# 3 METHODOLOGY

At the end of the previous chapter, I identified the need for a study that combined two interwoven strands: firstly, the design and enactment of an innovative pedagogy that promotes shared epistemic agency in a school context; and secondly, data collection and analytical methods that would enable me to answer my research questions about what indicates and sustains shared epistemic agency. My reading of methodology literature led me to combine these two strands under the auspices of action research, allowing me to engage in "a form of disciplined, rigorous enquiry, in which a personal attempt is made to understand, improve and reform practice" (Ebbutt in Cohen et al., 2018, p. 345). The first section of this chapter sets out my initial vision for what my pedagogy should achieve, informed by the literature introduced in chapter 2. The second section reviews how action research is justified as a research method both in general and for this specific project, and then introduces my plan for my own cycles of action research. The third section outlines the research design that combines the pedagogy stages that correspond to the teaching cycles and the research cycles that outline how data is collected. The fourth section discusses how enacting the pedagogy as part of the action-research methodology allowed me to continuously adapt the pedagogy, its enactment, and the design of the project to meet the aims of the study.

## 3.1 The Pedagogy

This research project investigates the emergence of shared epistemic agency amongst the students in a mathematics classroom organised around an innovative knowledge-building pedagogy. The innovative pedagogy is based around five principles that I have synthesised from the literature and summarised in chapter 2, as well as being informed by practices that I personally trialled in the classroom. As these principles stipulate a handing over of responsibility to the students, I will henceforth refer to students as "participants", being faithful to the commitments of my innovative pedagogy (my role as a participant will be discussed later in chapter 6). This is to emphasis not only their responsibility but also their agency in advancing the collective mathematics knowledge of members of the classroom. The participants are responsible for:

1. Building objects of mathematical knowledge (cf. Bereiter, 2002; Damşa et al., 2010; Emirbayer & Mische, 1998; Reed, 2001; Scardamalia, 2002).

    My plan is to have pairs of participants take responsibility for teaching the other members of the class a mathematics topic (these pairs are therefore named "teacher participants"). They are responsible for planning and leading the discussion and learning of a mathematics topic. They make use of relevant information which is not supplied by myself, but discovered independently from other sources such as mathematics websites (MathsWatch, Corbettmaths, Maths Genie), the broader internet, or other individuals. The knowledge objects by which they will reify their mathematics knowledge is the PowerPoint lesson plan they are asked to

produce for the lesson, and the answers to the mathematics questions the participants solve during the lesson.

2. The process that makes this knowledge explicit so that it can be shared, internalised and used by all the classroom participants (cf. Bandura, 2001; Damşa et al., 2010; Nonaka, 1991).

   My idea is that, as the teacher participants prepare their lesson plan to teach the rest of the class (the student participants), they consider and decide on how best to make the mathematics topic explicit so that the student participants will be able to make sense of it. This could involve deciding on how their exposition of the mathematics concept is structured and how the contents of the PowerPoint lesson plan support this exposition.

3. The discursive process that communicates the knowledge to the classroom community (cf. Emirbayer & Mische, 1998; Nonaka, 1991; Scardamalia & Bereiter, 2014).

   I intend for the participants of the classroom to engage in discussions to improve their knowledge of the mathematics topic being taught. Through this discussion, tacit knowledge is explicated, and participants ask questions and receive answers that help to clarity their knowledge. My idea is that as I am not the “mathematics authority”, the participants must find their own ways to advance their collective knowledge, including sharing what they know and building on each other’s knowledge.

4. Maintaining the social relations and communicative processes that are conducive to the advancement of mathematical knowledge (cf. Bandura,

2001; Damşa, 2014; Damşa et al., 2010; Wenger, 1998):

> I hope that as the participants take turns to collaborate with each other as teacher participants, and as they interact with other participants in the classroom, they will develop relationships in which they appreciate and value each other's contributions to the advancement of their mathematics knowledge. This appreciation and valuing of each other arises from their interdependence and from the empathy that comes from each participant, having experienced being both a teacher participant and a student participant at different times.

5. Reflecting on practice and making plans for the improvement of ideas and practices (cf. Bandura, 2001; Bereiter & Scardamalia, 1998, 2011; Emirbayer & Mische, 1998; Yang, Chen, et al., 2020).

