinking and construction of knowledge with the facilitator guiding the process (hence the closed mouth in the visual representation). Table 6-4 below summarises the information used in determining each participant’s category.

*Table 6-4 Summary of data analysis for the beliefs category in mathematics profile*

<i>Section 2.3.4</i>	<i>Beliefs regarding the teaching and learning of mathematics</i>
<i>Role of teacher (Ernest, 1988)</i>	Transmitter, instructor, explainer, facilitator
<i>Role of learner (Ernest, 1988)</i>	How the participant arranged learning experiences for the learners on a passive reception to active construction continuum

The instructional belief profiles were decided on using the reflections pertaining to instructional behaviour from chapters 4 and 5 and the video-recorded lessons participants included in their portfolios. Similarly to the approach applied above, each of the traditional/reform and authoritarian/democratic learning continuums (each forming an axis of the landscape grid in Figure 6.5) was divided into four equal divisions. However, these are not differentiated into categories, but rather form four smaller sub-quadrants in each of the four main quadrants of the grid. I have purposefully avoided using numbers on the landscape grid so that this remains a representation of their changing instructional behaviour, as I see it, without attaching a value or measurement to it. An initial and final quadrant for each participant was derived according to their position on each of the traditional/reform teaching and autocratic/democratic learning continuums, drawing on the criteria illustrated in Table 6.5 below.



*Figure 6.5 An example of the Cartesian plane depicting the instructional behaviour profile*



**Table 6-5 Summary of instructional behaviour landscape grid criteria**

**Democratic**

<i>Values content</i> <i>Expository methods</i> <i>Algorithms focus</i> Informal methods encouraged and used Individual, collaborative and cooperative group work Heuristic listening	<i>Hands on discovery</i> <i>Finding patterns</i> <i>Methods important</i> Informal methods encouraged and used Individual, collaborative and cooperative group work Heuristic listening	<i>Making connections</i> <i>Exploration</i> <i>Problem solving</i> <i>Modelling</i> Informal methods encouraged and used Individual, collaborative and cooperative group work Heuristic listening	<i>Mathematical communication</i> <i>High level reasoning</i> Informal methods encouraged and used Individual, collaborative and cooperative group work Heuristic listening
<i>Values content</i> <i>Expository methods</i> <i>Algorithms focus</i> Cooperative group work Informal methods explicitly encouraged Dominantly interpretive	<i>Hands on discovery</i> <i>Finding patterns</i> <i>Methods important</i> Cooperative group work Informal methods explicitly encouraged Dominantly interpretive	<i>Making connections</i> <i>Exploration</i> <i>Problem solving</i> <i>Modelling</i> Cooperative group work Informal methods explicitly encouraged Dominantly interpretive	<i>Mathematical communication</i> <i>High level reasoning</i> Cooperative group work Informal methods explicitly encouraged Dominantly interpretive
<b>Traditional</b> <i>Values content</i> <i>Expository methods</i> <i>Algorithms focus</i> Less focus on steps Some group work Some informal learner methods but mostly still formal Some interpretive listening	<i>Hands on discovery</i> <i>Finding patterns</i> <i>Methods important</i> Less focus on steps Some collaborative group work Some informal learner methods Some interpretive listening	<i>Making connections</i> <i>Exploration</i> <i>Problem solving</i> <i>Modelling</i> Less focus on steps Some collaborative group work Some informal learner methods Some interpretive	<b>Reform</b> <i>Mathematical communication</i> <i>High level reasoning</i> Less focus on steps Some collaborative group work Some informal learner methods Some interpretive listening
<i>Values content</i> <i>Expository methods</i> <i>Algorithms focus</i> <i>Mostly individual</i> Official steps taught Formal algorithms Individual work Use of examples Evaluative listening	<i>Hands on discovery</i> <i>Use of groupwork</i> <i>Finding patterns</i> <i>Methods important</i> Official steps taught Formal algorithms Individual work Use of examples Evaluative listening	<i>Making connections</i> <i>Exploration</i> <i>Problem solving</i> <i>Modelling</i> Official steps taught Formal algorithms Individual work Use of examples Evaluative listening	<i>Mathematical communication</i> <i>High level reasoning</i> Official steps taught Formal algorithms Individual work Use of examples Evaluative listening

**Authoritarian**

The placing of each participant’s initial and final instructional behaviour profile (to indicate the change that took place over the year) was determined by deductively analysing their teaching practice according to the following guidelines from the literature (see section 2.3.5).

*Table 6-6 Summary of data analysis to determine the position of traditional/reform continuum of instructional behaviour profile*

<i>Section 2.3.5</i>	<i>Traditional versus reform practices</i>
<i>Values</i>	<p>Traditional – values content, correctness of learners’ responses and mathematical validity of methods</p> <p>Reform – values finding patterns, making connections, communicating mathematically and problem-solving</p>
<i>Teaching methods</i>	<p>Traditional – expository, transmission, lots of drill and practice, step by step mastery of algorithms</p> <p>Reform – hands-on guided discovery methods, exploration, modelling. High level reasoning processes are central</p>
<i>Grouping learners</i>	<p>Traditional dominantly homogenous</p> <p>Reform dominantly heterogeneous</p>

*Table 6-7 Summary of data analysis to determine the position of authoritarian/democratic continuum of instructional behaviour profile*

<i>Section 2.3.5</i>	<i>Authority versus democracy</i>
<i>Algorithms/techniques</i>	Official methods taught versus learners’ methods

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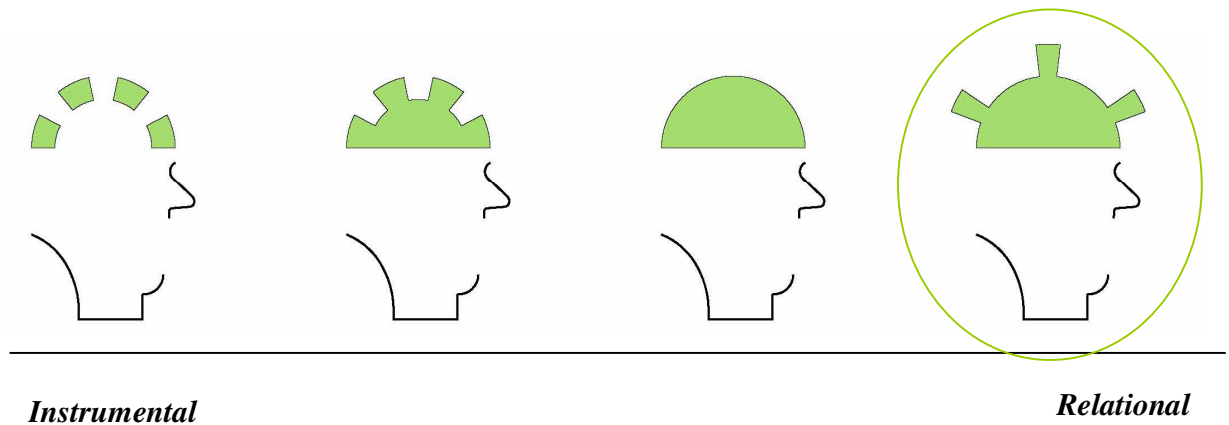
	encouraged. Intentionally differentiating between horizontal (informal learner methods) and vertical (more formal algorithms) mathematisation
<i>Learner relations</i>	Encourages individual competition or collaborative group work
<i>Teaching style</i>	Expository class teaching or also use of projects, group and individualised work
<i>Listening</i>	Evaluative, interpretive or heuristic

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The rest of this section shows a summary of the profiles of each participant based on a data analysis using the criteria shown in Tables 6-1 - 6-7. A verbal summary is provided, rather than the tables, but the actual tables can be found in Appendix F. A visual representation of each participant's mathematics and instructional behaviour profiles is then depicted: the initial one determined at the beginning of the year and the final one as displayed towards the end of the year. It is anticipated that these visual representations will highlight the changes that took place in participants during the course of the year and also facilitate the cross-case discussion in the section that follows.

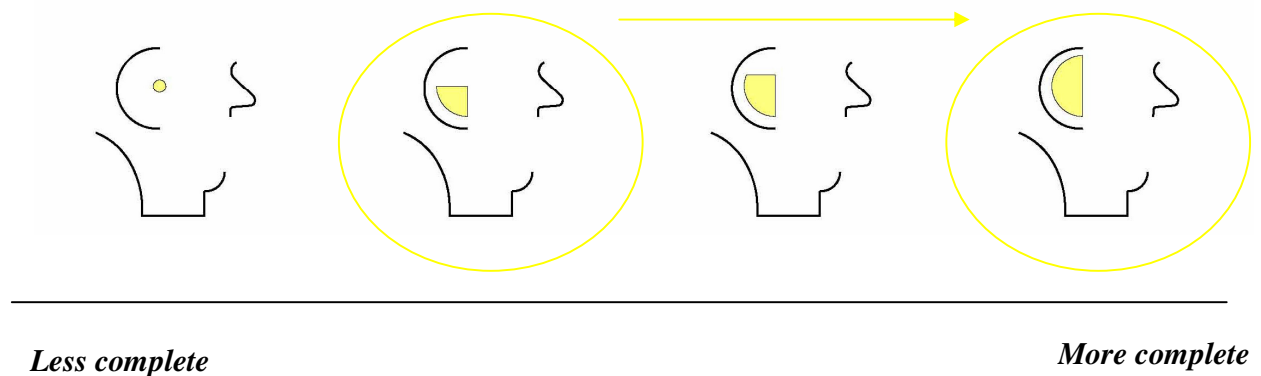
### **6.2.1 Marge**

Marge displayed strong subject matter knowledge throughout the year. She was able to draw on this to effectively design learning tasks of a high mathematical standard and ask questions that elicited a high level of thinking from the learners.



**Figure 6.6** Visual representation of Marge's subject matter knowledge

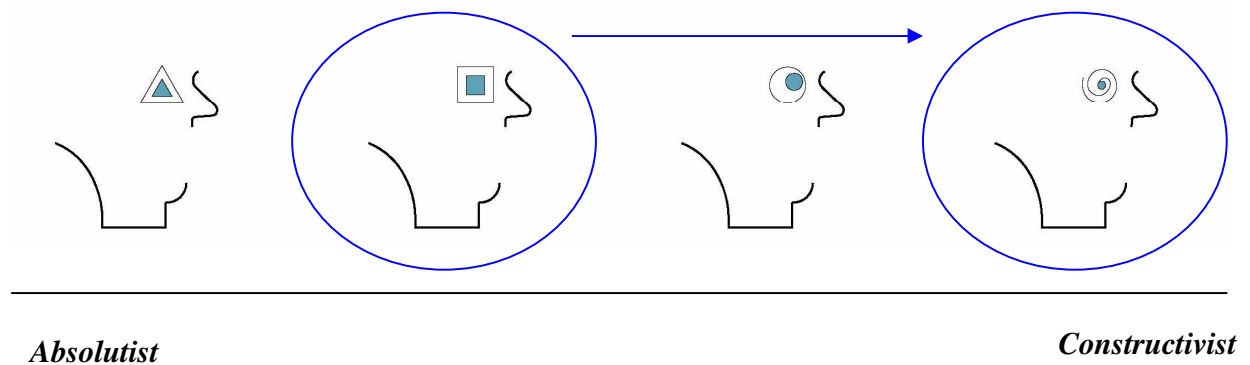
Marge was the only student to progress to the 'more complete' category in terms of her pedagogical content knowledge. The main characteristic that finally put her into the more complete category was her ability and intent to explore learners' thinking, whether or not the answer was correct. Towards the end of the year, Marge appeared to understand how useful learners' errors and alternative conceptions could be, not only to her but as discussion points for the class in the construction of their mathematical thinking and reasoning.



**Figure 6.7** Visual representation of Marge's pedagogical content knowledge

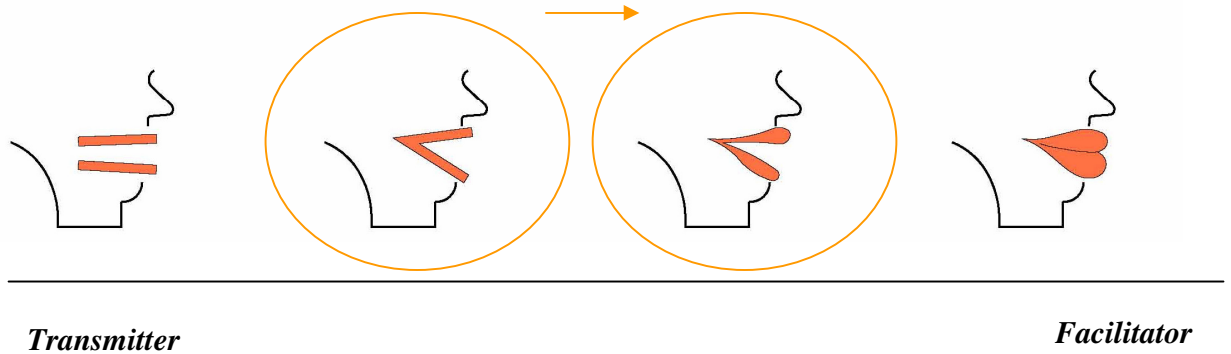
Marge was also the only student whose conception of mathematics changed to a problem-solving view. By her own admission, she began the year with an instrumentalist view where she valued and foregrounded the structure, rules and algorithms. Marge took the challenges of the course very seriously and her perfectionist approach encouraged her to make every effort

to master a more constructivist approach to her teaching. Marge, however, was not satisfied with just mastering the approach superficially. She wanted to understand it and incorporate that understanding into her own practice-theory. She therefore began accessing and reading large volumes of literature relating to mathematics and the teaching thereof. Through this process and her school-based experiences, her reflections and learning task designs began to demonstrate her increased understanding and appreciation of the domain of mathematics and mathematics education. It was the combination of Marge’s continued diligence in making positive changes in her view of mathematics as well as her extensive reading that enabled her to adopt the problem-solving view of mathematics.