> I built reflection time into the pedagogy. All participants, including myself, have time to reflect on our individual actions and those of other participants, considering how these actions impact the advancement of collective mathematics knowledge. The purpose of this process is for the participants to contemplate strategies for acting in future in order to improve the process of advancing their mathematics knowledge.

### 3.1.1 The Stages of the Innovative Pedagogy

The innovative pedagogy that I outline here is the initial design with which this project began. My proposals take place in cycles of four stages; the structure of these cycles is shown in Figure 3.1 below.

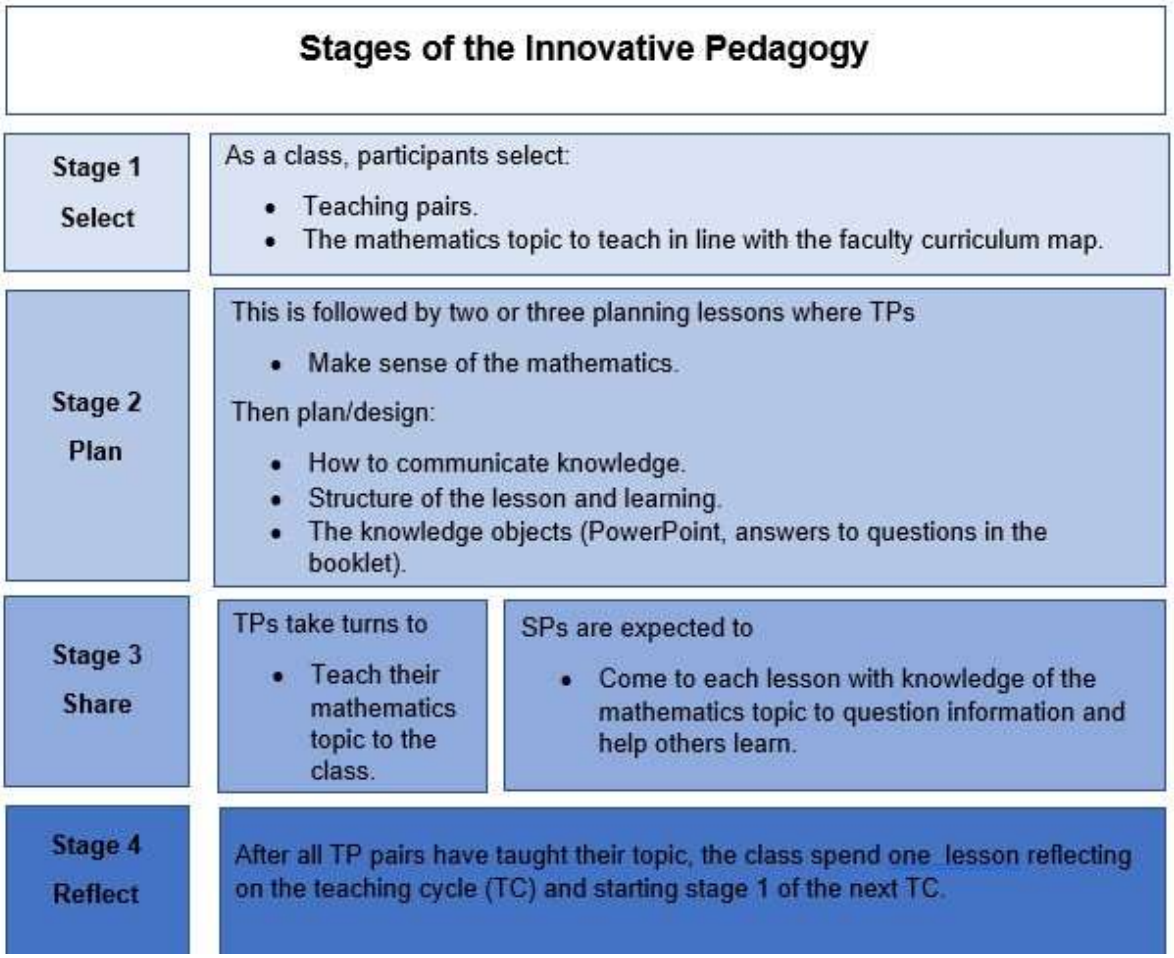



Figure 3.1 – Stages of the innovative pedagogy

The four stages of the pedagogy are: Select, Plan, Share, and Reflect; these, in turn, have been developed with the guidance of the five pedagogic principles extracted from the outstanding literature. These four stages form a teaching cycle, and allow the participants to learn mathematics at each stage individually, in pairs, and as a community. In the first stage of each teaching cycle, the participants select their partners and the mathematics topics that they will later share with the classroom