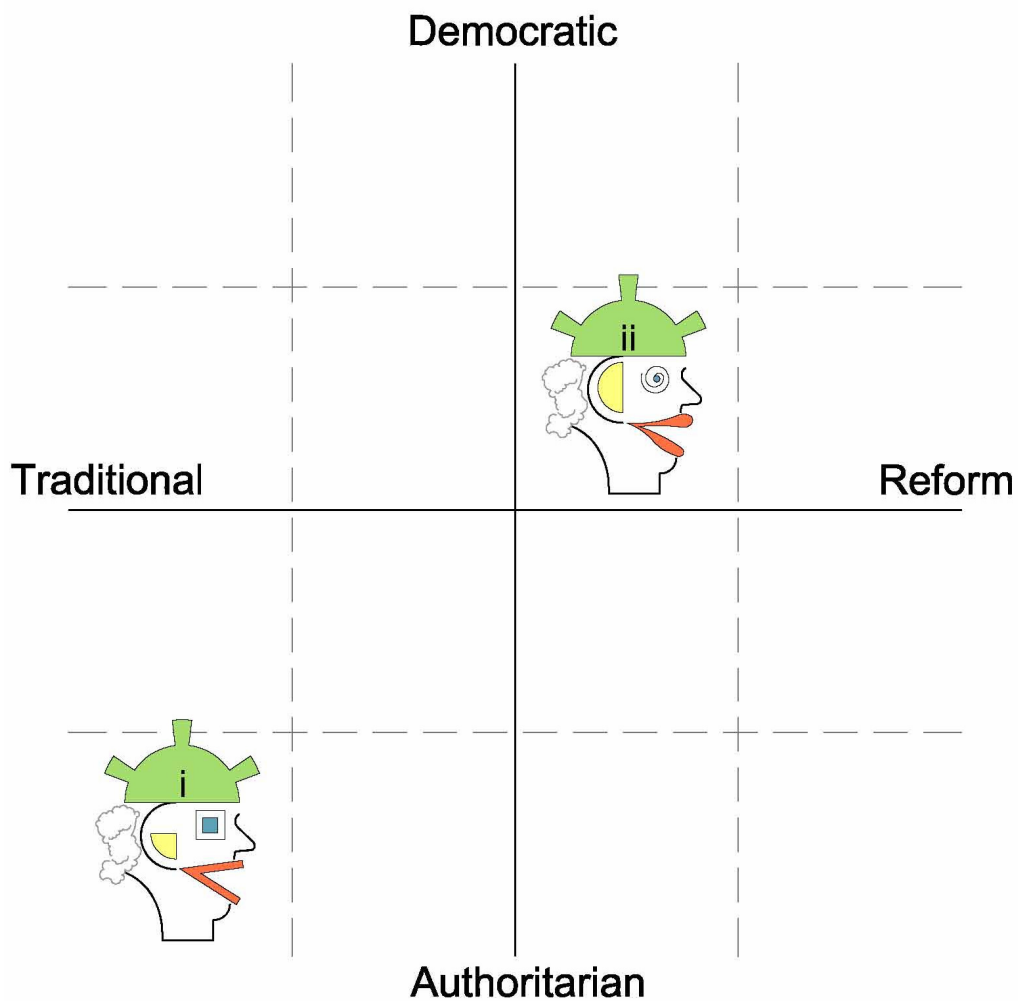
**Figure 6.8** Visual representation of Marge’s conceptions of mathematics

Marge treated the learners as ‘transceivers’ right from her first school-based education but initially her questions were limited to more low-level reasoning and fact recall. During the course of the year, she began to incorporate into her lesson plans the type of questions she planned to ask learners. This seemed to improve the level of questioning and required answers from the learners that demonstrated their mathematical understanding. Marge’s final profile shows her as an explainer (rather than facilitator) as she did not demonstrate the ability to facilitate mathematical discussions on a continuous basis that required the learners to do most of the talking and use high-level reasoning and thinking.



*Figure 6.9 Visual representation of Marge's beliefs about the teaching and learning of mathematics*

However, Marge's instructional behaviour changed significantly during the course of the year. As she began to take on the challenge of a more constructivist and problem-solving approach to the teaching and learning of mathematics, the design of her learning tasks began to change. She enjoyed setting problems that engaged the learners and began making more use of hands-on discovery, identification of patterns and modelling. As already indicated, high-level reasoning became more valued in her practice but not to the extent where it was being required often enough or with enough heuristic listening on Marge's part. It was clear that she was still always in control of the lesson and the class, rather than this being a negotiation and sharing of thinking between learner and facilitator. This is the reason her instructional behaviour profile made changes on both continuums but not to the optimal reform and democracy quadrants.

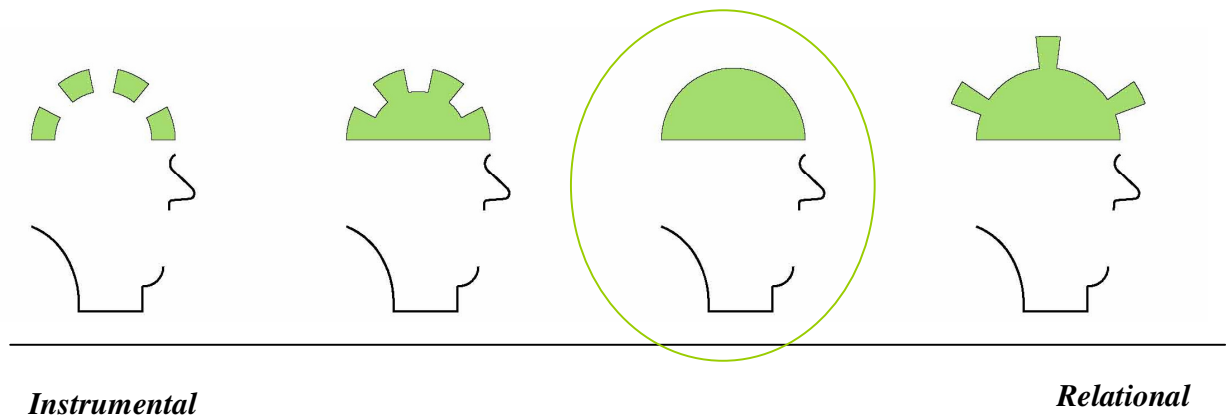


*Figure 6.10 Mathematics and instructional behaviour profile changes of Marge from initial (i) to final (ii)*

In her final mathematics profile, Marge demonstrates a well-rounded view of mathematics and the teaching thereof. On the solid foundation of her strong relational subject matter knowledge, her pedagogical content knowledge also improved. Marge's conceptions of mathematics changed from instrumentalist to problem-solving and from instructor to explainer. The changes in her instructional behaviour were also evident in the shift she made towards a more reform dominated practice tending towards more democracy in her classroom culture.

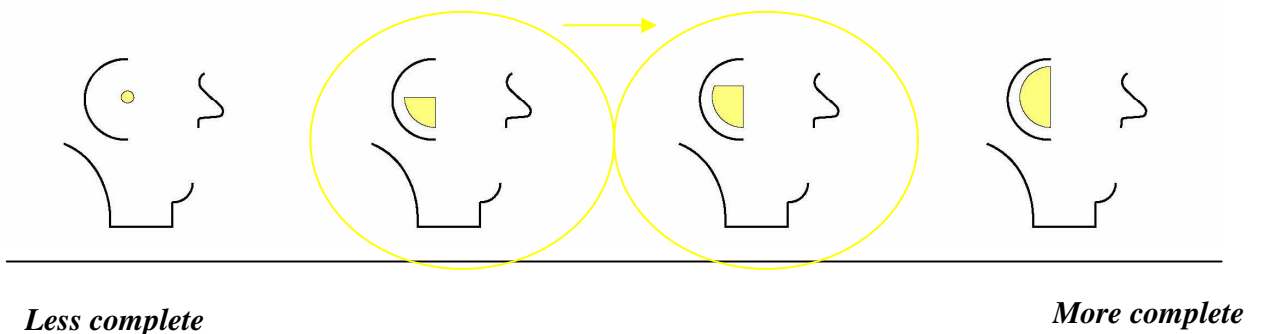
### 6.2.2 Lena

Lena showed no fundamental gaps in her subject matter knowledge throughout the year. She was able to draw on this effectively to design learning tasks of a high mathematical standard and teach Grade 12 learners with confidence right from the beginning of the year. However, her learning task designs and the lessons analysed did not show the depth of relational understanding that both Marge and Toni demonstrated.



*Figure 6.11 Visual representation of Lena's subject matter knowledge*

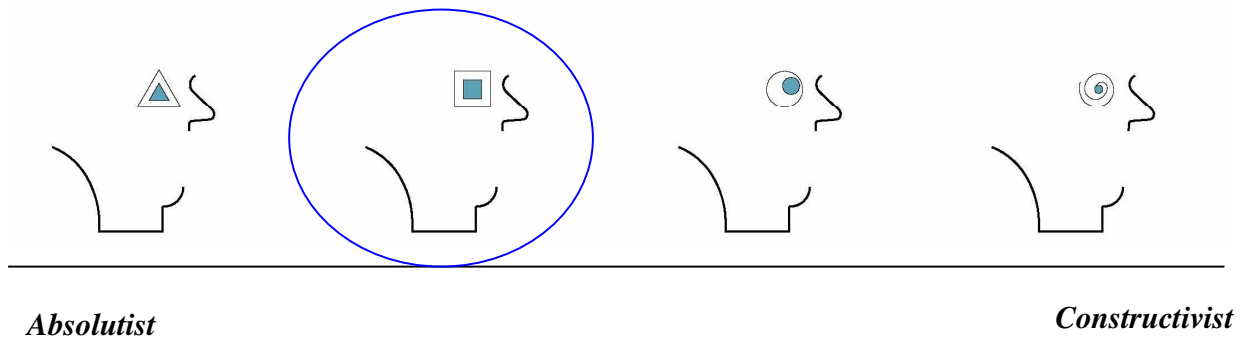
Lena designed creative and well-thought-out learning task designs. She demonstrated some understanding of the learners' context in terms of designing problems in authentic contexts. Her knowledge of the curriculum was excellent and her classroom management was good throughout the year. However, Lena did not reach the point of investigating or valuing learners' errors and the learners' thinking behind these.



*Figure 6.12 Visual representation of Lena's pedagogical content knowledge*

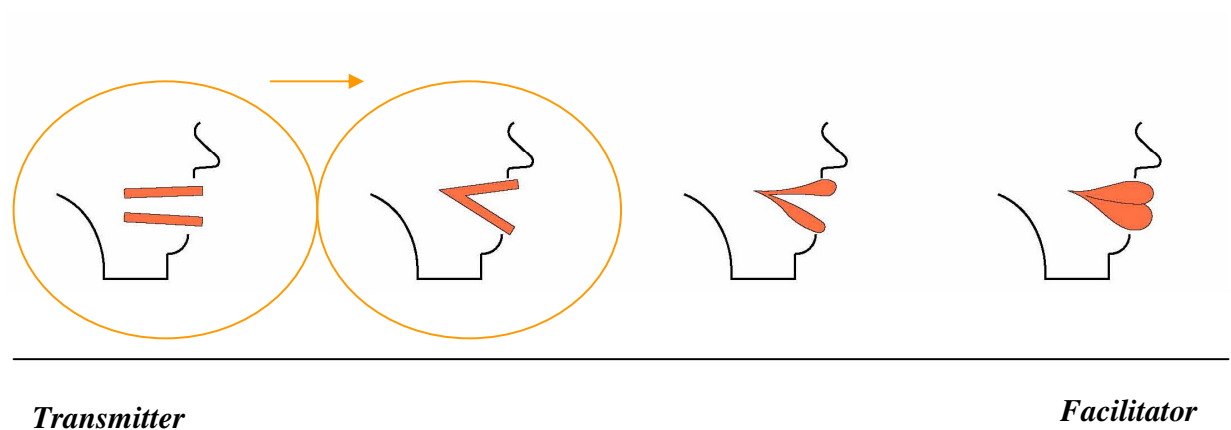


Lena's view of mathematics seemed to remain constant throughout the year. Although her teaching became more process-orientated, knowing and correctly applying the rules and algorithms appeared to remain her focus.



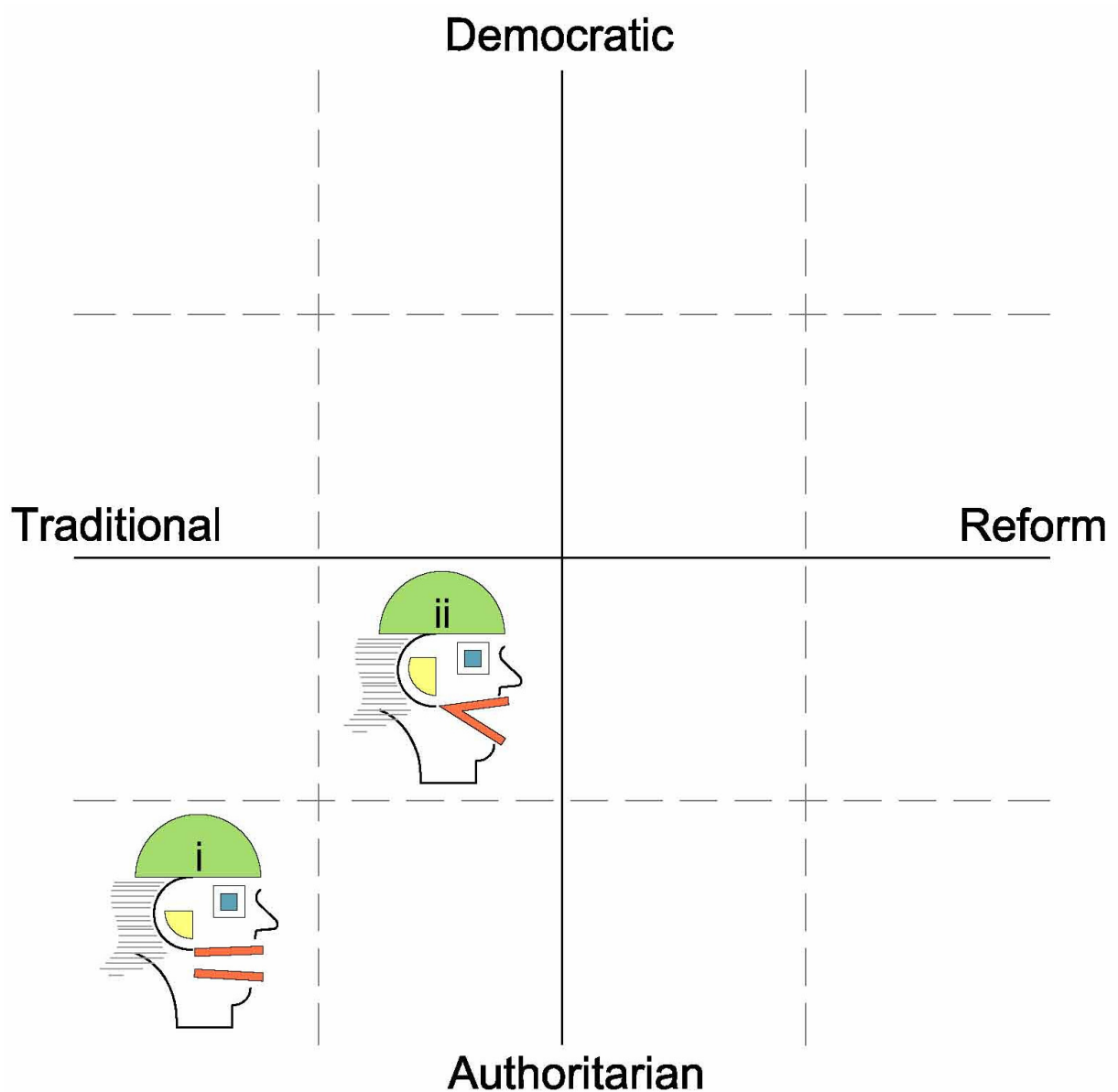
*Figure 6.13 Visual representation of Lena's conceptions of mathematics*

Initially Lena seemed to teach without requiring any response or communication from the learners. She made repeated use of teacher pauses (see Section 5.3.2) where she appeared to require a response from the learners, but would very rapidly provide the answer herself and continue with her explanation. Later Lena started to give slightly longer pauses and more opportunities for learners to respond, although her questions seldom elicited high-level mathematical reasoning from the learners.



*Figure 6.14 Visual representation of Lena's beliefs about the teaching and learning of mathematics*

Lena's instructional behaviour made a slight shift on each of the continuums during the course of the year. Although mastering of content remained her focus, her learning task designs and one of her lessons indicated her intent to move towards improving the conceptual understanding of learners. She designed problems that required more hands-on involvement from the learners and aimed at getting them to identify patterns. However, the learners were seldom asked to communicate their thinking or reasoning as feedback and discussion during the class. Lena developed good relations with the learners, used a variety of individual and group work and her lessons became more learner-centred and task-based.