community. The pedagogy allows the students to examine their own and other participants' current mathematics knowledge and learning behaviours when selecting and deciding whom they will work with as teacher participants. The participants select other teaching partners in the first stage of subsequent teaching cycles; in this way, they work with different individuals from the class, and mutual community relations are further developed (pedagogic principle 5).

In the Plan stage, the pedagogy incorporates pedagogic principles 1 and 2. The teacher participants collaboratively produce a knowledge object in the form of a PowerPoint lesson plan that structures how they will make the mathematics topic explicit to the student participants during the lesson. They will also produce solutions to the mathematics questions that the student participants will solve during the lesson. This lesson plan and answers reifies, therefore externalises (Nonaka, 1991) the teacher participant's mathematics. Students have been observed to learn more effectively when they prepare to teach others (Bargh & Schul, 1980); such preparation awakens a need for explication and clarification that requires selfexplanation (Chi et al., 1994). My expectation is that, just as SEA develops through the collaborative production of a knowledge object (Damşa et al., 2010; Damşa, 2014), the teacher participants' engagement in the Plan stage will lead to the development of SEA. The key attribute of mutual relations emerges at this stage, as planning takes place across and between partners.

In the Share stage, the pedagogy incorporates learning through interaction to produce new knowledge. The teacher participants who selected and planed their mathematics topic share their knowledge, through actions and reifications, with the

student participants (pedagogic principle 3). The student participants are expected to come to the lesson with knowledge to share of the mathematics topic. In the ensuing communicative process, as the participants interact to advance their mathematics knowledge and that of other participants (pedagogic principle 3), the characteristics of shared epistemic agency are expected to emerge. In the Reflect stage, the participants will meet with me individually or in pairs in an interview setting to discuss the lesson in which they acted as teacher participants. The process will require them to reflect on their lesson and the lessons of other participants to decide on improvements they could make to their next lesson. Reflection also takes place as a whole class activity, where the participants publicly share what they feel will lead to future improvement. While time is put aside for reflection so that practices can be continuously improved, I expect that, as the pedagogy design calls for the participants to repeatedly participate as teacher participants and student participants, the very nature of their learning will become reflective, causing them to implicitly and continuously improve what they do. This Reflect stage, nevertheless, explicitly strengthens the mutual community relations that enables the give and take of feedback.

Table 3.1 below incorporates the stages of the innovative pedagogy, the pedagogic principles that set it up, and the characteristics (see section 4.3) that I will use to analyse the emergence of shared epistemic agency.

| **Stage** | **Learning through …** | **Pedagogic principles**<br><br>**(the justification for the stages)** | **Expected characteristics of shared epistemic agency –**<br><br>**(what I will look for)** |
|---|---|---|---|
| Select | Mutual community relations | Principle 5. Student responsibility for maintaining the social relations and communicative processes that are conducive to the advancement of mathematical knowledge (cf. Bereiter, 2002; Damşa et al., 2010; Emirbayer & Mische, 1998; Reed, 2001; Scardamalia, 2002) | • Mutual relations, including a participant aligning their thoughts and actions with those of others |
| Plan | Collaboration between pairs | Principle 3. Student responsibility for building knowledge objects (cf. Bereiter, 2002; Damşa et al., 2010; Reed, 2001; Scardamalia, 2002)<br><br>Principle 2. Student responsibility for the process that makes knowledge explicit so that it can be shared, | • Intentions to develop one's knowledge and to share it with others<br>• Extension – seeking to know from external source<br>• Explication – making knowledge explicit to each other<br>• Expertise – taking on the role of teacher<br>• New knowledge – the knowledge to share with others reified as a PowerPoint lesson plan |