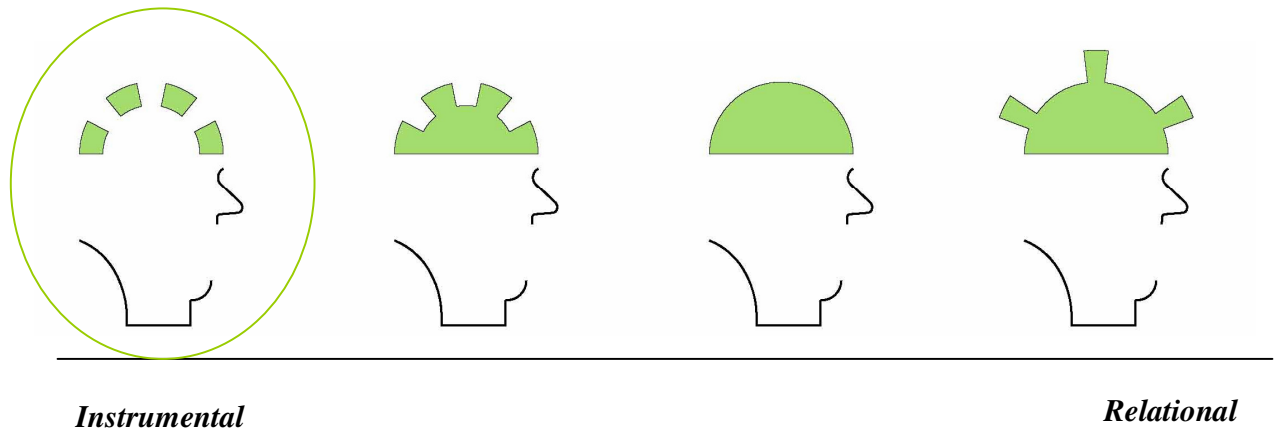


*Figure 6.15 Mathematics and instructional behaviour profile changes of Lena from initial (i) to final (ii)*

The changes that took place in Lena’s mathematics profile are limited to her pedagogical content knowledge and her beliefs in the teaching and learning of mathematics. Both of these moved up one category. Her instructional behaviour profile also moved one sub-quadrant on each of the continuums.

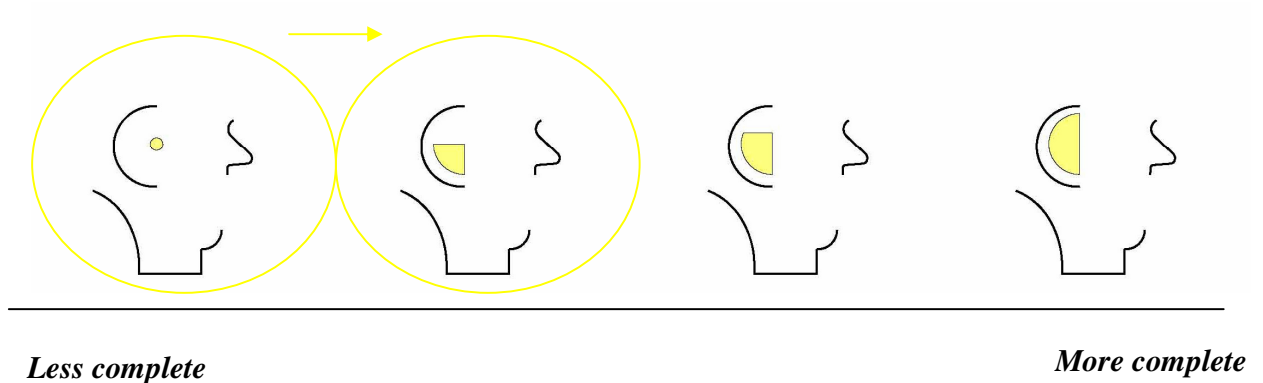
### 6.2.3 Peta

As already indicated in chapter 5, Peta demonstrated a number of conceptual gaps in her subject matter knowledge throughout the course of the year. She made some fundamental errors in the baseline assessment and various errors were observed during her lessons.



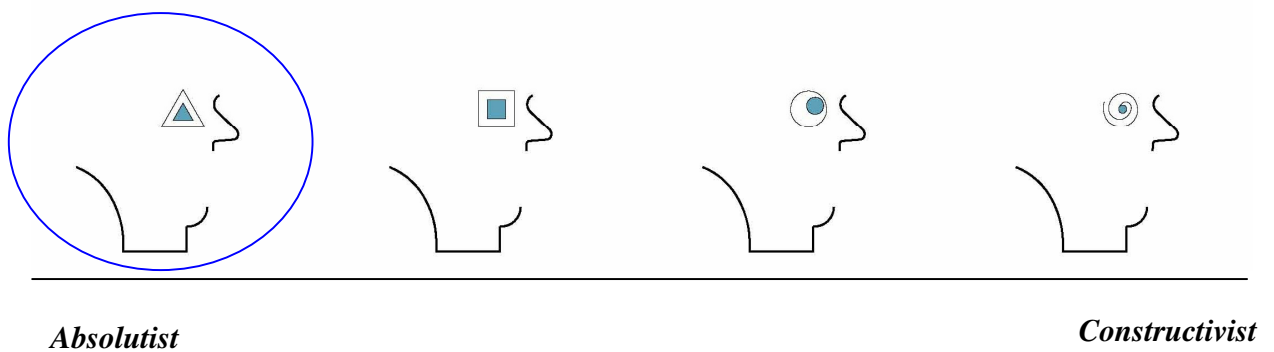
*Figure 6.16 Visual representation of Peta’s subject matter knowledge*

Peta relied heavily on support from the lecturers in designing her learning tasks, but the quality of these learning tasks did improve significantly over the course of the year. She appeared to work more effectively with learners in lower grades and began posing questions in response to learners’ questions as the year progressed and she gained more confidence. Peta did not investigate incorrect answers or thinking of learners although she did move towards designing lessons that were more learner-centred towards the end of the year. Her pedagogical content knowledge is therefore depicted as changing from the first to the second (more complete) category.



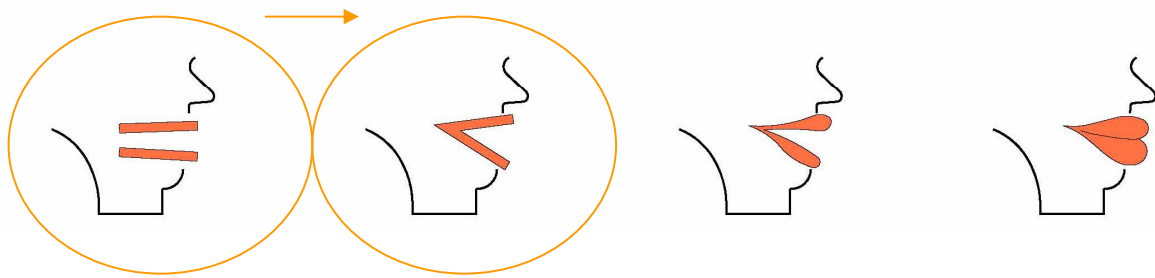
**Figure 6.17** Visual representation of Peta's pedagogical content knowledge

From the beginning of the year Peta dealt with mathematics as a very rigid, structured and absolute (in terms of right or wrong) approach. Her focus remained content-orientated with an emphasis on using the correct methods and formulae and finding the correct answer. It was therefore not easy to find any evidence of a shift in this view of mathematics.



**Figure 6.18** Visual representation of Peta's conceptions of mathematics

Peta initially seemed to teach without requiring any response or communication from the learners. This could perhaps have been due to the lack of confidence that she mentions in her own reflections. During the second school-based experience Peta began to provide more opportunities for learners to respond, although her questions mostly focused on computational solutions or recall rather than on mathematical thinking or processes.

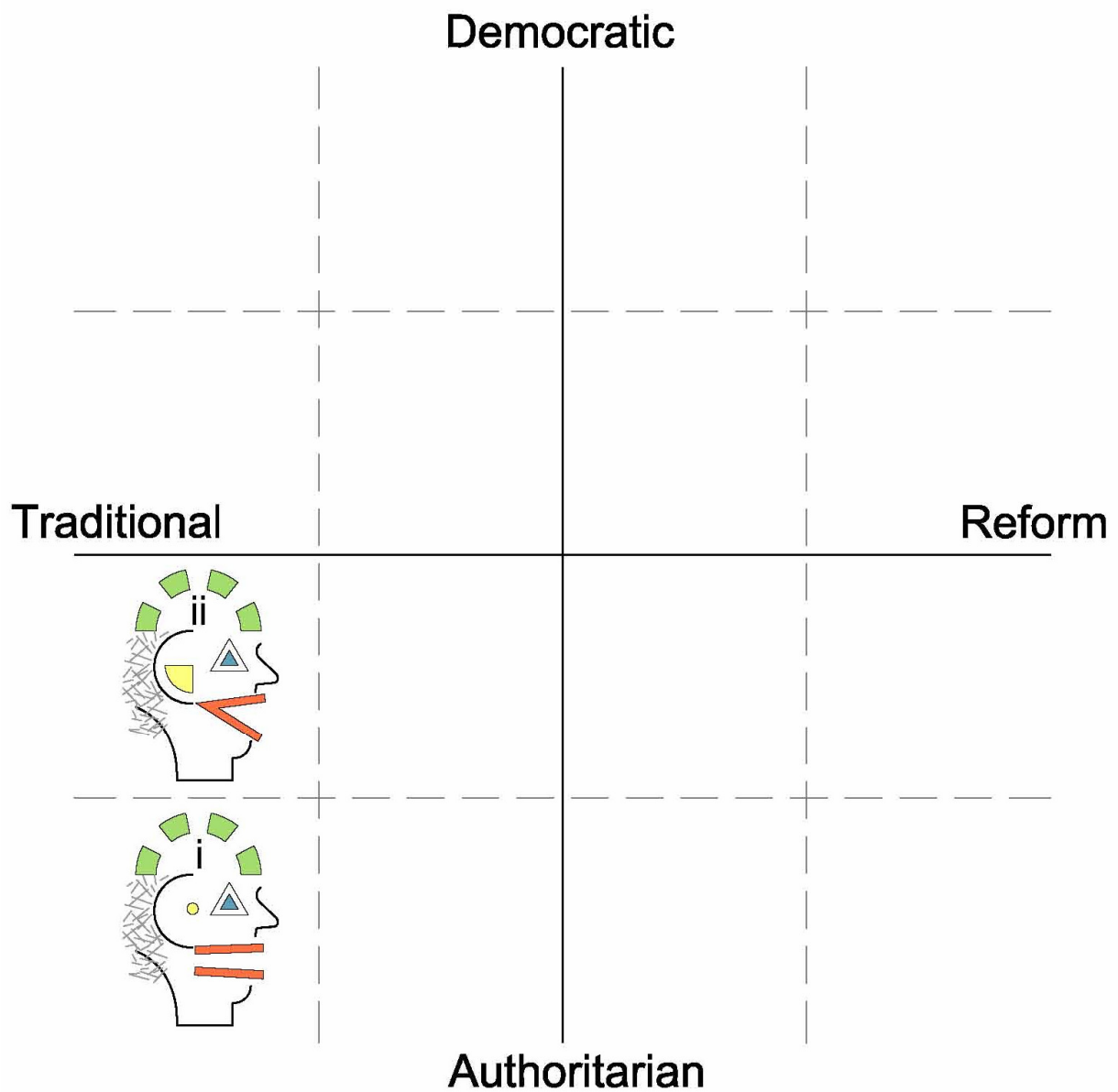


*Transmitter*

*Facilitator*

*Figure 6.19 Visual representation of Peta's beliefs about the teaching and learning of mathematics*

Peta's instructional behaviour made a slight shift up on the authoritarian/democratic continuum during the course of the year. This shift is indicated due to the more learner-centred and problem-solving approach she was able to implement later in the year that afforded the learners more active construction of knowledge, albeit at a low level. Although these learning tasks required more hands-on discovery from the learners, mastering of content remained her focus. Discussions encouraging feedback and investigating learners' thinking were not observed and questions posed did not elicit high-level reasoning, pattern identification or any of the other approaches to the teaching and learning of mathematics that would indicate a positive shift towards more reform type teaching.

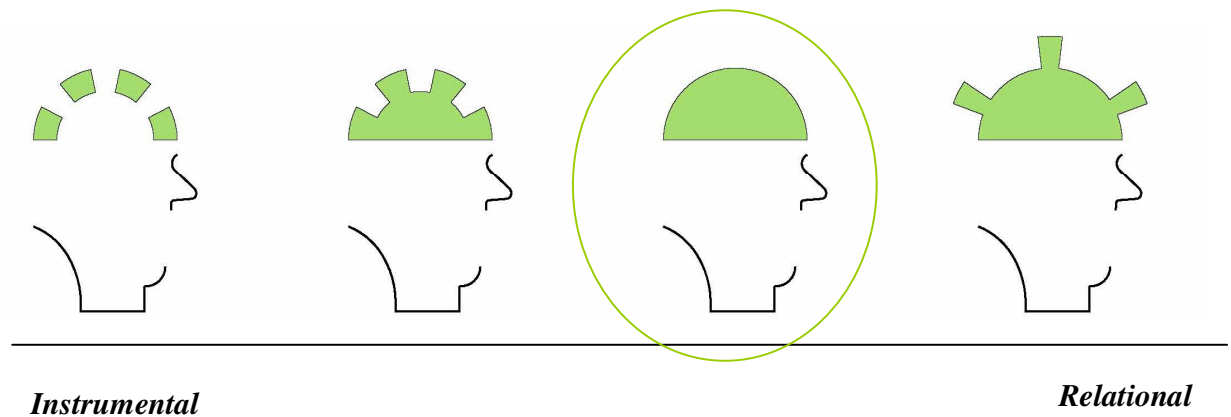


*Figure 6.20 Mathematics and instructional behaviour profile changes of Peta from initial (i) to final (ii)*

The changes that took place in Peta's mathematics profile were within her pedagogical content knowledge and her beliefs in the roles of teaching and learning of mathematics. Both of these moved up one category. Her instructional behaviour profile also moved one sub-quadrant up on the authoritarian/democracy continuum.

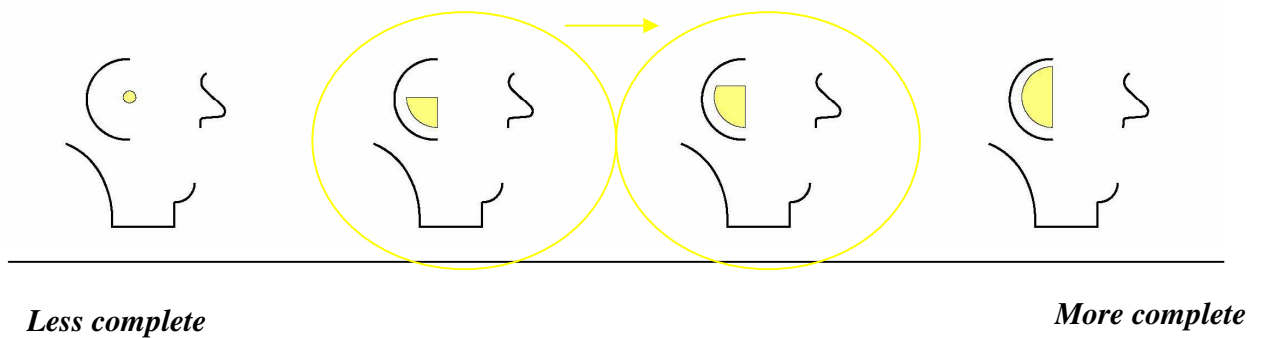
### 6.2.4 Kapinda

Like Lena, Kapinda showed no fundamental gaps in her subject matter knowledge throughout the year. She was able to draw on this effectively to design creative and engaging learning tasks. Kapinda's interactions with the mathematics content and processes in her learning tasks and observed lessons did not show the depth of relational understanding that both Marge and Toni demonstrated.