| | | | |
|---|---|---|---|
| | | internalised, and used by all the classroom participants (cf. Bandura, 2001; Damşa et al., 2010; Nonaka, 1991)<br><u>Principle 5.</u> Student responsibility for maintaining the social relations and communicative processes that are conducive to the advancement of mathematical knowledge (cf. Bandura, 2001; Damşa, 2014; Damşa et al., 2010; Wenger, 1998) | • Mutual relations – working collaboratively |
| Share | Interaction with the community | <u>Principle 3.</u> Student responsibility for the discursive process that communicates the knowledge to the classroom community (cf. Emirbayer & Mische, 1998; Nonaka, 1991; Scardamalia & Bereiter, 2014)<br><u>Principle 5.</u> Student responsibility for maintaining the social relations and communicative processes that are conducive to the advancement of mathematical knowledge (cf. | • Intentions to resolve an unknowing<br>• Extension – seeking to extend one's knowledge<br>• Explication – making knowledge explicit to others<br>• Expertise – process authority<br>• New knowledge – resolution of the unknowing<br>• Mutual community relations – developing relations that enable knowledge advancement |

| | | | |
|---|---|---|---|
| | | Bandura, 2001; Damşa, 2014; Damşa et al., 2010; Wenger, 1998) | |
| Reflect | Reflection | Principle 4. Student responsibility for reflecting on practice and making plan1.1s for improvement of ideas and practices (cf. Bereiter & Scardamalia, 1998, 2011; Brown & Campione, 1996; Emirbayer & Mische, 1998; Yang, Chen, et al., 2020) | • Mutual community relations |

Table 3.1 – The innovative Pedagogy – Learning, principles and characteristics of shared epistemic agency.

## 3.2 Rationale for Action-Research Approach

Action research fits the purpose of this study as I am seeking to systematically investigate and legitimise what I believe, from my experience as a teacher, would improve students' mathematics learning. As a rigorous practice-based methodology, it allows me, as the teacher-researcher, to study what happens in my classroom from within and continuously make modifications and evaluations as the research progresses. The findings of this project will be my subjective interpretations of the experiences and communications of my Year 10 mathematics classroom participants; the knowledge to be gained from this research is socially constituted, and emerges as a result of our actions and participation in the research.

### 3.2.1 History of Action Research

The tradition of action research can be traced back to Kurt Lewin's writings on social psychology (1946), which he based on his field work with communities during which he conceived action as emerging from a process of group interactions and exploration, rather than as the sole result of rational deduction; or, as in Dewey's theory of learning, as a product of our experiences of practice, rather than as a surrender to already-formed ideas (1973).

Lawrence Stenhouse's seminal work, *An Introduction to Curriculum Research and Development* (1975), whose purview was educational policy in the UK, makes an exceptional case for the usefulness of action research

as a methodology for studying and improving the practice of teaching. In contrast, research informed by theories such as those of Lewin and Dewey contribute to the relevance of historical research methods as opposed to traditional scientific research (Stenhouse, 1981). The interests of scientific research lie in developing general and predictive laws and theories based on observed data (induction). These theories provide information about the context of our actions and allow us to apply them to predict the outcome of specific actions (Stenhouse, 1981, p. 105). Scientific researchers tend more towards a positivist perspective: they believe that knowledge ascertained from experience is certain and true (Somekh, 2006), and assume that there is an answer to everything, even if it is still "out there" waiting to be discovered. Once discovered, all possible answers will be commensurable, compatible, and agreeable to every one (Berlin, 1997).

Historical research, a category to which action research belongs, is concerned with the analysis of our experiences in terms of their context in time and space
(Stenhouse, 1981). In contrast to positivist research, action researchers tend to take an interpretive epistemological position, assuming that knowledge is ambiguous and uncertain, and that there is no single answer to a given question; rather, multiple answers can be arrived at that could generate further questions (Berlin, 1997). They assume that knowledge can be created through dialogue with one another as well as through discovery. Answers can be provisional, tentative, and open to critique and

modification. They can be incommensurable and unsolvable (Berlin, 1997; Mouffe et al., 2013).

This historical view of knowledge as pluralistic and historically-mediated is the basis on which teachers as practitioners are called to become researchers, as, since it holds the view that knowledge is not fixed, it allows that everyone has the capacity to create knowledge and develop theories. The kind of theory produced from within practices by practitioners who engage in action research is different from that produced by academics. It is personal and flexible, and of practical use in the dayto-day practice of teaching – e.g., in the classroom – where problems are interdependent on each other, and situations are flexible, consisting of changing and interacting factors. In contrast, theories developed by non-practice-embedded "experts" are abstract, and practices and concepts are spoken about from an outsider perspective (McNiff, 2013) – nevertheless, they continue to be techniques and models that need to be verified in the uncertain and complex environment of the classroom. Considering these two views of the production of theory, it is rational to expect that teachers should be encouraged to develop theories that improve their practice. However, this is not traditionally the case; critics of teachers who carry out action research in their setting have argued that research should be left to academics (cf. Hattie, 2016), and that tacit knowledge on the part of teachers can reduce their motivation to publish their findings or produce theories (Taber, 2013). Teachers are viewed as "doers" of educational theory, and their competence is considered to lie in the ability to improve the practice of teaching, while academics are viewed as thinkers who

debate knowledge and explain how learning occurs. Stenhouse (2012) argued against this divide between academics and practitioners that legitimises the knowledge of academics and not that of teachers, advocating for action research as a basis for teaching(p.1). This is evident in his notion of the teacher as an "extended professional" (1975, p. 143), or as a reflective practitioner (Schon, 2008) who is not expected to take the conclusions of academics on faith, but who rather tests ideas against their real classrooms – the “laboratories” in which they command their own knowledge, and in which they are able to develop their own theories. This is what action research means: it is where the act of research cannot be separated from the research goals or from the justifications of the profession; where the knowledge gained is tested and modified by professional practice. The teacher, in turn, is expected to approach their practice from a research stance, viewing it as exploratory and provisional (Stenhouse, 2012, p. 133).

Other contributions to action research theory include Habermas’ critical theory of communicative action (1991), on which the moral purpose and goal of human action is to understand each other. Communicative action adds to the pluralistic view of knowledge, as it seeks to create an ideal situation in which individuals have equal rights to speak and communicate their feelings, wishes, and views. This was the basis of the emancipatory action research of Carr and Kemmis (Carr, 1986). On their view, communicative action is the type of action people undertake when they “make a conscious and deliberate effort to reach (a) *intersubjective agreement* about the ideas and language they use amongst participants as

a basis for (b) *mutual understanding* of one another's points of view in order to reach (c) *unforced consensus* about what to do in their particular situation" (Kemmis et al., 2014, p. 36).

In line with Stenhouse's view of the teacher as an extended professional, here professional practice is understood as an endeavour undertaken by those who make independent and autonomous decisions, free form nonprofessional or external constraints, to commit to the wellbeing of their clients based on theoretical knowledge and research.

John Elliott's (2011) description of professional practice drew on Hans Gadamer's philosophy that viewed action as emergent from continuous self-reflection, and experience itself as consequently being "skepticism in action" (Gadamer in Somekh, 2006). Elliott conceptualised professional practice, including teaching practice, as a "practical science" (2011, p. 66), in which professionals, in order to be responsive to change and uncertainty in practical situations, exercise practical wisdom to give an appropriate response. These practical situations are typically complex, difficult to predict due to their fluidity, value-laden, and difficult to stereotype. These intelligent professionals exercise their "situational understanding" (p. 66) that is based on repertoires of experience; they do not simply apply or recall sets of abstract or theoretical propositions in these situations (Elliott, 2011, pp. 66–67). In Elliott's view, self-evaluation and personal systematic reflection is part of the action research process. Professionals collect and interpret data, and base their actions on a situational understanding that integrates their moral commitments with practical aims.

### 3.2.2 What is Action Research?

Action research can be broadly defined as systematic inquiry made public (Stenhouse, 1981, p. 104), carried out by professionals to improve their practice.

The “action” part of the term refers to "action disciplined by inquiry, a personal attempt at understanding while engaged in a process of improvement and reform" (Hopkins, 2014, p. 58). It includes communicative action (Habermas, 1991), practical wisdom, and situational understanding (Elliott, 2011). Stenhouse (2012) posits that the inquiry should be rooted in professional curiosity, acutely felt and systematic in that it is structured over time, continuously integrating both the experience and intellect of the practitioner in practice and the relevant thinking of others. It becomes research when it is published, inviting critical dialogue. The publication offers explanations and descriptions of what the professional has done, which in this context constitutes the “theory” (McNiff, 2013, p. 17). It is the publication of the theory that makes the research become a claim to knowledge.