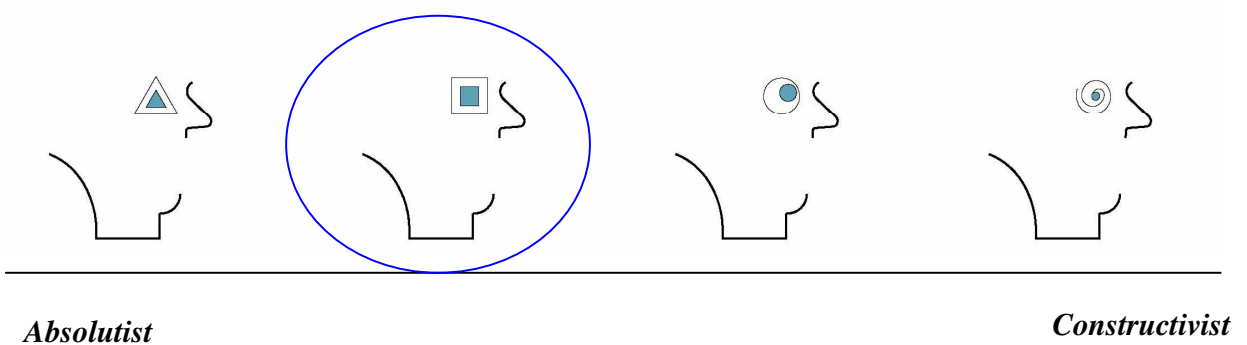
*Figure 6.21 Visual representation of Kapinda's subject matter knowledge*

Kapinda demonstrated an excellent understanding of the learners' context in terms of designing problems in authentic contexts that engaged the learners. Her learning tasks were creative and well planned. Kapinda's knowledge of the curriculum was good and she never seemed to experience any difficulties with classroom management. She progressively made more use of alternative assessments including peer assessment and the use of rubrics. Kapinda did not reach the point of investigating or valuing learners' errors though and the learners' thinking behind these and this is what restricted her pedagogical content knowledge from being placed in the fourth and most complete category.



**Figure 6.22** Visual representation of Kapinda's pedagogical content knowledge

Kapinda's view of mathematics was not very obvious from her reflections. However, her interaction with the content in the tasks she designed seemed to indicate a content orientation initially that was also calculational rather than conceptual. Her verbal response to my asking about the "mathematics silence" in her reflections also suggested that she willingly wanted to embrace and utilise the constructivist approach to the teaching and learning of mathematics but that she did not see how this could be possible in terms of how she "knew" mathematics as a subject both at school and university. Although her teaching became more process-orientated during the course of the year, knowing and correctly applying the rules and algorithms appeared to remain her focus.

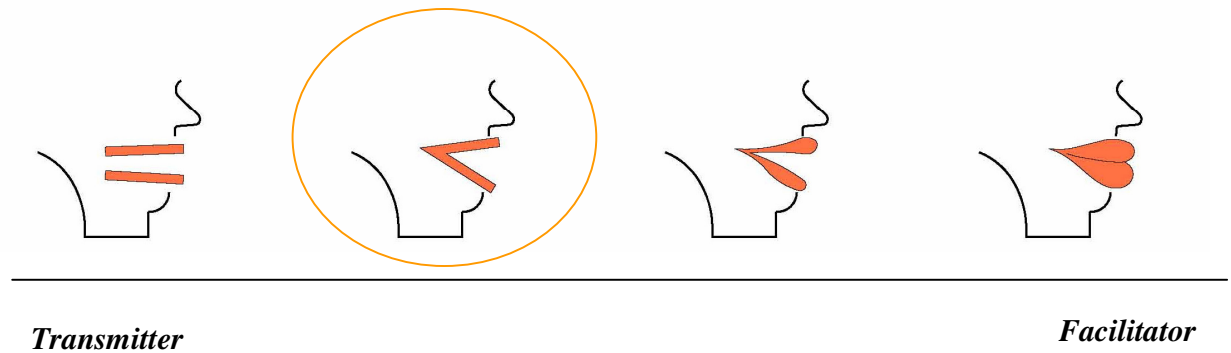


**Figure 6.23** Visual representation of Kapinda's conceptions of mathematics

Kapinda acknowledged and involved the learners from the beginning of her teaching. The questions that she posed mainly remained at recall level, although some of the last worksheets

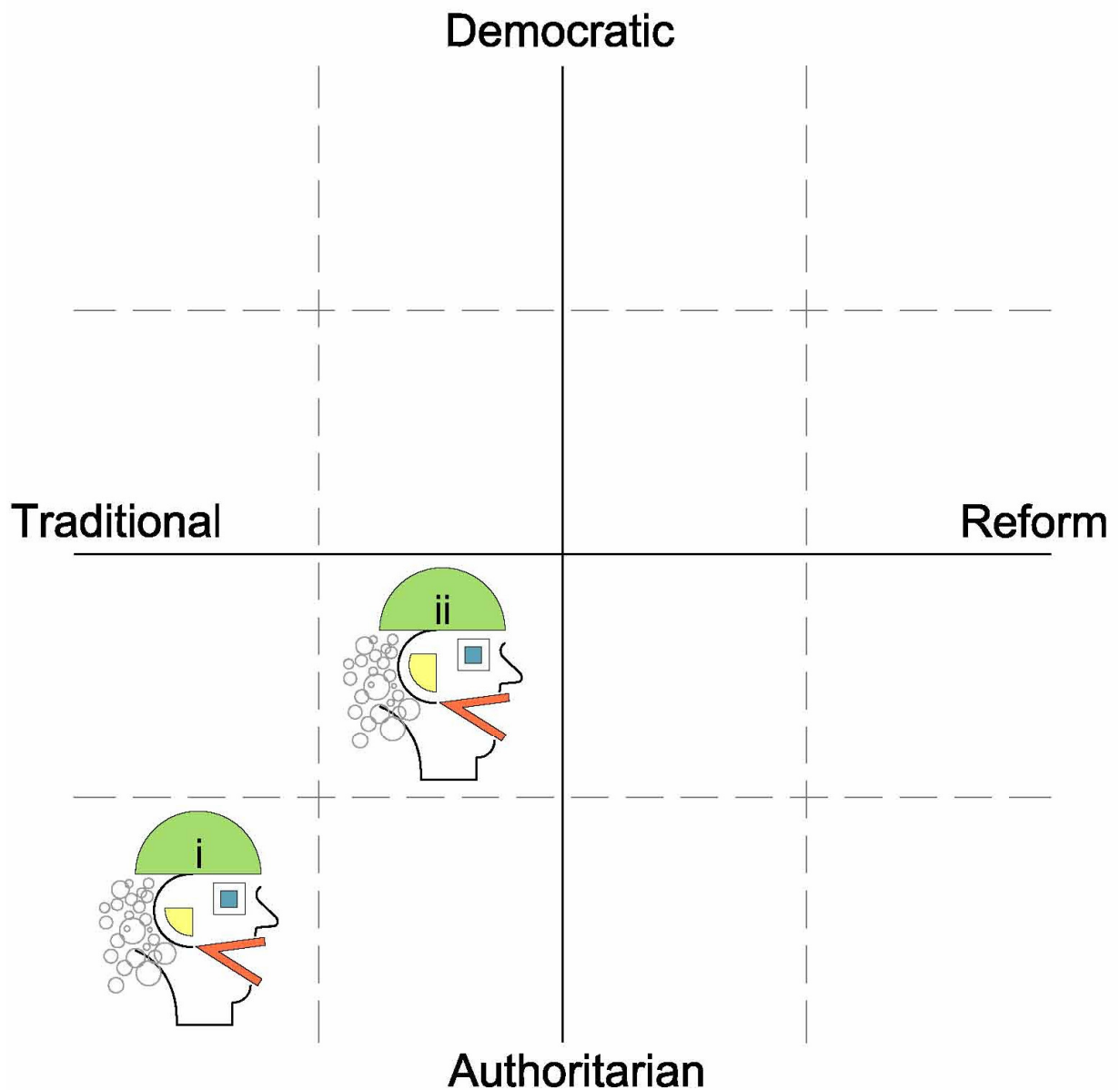


she designed suggested that she wanted learners to conceptually understand the mathematics rather than merely follow the methods or apply the algorithms. Even towards the end of the year when learners were asked to explain their solutions to the rest of the class, the focus remained on the answer and not on investigating their thinking and understanding behind it.



**Figure 6.24** Visual representation of Kapinda's beliefs about teaching and learning mathematics

Kapinda's instructional behaviour, like that of Lena's, made a slight shift on each of the continuums during the course of the year. Although mastering of content remained her focus, her learning task designs and some of her final lessons indicated her intent to move towards improving the conceptual understanding of learners. She designed problems that required more hands-on involvement from the learners and aimed at getting them to identify patterns. However, even if the learners were asked to communicate their thinking or reasoning as feedback and discussion during the class, they were expected to present the solution rather than the reasoning. Kapinda consistently demonstrated very good relations with the learners, used a variety of individual and group work and her lessons became more learner-centred and task-based.

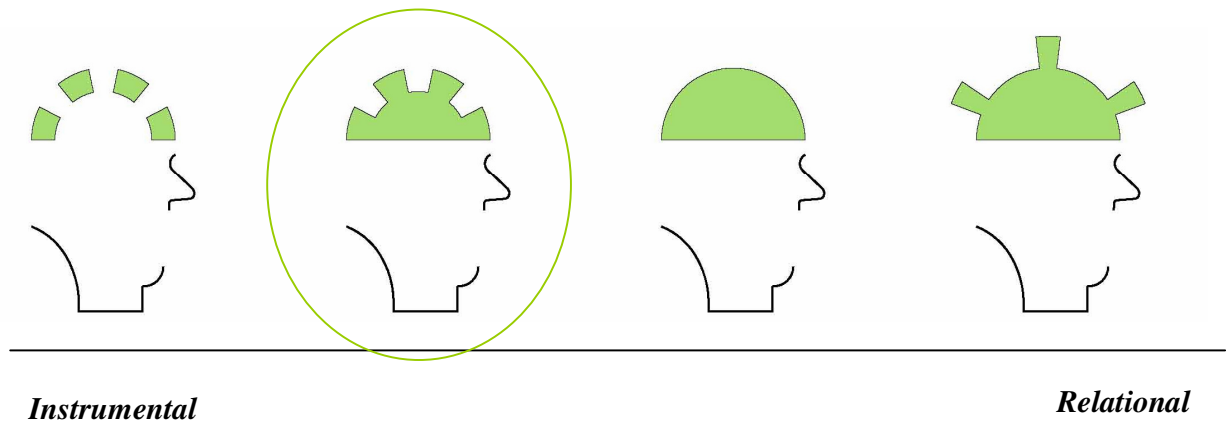


*Figure 6.25 Mathematics and instructional behaviour profile changes of Kapinda from initial (i) to final (ii)*

The only change that took place in Kapinda's mathematics profile is in her pedagogical content knowledge, which moved one category to the right. Her instructional behaviour profile also moved one sub-quadrant on each of the continuums.

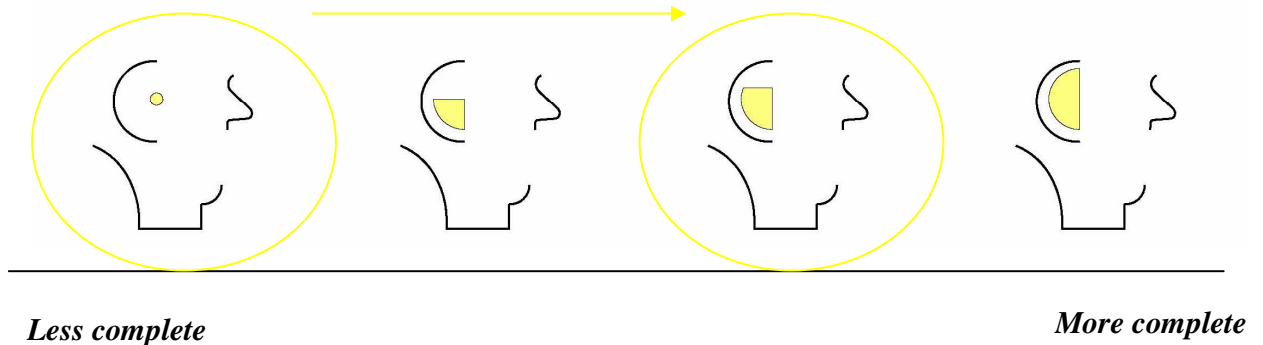
### 6.2.5 Anabella

As already indicated in chapter 5, Anabella also demonstrated some conceptual gaps in her subject matter knowledge throughout the course of the year. She made two fundamental errors in the baseline assessment and various errors were observed in her learning tasks and during her lessons.



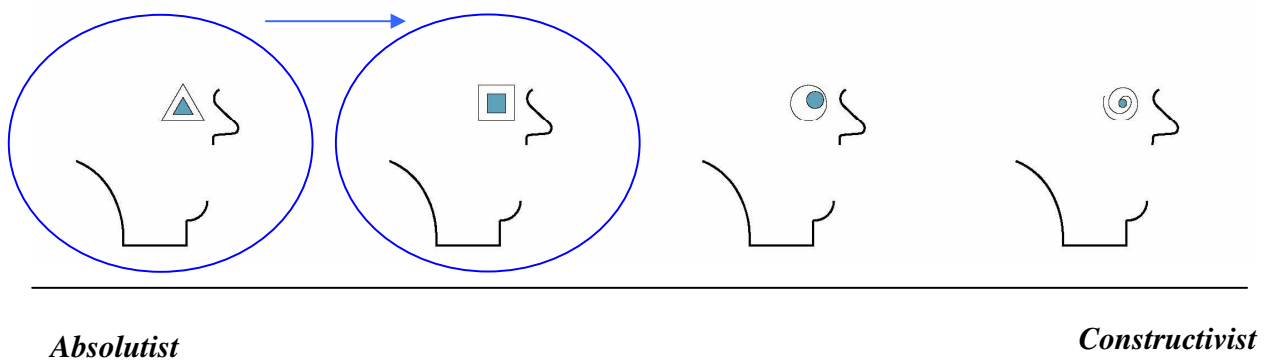
*Figure 6.26 Visual representation of Anabella's subject matter knowledge*

Initially Anabella struggled to design learning tasks to achieve the mathematical outcomes she wanted to achieve. She seemed to use neither alternative assessment nor the curriculum in determining the prior knowledge with which she expected learners would enter her lessons. Similarly to Peta, the quality of Anabella's learning task designs improved a lot during her second school-based experience. She appeared to work more effectively with learners in lower grades and began posing questions in response to learners' questions as the year progressed and she gained more confidence. She also began to implement some alternative forms of assessment. Anabella did not investigate incorrect answers or thinking of learners although she did move towards designing lessons that were more learner-centred towards the end of the year. She also made use of scaffolding as the year progressed (which is a competency that differentiated her from Sophie and Peta who both ended the year in the second pedagogical content knowledge category). Her pedagogical content knowledge is therefore depicted as changing from the first to the third (more complete) category.



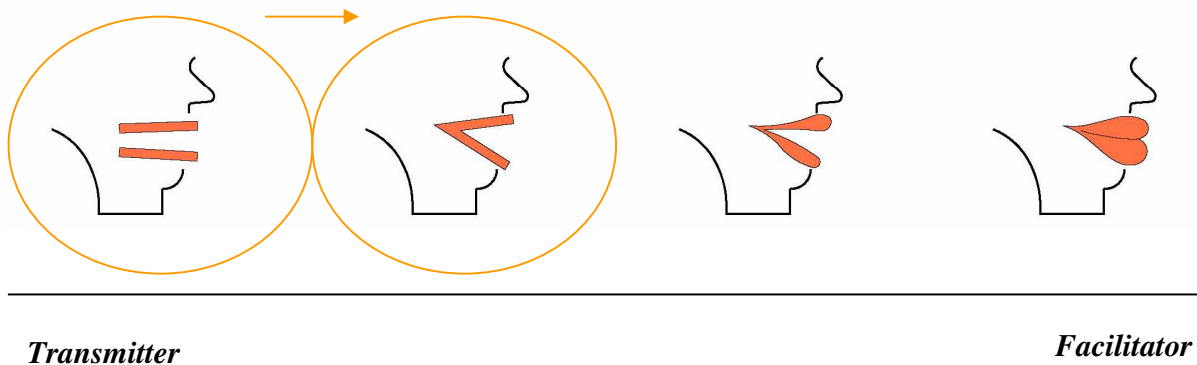
**Figure 6.27** Visual representation of Anabella's pedagogical content knowledge

At the beginning of the year Anabella dealt with mathematics as a very rigid, structured and absolute approach. Her focus was initially content-orientated foregrounding computational solutions. During the second school-based experience Anabella was given a Grade 8 class as her responsibility and here her learning tasks showed more of a process-orientated and calculational shift. Her view of mathematics appeared a little less absolute and rigid and she was able to integrate problem solving within her final few lessons in a more authentic context.



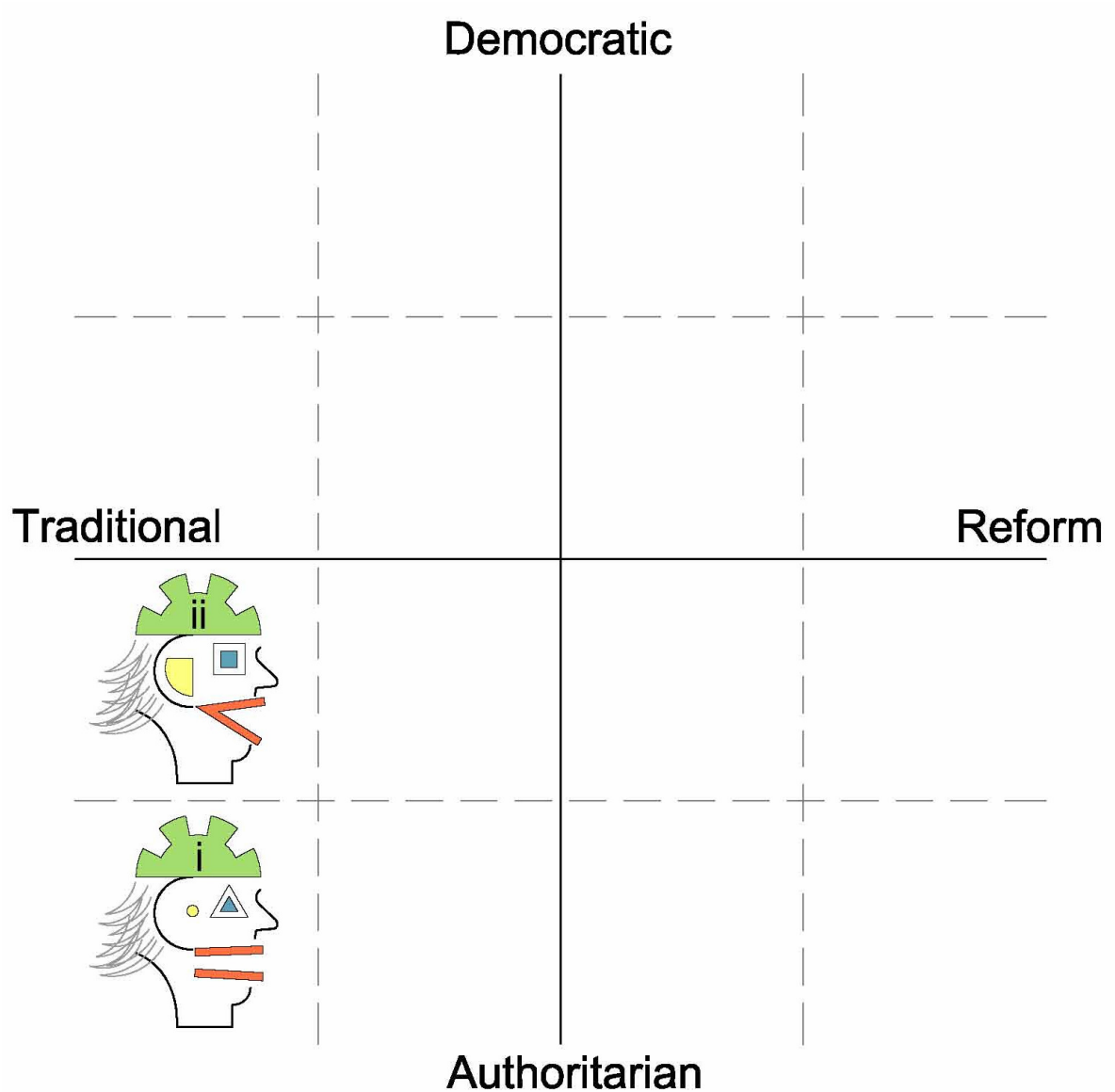
**Figure 6.28** Visual representation of Anabella's conceptions of mathematics

Anabella initially seemed to demonstrate expository teaching without encouraging any response or communication from the learners. During the second school-based experience Anabella began to provide more opportunities for learners to respond, although her questions did not elicit high-level reasoning or an explanation from learners of their thinking processes.



*Figure 6.29 Visual representation of Anabella's beliefs about teaching and learning mathematics*

Anabella's instructional behaviour made a slight shift up on the authoritarian/democratic continuum during the course of the year. This shift is indicated due to the more learner-centred and problem-solving approach she was able to implement later in the year that afforded the learners more active construction of knowledge, albeit at a low level. Although these learning tasks required more hands-on discovery from the learners, mastering of content remained her focus. Discussions encouraging feedback and investigating learners' thinking were not observed and questions posed did not elicit high-level reasoning, pattern identification or any of the other approaches to the teaching and learning of mathematics that would indicate a positive shift towards more reform type teaching.

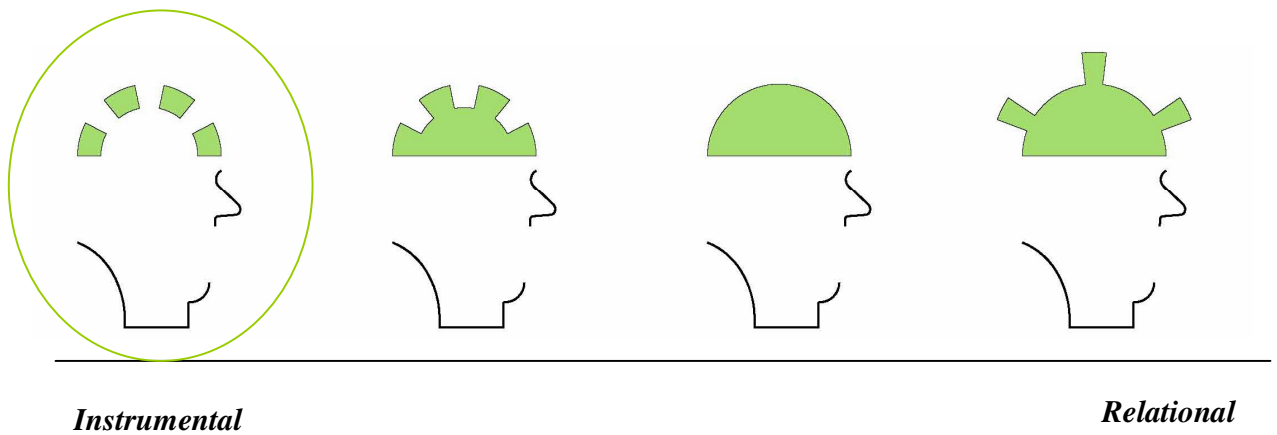


*Figure 6.30 Mathematics and instructional behaviour profile changes of Anabella from initial (i) to final (ii)*

Anabella's mathematics profile changed in three of the four components. Her pedagogical content knowledge moved two categories to the right while her conceptions and beliefs both moved one category. Anabella's instructional behaviour profile also moved one sub-quadrant up on the authoritarian/democracy continuum.

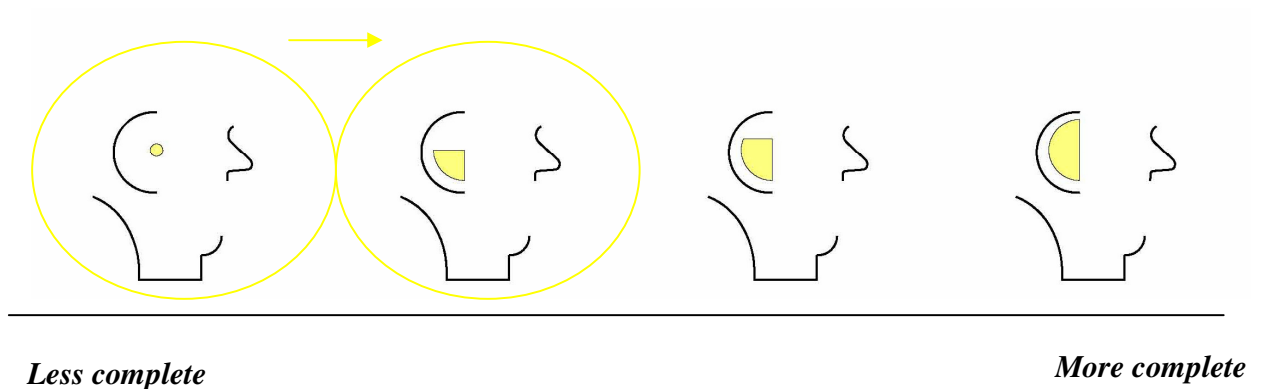
### 6.2.6 Sophie

Sophie demonstrated a number of conceptual gaps in her subject matter knowledge throughout the course of the year. She made fundamental errors in the baseline assessment and various errors were observed during her lessons.



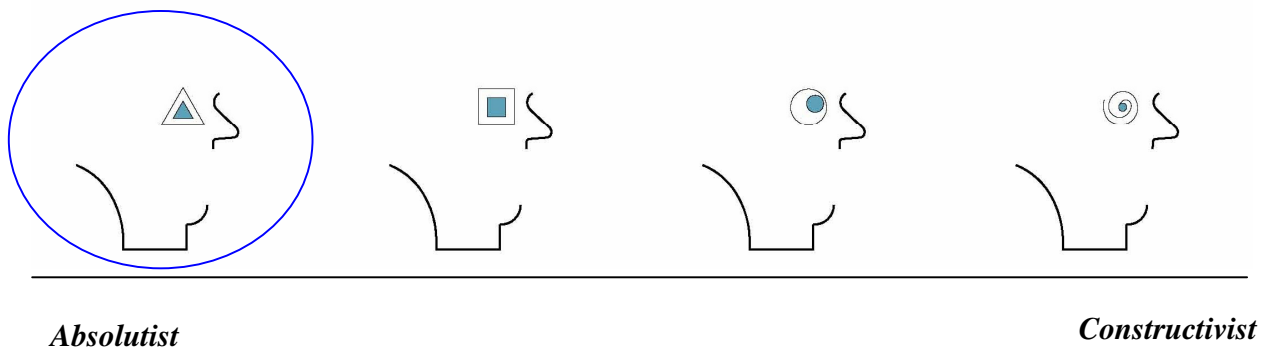
*Figure 6.31 Visual representation of Sophie's subject matter knowledge*

Sophie struggled to improve the poor quality of her learning task designs. Although the context and quality of problems improved and the intentions and course of her lessons later became clearer in her learning task designs, Sophie continued to present tasks and worksheets to learners with instructions that were unclear or ambiguous. She did not investigate incorrect answers or thinking of learners although she did move towards designing lessons that were more learner-centred and contextual towards the end of the year. These contexts, though, often detracted from the intended curriculum outcomes to be achieved. Sophie's pedagogical content knowledge is therefore depicted as changing from the first to the second (more complete) category.



**Figure 6.32** Visual representation of Sophie's pedagogical content knowledge

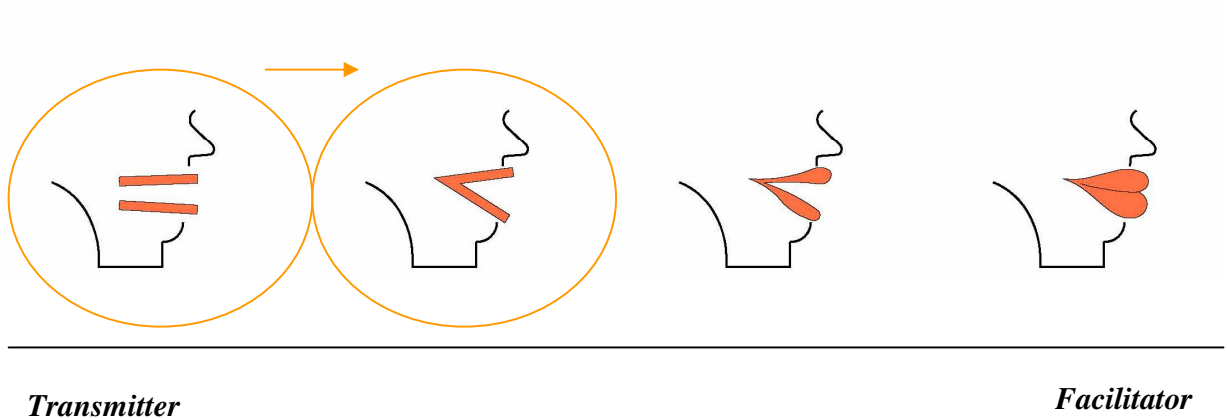
From the beginning of the year Sophie dealt with mathematics as a very rigid, structured and absolute (in terms of right or wrong) approach. Her focus remained content-orientated with an emphasis on using the correct methods and formulae and finding the correct answer. It was therefore not easy to find any evidence of a shift in this view of mathematics throughout her final portfolio or interaction with the mathematical content.



**Figure 6.33** Visual representation of Sophie's conceptions of mathematics

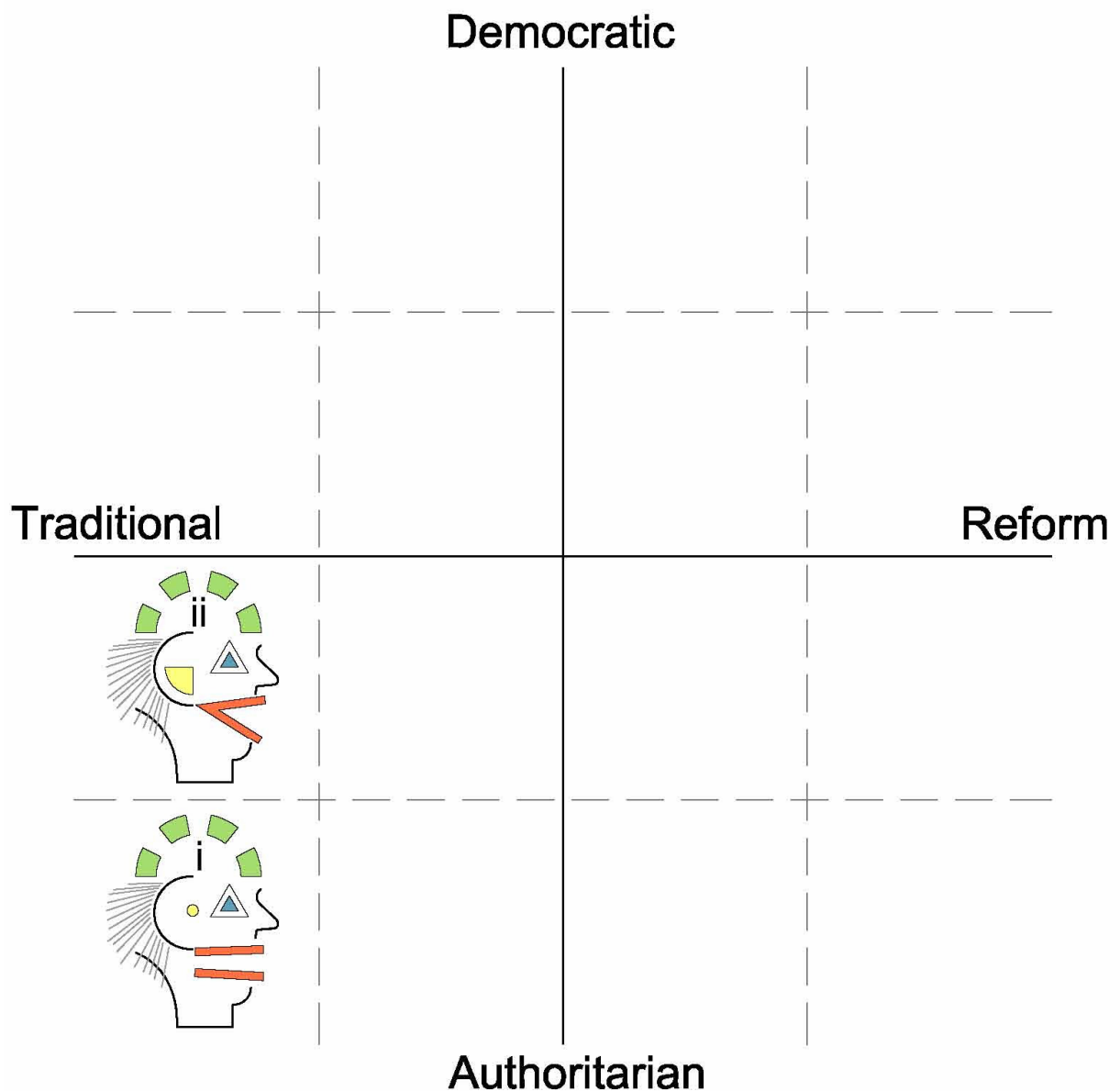
At the beginning of the year Sophie seemed to teach without requiring any response or communication from the learners. This could perhaps have been due to her not being comfortable with teaching in English as it is her second language. During the second school-based experience Sophie slowly began to provide more opportunities for learners to respond, although her questions mostly focused on computational solutions, and facts (such as recalling formulae) rather than on mathematical thinking or processes.





*Figure 6.34 Visual representation of Sophie's beliefs about teaching and learning mathematics*

Sophie's instructional behaviour made a slight shift up on the authoritarian/democratic continuum during the course of the year. This shift is indicated due to the more learner-centred and attempted problem-solving approach she was able to implement later in the year that afforded the learners more active participation in the lesson. Although these learning tasks required more hands-on engagement from the learners, not much mathematical thinking or reasoning was required from learners. Neither tasks nor discussions encouraging feedback and investigating learners' thinking were observed and questions posed did not elicit high-level reasoning, pattern identification or any of the other approaches to the teaching and learning of mathematics that would indicate a positive shift towards more reform type teaching.

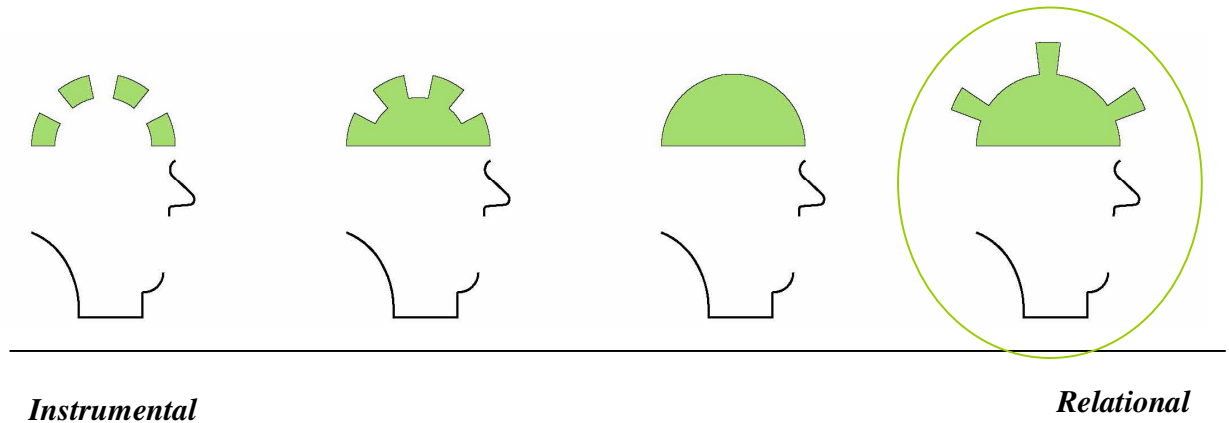


*Figure 6.35 Mathematics and instructional behaviour profile changes of Sophie from initial (i) to final (ii)*

Sophie’s mathematics profile changed in two of the four components. Her pedagogical content knowledge and beliefs about the teaching and learning of mathematics both moved one category to the right. Sophie’s instructional behaviour profile also moved one sub-quadrant up on the authoritarian/democratic continuum.

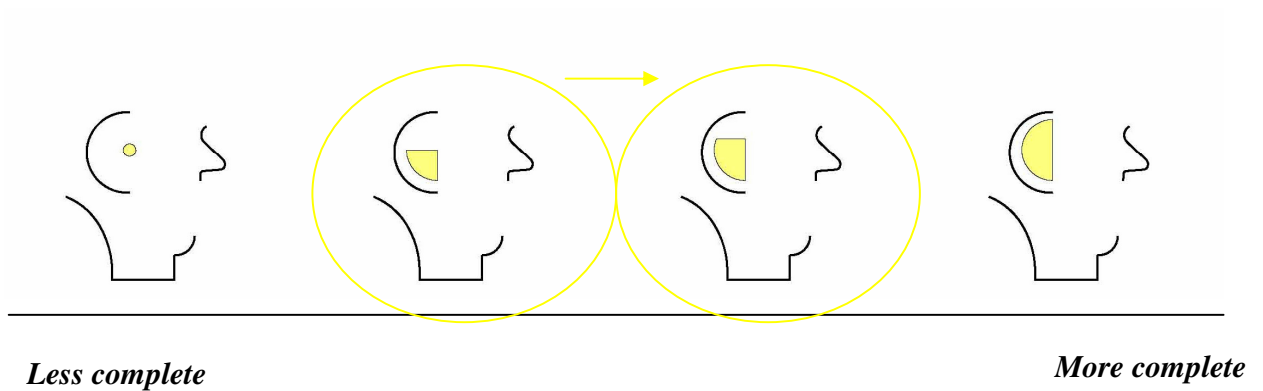
### 6.2.7 Toni

Like Marge, Toni also displayed strong subject matter knowledge throughout the year. He was able to effectively draw on this in designing learning tasks of a high mathematical standard and ask questions that elicited a high level of thinking from the learners.



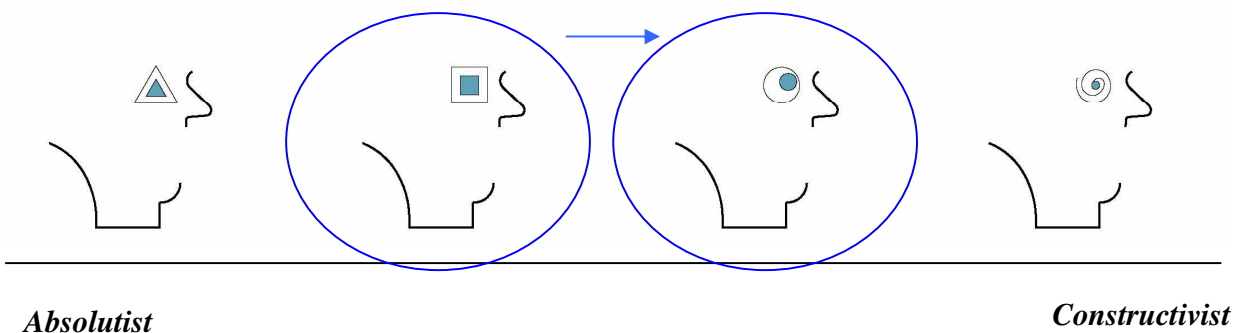
*Figure 6.36 Visual representation of Toni's subject matter knowledge*

From the beginning of the year when Toni started trying to design contextual problems, he ensured that the mathematical content was not lost amidst the context. His planning was of a high quality and he made effective use of scaffolding to enable learners to work more independently and used various forms of alternative assessment towards the end of the year. His knowledge of the curriculum and his classroom management were also both outstanding throughout the course of the year. However, Toni did not reach the point of investigating or valuing learners' errors and the learners' thinking behind these and this is the main reason he did not progress to the final category on the right, as this is in my opinion an important facet of pedagogical content knowledge.



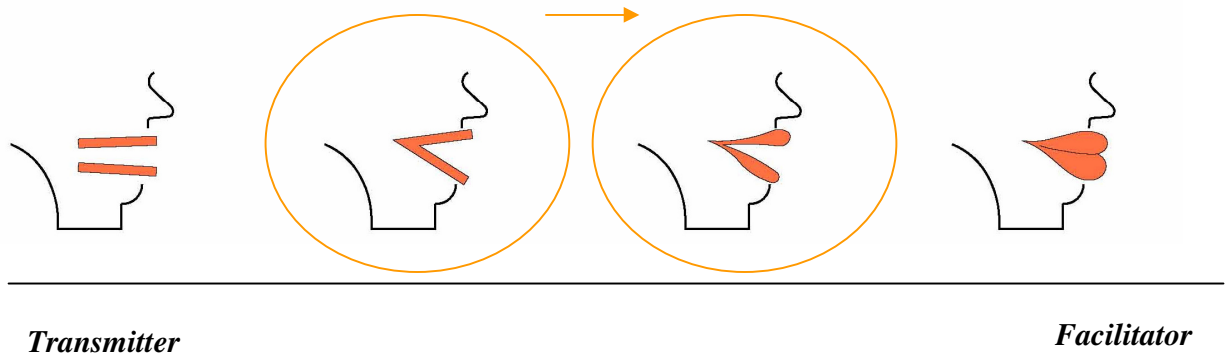
**Figure 6.37** Visual representation of Toni's pedagogical content knowledge

Toni's initial view of mathematics seemed to be more instrumentalist with a focus on rules and algorithms. During the course of the year his teaching became more process-orientated though, moving from a focus on calculational to more conceptual understanding.



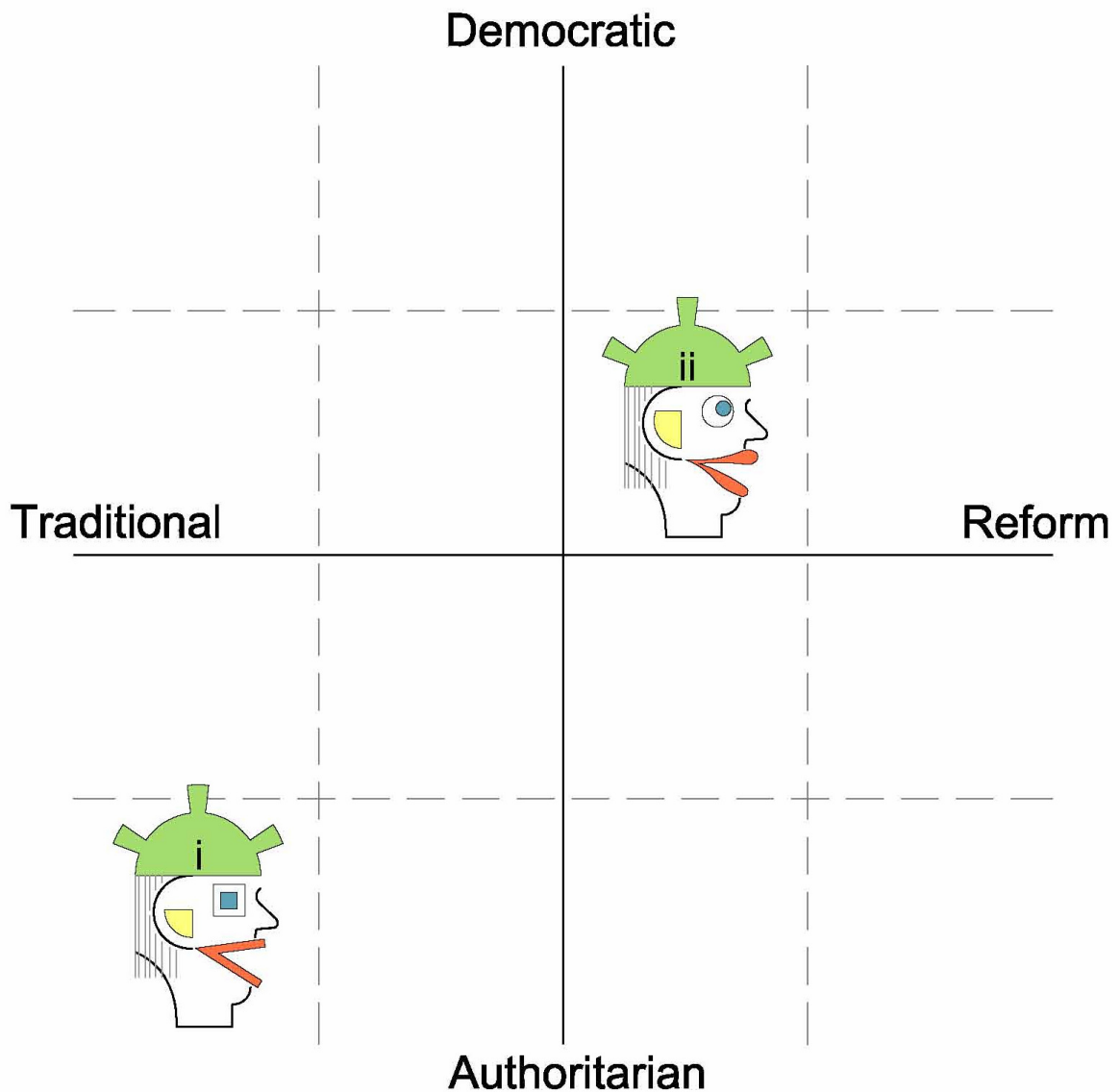
**Figure 6.38** Visual representation of Toni's conceptions of mathematics

Toni treated the learners as 'transceivers' from the beginning of his first school-based education. He demonstrated a strong ability to think on his feet and involve a number of learners in his still-dominantly-expository but transactional teaching. Toni's final profile depicts him as an explainer (rather than facilitator) as, similarly to Marge, he never demonstrated the ability to facilitate mathematical discussions on a continuous basis that required the learners to do most of the talking and use high-level reasoning and thinking (which I refer to as decoding).



*Figure 6.39 Visual representation of Toni's beliefs about teaching and learning mathematics*

Toni was the only other participant (alongside Marge) whose instructional behaviour changed significantly during the course of the year. As he began to embrace a more constructivist and problem-solving approach to the teaching and learning of mathematics, the design of his learning tasks began to change. His learning task designs and lessons began making more use of hands-on discovery, identification of patterns and exploration. Toni began demanding more high-level reasoning from his learners but not to the extent where it was being required often enough or with enough heuristic listening on Toni's part. He still seemed more comfortable being in control of the lesson and the class, rather than this being a negotiation and sharing of thinking between learner and facilitator. This is the reason his instructional behaviour profile made changes on both continuums but not to the optimal reform and democracy quadrants.



*Figure 6.40 Mathematics and instructional behaviour profile changes of Toni from initial (i) to final (ii)*

Toni's final mathematics profile indicates a shift of one category to the right in the pedagogical content knowledge, conceptions and beliefs components. The changes in his instructional behaviour were also evident in the changes he made towards a more reform-dominated practice and encouraging more democracy within his approach to the teaching and learning of mathematics.

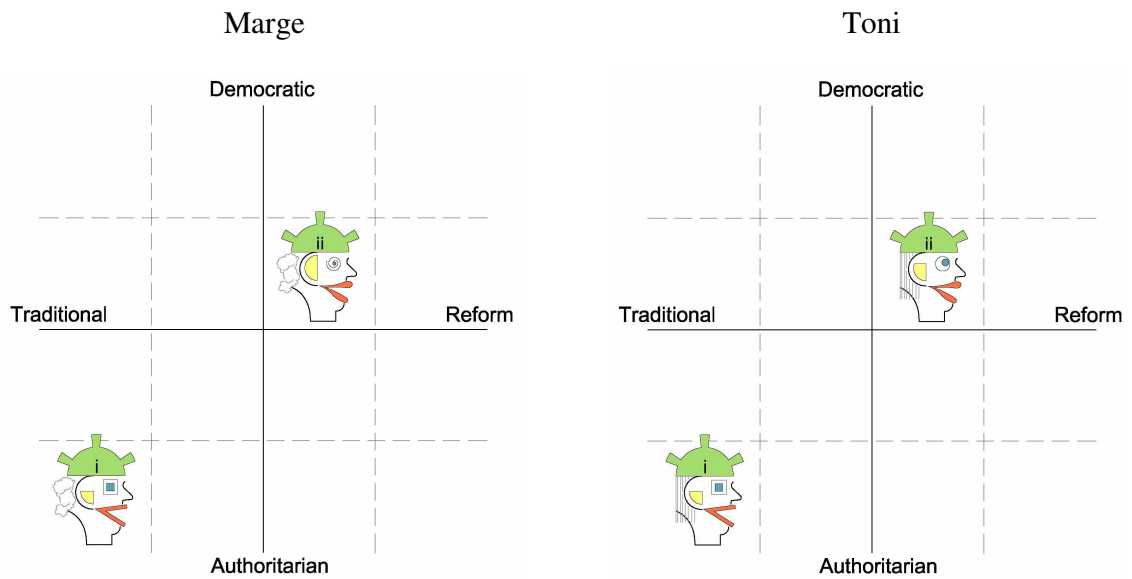
### **6.3 Cross-case comparisons**

Changes in individual participants' mathematics profiles and instructional behaviour were discussed in the section above. In this section I discuss the cross-case comparison. This was done by first grouping participants with identical starting mathematics profiles and comparing their final mathematics profiles and the changes in their instructional behaviour. This process was then repeated by comparing participants who had similar (only one component differed) initial mathematics profiles or similar final mathematics profiles. Differences in the various profiles are also discussed.

#### **6.3.1 Identical initial mathematics profiles**

Marge and Toni have identical starting profiles as do Peta and Sophie. I have grouped these pairs together calling them Groups 1 and 2. Their visual profiles are depicted in Figure 6.41.

**Group 1** (Marge and Toni) both exhibited excellent relational subject matter knowledge. They both started off the year displaying some pedagogical content knowledge, having an instrumentalist conception of mathematics and indicating a belief that their role in the teaching and learning of mathematics pertained mainly to instructing. During the course of the year they both changed this belief to enact the role of explainer. Marge's pedagogical content knowledge moved to the most complete category and her conceptions of mathematics changed to a problem-solving view. Toni's pedagogical content knowledge moved one category to the right and his conceptions changed to the Platonist view. In my opinion, the main reason for these final mathematics profile differences is the vast amount of literature that Marge accessed and incorporated into her practice, her reflections and her practice-theory as the year progressed. While Toni also did some reading of the literature, he did not cover nearly the extent that Marge managed to read through and internalise. Both these participants also demonstrated a high level of insight and an ability to be accurately self-critical in their reflections. These reflections also indicated their ongoing analysis of their practices and learning task designs in order to continually improve these.



**Figure 6.41** Visual profiles of Group 1 (Marge and Toni)

What is interesting is that both participants' instructional behaviour profiles followed the same trajectory of change. From this observation I am making the assumption that the additional change in the pedagogical content knowledge and conceptions categories for Marge did not necessarily enable more change in her instructional behaviour and neither did her vast engagement with the literature. It is also interesting to note that neither of these participants reached the role of facilitator in terms of their beliefs about the teaching and learning of mathematics. This is perhaps linked with both of them not moving into the final reform and democracy sub-quadrants. In order for a participant to be placed in the final reform sub-quadrant, they needed to continually be creating opportunities for learners to engage in and discuss their mathematical reasoning and understanding. These opportunities should demand high-level reasoning from learners that also allow them to deepen their conceptual and relational understanding and application of the domain of mathematics. This echoes the role of a facilitator whose learners are expected to “decode” problems and signal their process of thinking and understanding back to the facilitator. The facilitator enables and guides the discussions but does not necessarily dominate them. This, in turn, is linked to the final democracy sub-quadrant. Instructional behaviour in this quadrant would involve more heuristic listening on the part of the teacher. In this cross-case comparison, what is foregrounded for me is the importance of the belief component of the mathematics profile in



enabling optimum change in pre-service teachers' instructional behaviour. Another aspect that has emerged is the role that literature appears to play in enabling change in the mathematics profile of the pre-service teachers.

**Group 2** (Peta and Sophie) have exactly the same initial and final profiles. They both demonstrated disquieting fundamental gaps in their subject matter knowledge, did not have very much pedagogical content knowledge to begin with, shared the absolutist conception of mathematics and initially enacted the role of transmitter regarding their beliefs about the teaching and learning of mathematics. During the course of the year, they both gained in pedagogical content knowledge (improved planning and quality of their learning task designs, some use of alternative assessment, responding to a question with a question and knowledge of the curriculum) and changed their enacted role from transmitter to instructor, where there was more evidence of them requiring participation and communication from their learners.



**Figure 6.42** Visual profiles of Group 2 (Peta and Sophie)

In line with the comparison in Group 1, this pair also made the same changes in their instructional behaviour. They both started including problems in their learning task designs which engaged the learners (making the lessons more learner-centred and less authoritarian) but which did not promote the more reform type values and activities such as pattern identification, modelling, exploration and investigation with an emphasis on high-level

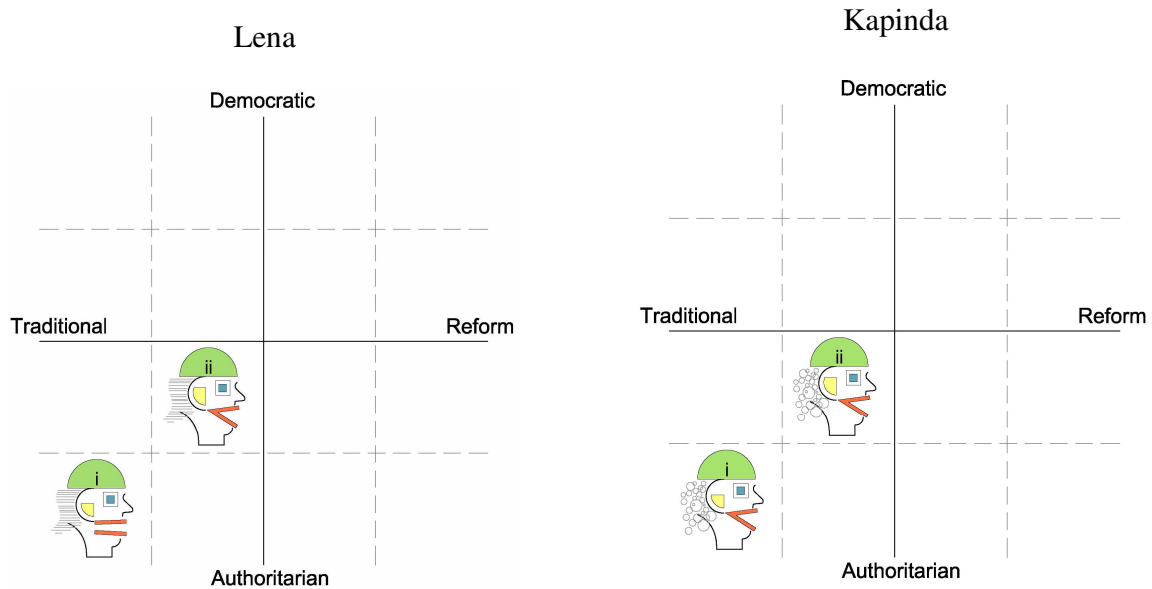
mathematical reasoning. Peta's final learning task design did require pattern identification but this was not seen as enough evidence to move her instructional behaviour into the next sub-quadrant of the traditional/reform continuum. The continual low-level engagement with the conceptual issues and processes of mathematics and a consistent focus by both participants on mastering content were other aspects that restricted their movement on this continuum.

This cross-case comparison highlights an issue relating to the drive for more learner-centred lessons that our course often tries to propagate. Both participants reached a stage of including their learners more actively in their lessons. However, owing to the nature of the low level of mathematical processes being required (on average Mason's level 2), this increased activity from the learners only made the lessons less authoritarian and did not mean they were less traditional. In South Africa, with our new curriculum being embedded in the philosophy of Outcomes-based Education, learner-centredness is often seen as an indicator of a more "outcomes-based" lesson which is also often understood to be "less traditional" and more in line with the reform ideology. I have felt uncomfortable with this in my own specialisation module and this cross-case comparison has enabled me to understand the reason in terms of the superficial change that a more learner-centred lesson (in terms of activity rather than mathematical reasoning) can imitate. I think the issue of what is meant by a more learner-centred lesson is something that needs to be reviewed for the purposes of my own teaching. In chapter 7 I elaborate on this in the personal reflection.

### **6.3.2 Identical final mathematics profiles**

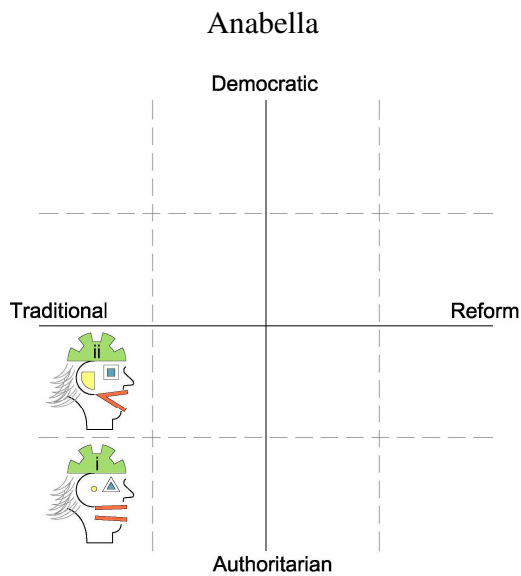
Lena and Kapinda (*Group 3*) had similar initial mathematics profiles (differing only in their enacted beliefs) and identical final mathematics profiles. Neither of them displayed gaps in their subject matter knowledge during the course of the year, although their knowledge did not appear as relational as that of Marge and Toni. Both Lena and Kapinda held an instrumentalist conception of mathematics throughout the year as deduced from their interaction with the content (mostly content-orientated and computational or calculational) and their focus on mastering of the content. They both enacted an instructors belief about the teaching and learning of mathematics and both moved one category towards "more complete" in their

pedagogical content knowledge. In fact, pedagogical content knowledge appeared to be the only change in Kapinda’s mathematics profile.



**Figure 6.43** Visual profiles of Group 3 (Lena and Kapinda)

Lena and Kapinda both made the same sub-quadrant changes in their instructional behaviour, moving towards being less authoritarian and less traditional in their teaching. However, neither of them moved onto the reform or democratic side of these continuums. Looking at this cross-case comparison in relation to the groups mentioned above, it appears that the pedagogical content knowledge component does not play a role in effecting change in on the authoritarian/democratic continuum but may perhaps influence participants’ instructional behaviour in becoming less traditional. Both participants in Group 2 had the second category of pedagogical content knowledge in their final profiles (I refer to this as ‘some pedagogical content knowledge’). Both participants in Group 1 (Marge and Toni) and these in Group 3 (Lena and Kapinda) ended on the third (or in Marge’s case fourth) category of the pedagogical content knowledge component. All these participants in Groups 1 and 3 made some positive change in their approach to teaching in becoming less traditional (in the case of Group 3) or even more reform orientated (in the case of Group 1).



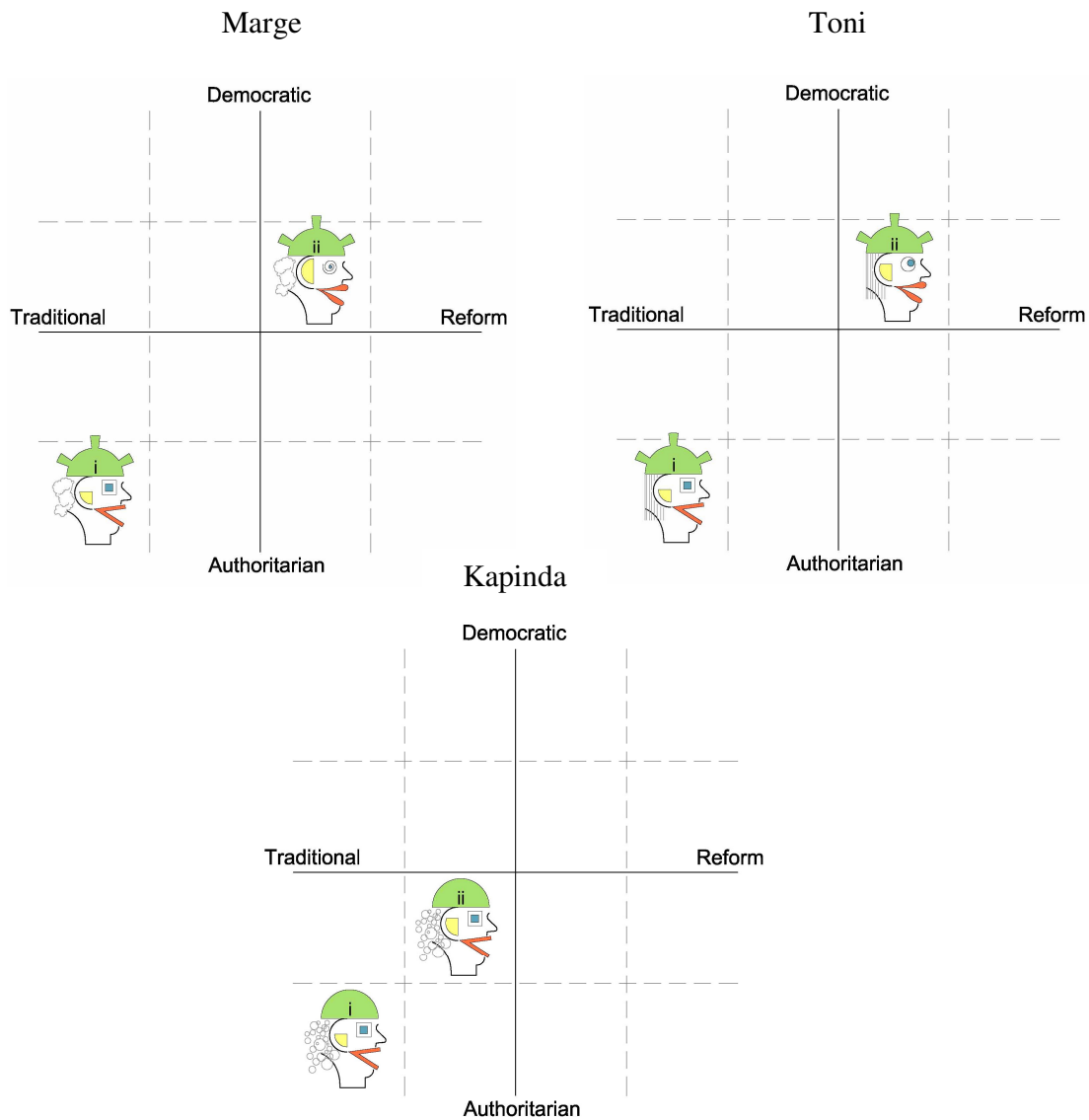
**Figure 6.44** Visual profile of Anabella

One of the participants who did not share an identical initial or final mathematics profile with any of the other participants was Anabella. However, Anabella has a similar final mathematics profile to both Lena and Kapinda with the only difference being her subject matter knowledge. Her pedagogical content knowledge for her final mathematics profile was in the third category and yet her instructional behaviour did not become noticeably less traditional. This therefore does not substantiate my assumption above that more complete pedagogical content knowledge enables pre-service teachers to teach in a less traditional manner. It is interesting though that in the mathematics specialisation course I teach, I spend a lot of time working on improving the pedagogical content knowledge of our students. It appears that this component might not be as influential in changing the instructional behaviour of pre-service teachers as I expected. I also revisit this in the personal reflection in the concluding chapter.

### 6.3.3 Similar initial and final mathematics profiles

Toni, Marge and Kapinda (*Group 4*) share similar initial mathematics profiles with the only difference being the more relational subject matter knowledge demonstrated by Marge and Toni. Their final mathematics profiles differ in terms of conceptions of mathematics and their enacted beliefs. Despite starting off similar, Marge and Toni's mathematics profiles and

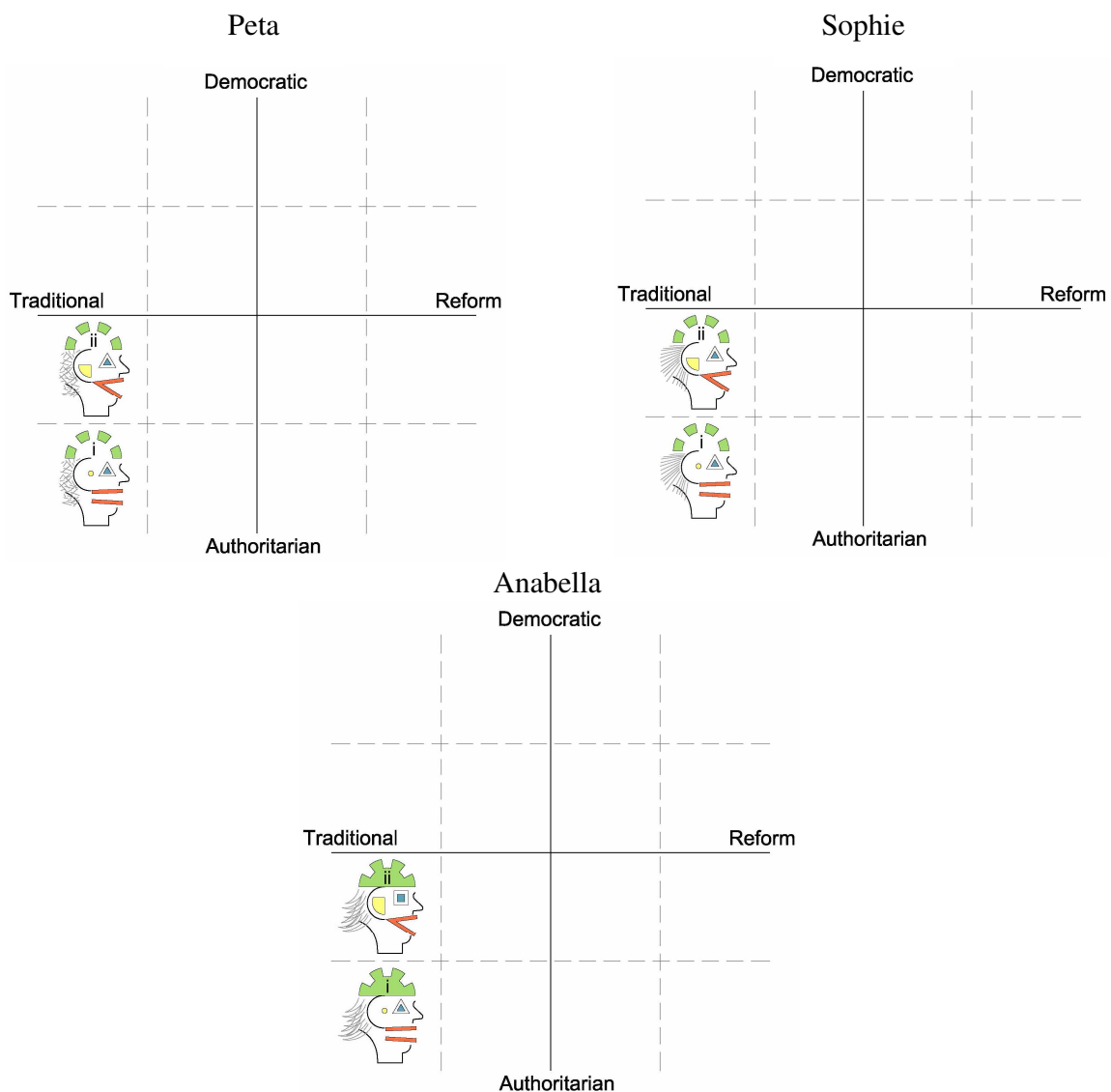
instructional behaviour profiles changed more substantially than Kapinda's. With the only initial difference in their mathematics profiles being in the subject matter knowledge, a surface reason for the differences in changes may be the more relational subject matter knowledge of Marge and Toni. I do think this is an important point as only the two participants with relational subject matter knowledge were able to make a change to the positive side of both instructional behaviour continuums. However, I think another reason lies in the quality and nature of the reflections as well as individually (outside of what is prescribed) consulting and incorporating literature from the domain of mathematics and mathematics education into one's practice. Kapinda did not show any evidence of this in her final portfolio, apart from the prescribed literature that is part of the PGCE course. Her reflections were not as analytical as those of Marge and Toni and perhaps did not play such an important role for her in her professional development. As mentioned in chapter 5, the content of Kapinda's reflections never pertained to the actual mathematical processes or content. This could be another aspect constraining her instructional behaviour change.



**Figure 6.45** Visual representation of Group 4 (Marge, Toni and Kapinda)

Lena did make use of increasingly analytical reflections and was also self-critical. However, her instructional behaviour was not as substantial as that of Marge or Toni. This could therefore reinforce the importance of relational subject matter knowledge in changing instructional behaviour. Lena made some reference to literature that she had sought and read herself (although not as much as Toni). This may be what enabled the change in her mathematics profile of her enacted role from transmitter to instructor. Perhaps Kapinda's not reading in the mathematics and mathematics education field is what constrained the development of the conceptions and belief components of her mathematics profile.

Peta, Sophie and Anabella can also be grouped together (*Group 5*) as having similar initial mathematics profiles. They differed initially only in their level of subject matter knowledge, with Anabella demonstrating less fundamental conceptual gaps and more integration of the various topics in mathematics. Their final mathematics profiles looked different though, with Anabella displaying more complete pedagogical content knowledge than the other two, and changing her conception of mathematics to instrumentalist rather than absolutist (where the other two participants' views remained). All three of them moved from transmitter to instructor in their enacted beliefs.



*Figure 6.46 Visual profiles of Group 5 (Peta, Sophie and Anabella)*

All three participants also demonstrated similar change in their instructional behaviour, becoming less authoritarian towards learning but not less traditional in their teaching approach. This reiterates what I mentioned above, that Anabella's change in pedagogical content knowledge, conceptions and enacted beliefs (which means she ended with a final mathematics profile similar to Kapinda and Lena) did not enable her to teach in a more reformed manner. I am therefore led to conclude that the component in the mathematics profile that appears to be most enabling in pre-service teachers moving towards the positive side of the traditional/reform continuum is their subject matter knowledge. Neither Anabella, Sophie nor Peta provided evidence of reading literature in mathematics or mathematics education, beyond the prescribed readings for the course. This supports the discussion above where this aspect relating to literature might have a constraining influence on the changes in participants' mathematics profiles. I initially suspected that the lack of deep conceptual knowledge might be the cause of participants not changing their conceptions of mathematics beyond instrumentalist and their enacted beliefs beyond instructor, but Kapinda and Lena both showed subject matter knowledge without any conceptual gaps and they both had instrumentalist conceptions and instructor roles in their final mathematics profiles.

## **6.4 Discussion**

For this summarising discussion I want to highlight some obvious differences in the groups discussed above. Group 1 (Marge and Toni) and Group 2 (Peta and Sophie) differed greatly in their mathematics profiles as well as the changes to their instructional behaviour. Three aspects stand out that may have influenced this. The first one relates to the subject matter knowledge. Group 1 demonstrated the most relational subject matter knowledge and made the most substantial changes to their instructional behaviour. Group 3 (Kapinda and Lena) had slightly less relational subject matter knowledge (with no conceptual gaps evident) and they made slightly less of a change in their instructional behaviour. Group 2 and also Group 5 (to include Anabella) presented the most gaps in their subject matter knowledge and they also made the least changes and I would venture to say progress in their instructional behaviour. From these differences the *component of subject matter knowledge does appear to play an*



*important part in enabling or constraining the changes in pre-service mathematics teachers' instructional behaviour.*

The second aspect pertains to the level and quality of the reflections participants kept during the year which were included in their final professional development portfolios. Marge, Toni and Lena were the most analytical, insightful and self-critical in their reflections. Kapinda and Anabella would be the participants I would place next in line although their reflections were more affective and less analytical at times and more focused on the learning task design requirements rather than the mathematics processes and content. Peta and Sophie then follow with reflections that were more an account of what happened in the lesson and how this made them feel. This order above, in terms of quality of reflections, closely (although not exactly) resembles the order of quality of instructional behaviour changes. From this I am suggesting that not just reflecting on one's practice/experiences but that *the quality of these reflections may affect the extent of positive change pre-service teachers make in their instructional behaviour.*

The third aspect deals with students accessing, reading, understanding and incorporating literature from the mathematics and mathematics education domain into their beliefs and practices. Marge was definitely the participant who did the most reading in this regard, beyond the prescribed works. She searched for her own articles on problem-solving approach, on constructivism and on the theory of realistic mathematics education in particular. By her own admission, she initially did not do much of this owing to time constraints. However, when she took time towards the middle of the year to read, changes started manifesting. Marge was the participant who reached the most complete category of pedagogical content knowledge and the only participant to change to a problem-solving view of mathematics. Toni also did a fair amount of reading, followed by Lena who did a little. Kapinda, Anabella, Peta and Sophie did not indicate any evidence of finding or reading additional sources in this domain. This order above is similar to changes noted in the mathematics profiles. Lena, Kapinda, Anabella and Peta were not able to change their conceptions of mathematics beyond instrumentalist or their enacted beliefs about the teaching and learning of mathematics beyond instructor. Not even the higher level of subject matter knowledge displayed by Kapinda and Lena supported this. I therefore suggest that *this aspect of literature is also one that needs to be foregrounded in*

*developing and improving pre-service teachers' mathematics profiles, with particular reference to their conceptions and beliefs.*

Finally an aspect that did not appear to affect the differences in the amount of change taking place in participants' instructional behaviour was the pedagogical content knowledge component of the mathematics profile. Marge was the only participant to have her final pedagogical content knowledge component defined by the "most complete" category. After that Toni, Lena, Kapinda and Anabella all had pedagogical content knowledge components in the third (almost complete) category. However, their final instructional behaviours differed substantially. Anabella, Sophie and Peta, on the other hand, ended the year in the same instructional behaviour sub-quadrant and yet Anabella's pedagogical content knowledge had gone from being "less complete" initially to "almost complete" at the end of the year while the other two ended up with "somewhat complete" categories of this component. This led me to conclude that *an improvement in pre-service teachers' pedagogical content knowledge possibly does not have the extent of influence on changing their instructional behaviour I had expected*. Much of our undergraduate courses in training FET mathematics teachers at the institution where I am employed, as well as the PGCE mathematics specialisation module, places emphasis on this component of the mathematics profile without perhaps considering the importance of the conceptions of mathematics and enacted beliefs components.

## **6.5 Conclusion**

This chapter has presented a third and final data reduction in the form of visual presentations of the participants' mathematics profiles and their instructional behaviour profiles. These are the two main constructs being explored in order to gain some insight into the influence of pre-service teachers' mathematics profiles on their instructional behaviour. In chapter 4 the first data reduction was a selection of reflections and entries from participants' final portfolios for their PGCE year which they use to show their professional development. In chapter 5 the second data reduction was a reflection of each participant written by myself as one of the PGCE lecturers and as the researcher. This commented on each participant in terms of their mathematics and instructional behaviour profiles according to my experiences and assessments of them and in response to their own reflections. The data reduction in this

chapter has drawn on those first two data reduction processes and summarised the mathematics profile and instructional behaviour profile of each participant. This was first done verbally (guided by data analysis tables for each of the mathematics profile components and instructional behaviour continuums) and then presented visually for the purposes of making the cross-case comparison simpler and more effective. Three of the four main aspects that emerged out of the cross-case comparison foregrounded the importance of the influence of subject matter knowledge, quality and insight of reflections and accessing and processing literature in the mathematics and mathematics education domain. The fourth aspect highlighted that the impact of the pedagogical content knowledge component of the mathematics profile on pre-service teachers' instructional behaviour was less than expected. These four main aspects are further discussed in the concluding reflections chapter 7 with reference to the conceptual framework.