Action research as a methodology is concerned with changing individuals and the culture of groups, institutions, and societies to which they belong (Kemmis, McTaggart cited in Cohen et al., 2018, p. 345). This view of action research aligns with the aims of this study: to concretely improve students' participation in their mathematics learning to improve their relationship with mathematics.

Action research is “a continuous process of problem posing, data gathering, analysis and action” (Wright, 2020, p. 329). It involves a spiral of self-contained cycles
(Kemmis et al., 2014; Koshy, 2010; Lewin, 1946; McNiff, 2013). The authors of the British Educational Research Association (BERA) Close-to-Practice research project specified at least two action research cycles (Wyse, 2018 in Wright, 2020). In the first stage of a typical action research cycle, the researcher plans what they will do based on their existing knowledge. In the second part, the acting part, the researcher implements the plans they developed in the first part. The third part consists of observing the outcome of the actions, and in the fourth part, the researcher reflects on what they will do next based on their analysis of the data they have collected in this cycle, and on the new knowledge gained. This reflection part also forms the next planning stage. It is a responsive and systematic procedure meant to deal with concrete problems located in complex situations. The process is monitored constantly by a variety of mechanisms over varying periods. As the teacher-researcher, I can make adjustments, modifications, or even changes in direction where necessary, based on feedback, to benefit the ongoing process.

It is important to pay heed to the fact that researchers in the positivist tradition consider action research to be lacking validity, rigour, and transferability (Koshy, 2010; McNiff, 2013; Somekh, 2006; Taber, 2013). In the pursuit of rigour, action researchers should take care not to reduce the methodological principles of action research into a collection of static methods and procedures (Wright, 2020). In keeping with this, regarding

validity and rigour, I will give detailed descriptions of the robustness of my data collection methods and my systematic analytical procedures at all stages of the action research process. This study will be published and open to criticism by the public.

In action research, the notion of “transferability” can be used in place of the term “generalisability” (Lincoln & Guba, 2003). The prevailing contention is that action research should not seek generalisable data, unlike most forms of social scientific research (Koshy, 2010; McNiff, 2013); rather, it is based on the belief that there are no definite answers to problems, nor theories that can be applied in all possible situations, but only personal theories that are open to modification by others in similar contexts. Being open to modification by others reflects the belief that learning continues, and is an invitation for others in mathematics education and education at large to contribute to their own experiences and knowledge. The outcome of this study should, therefore, not be judged on the basis of positivist criteria; rather, it should be judged in terms of its coherence: in particular, of my adherence to and successful propagation of my values regarding democratic participation in the mathematics classroom. Moreover, it should be remembered that the process of inquiry is as important as the outcome (Reason & Bradbury, 2008). In the context of my study, this process raises ethical issues, given the conflict between my role as a teacher to educate the participants and the research requirements. I will fully discuss the ethics of my research in section 3.3.4.

## 3.3 The Research Design

The research design aligns with the innovative pedagogy that dictates how mathematics learning will occur in the classroom. As previously mentioned, I structured the innovative pedagogy in four stages that make up a teaching cycle (see section 3.1). I collected data in two action research cycles (see section 3.2) that correspond to four and three teaching cycles, respectively.

### 3.3.1 The Teaching Cycles

The participants took part in seven teaching cycles during the research project. The five pedagogic principles underpinned the four stages of each teaching cycle (see table 3.1 and figure 3.1).

#### 3.3.1.1 Teaching Cycle Stage 1

The Select stage is the first stage of each teaching cycle, wherein the paired participants chose the topics they want to teach from the curriculum map designed by the mathematics faculty. The mathematics faculty aims for all mathematics classes to keep pace with each other as far as possible. Hence, after each teaching cycle, the next set of topics of choice for participants continues a sequence prepared in the faculty curriculum map. The participants were assigned to pairs in the first teaching cycle. In subsequent teaching cycles, participants chose their own pairs, and I later placed restrictions on this selection process (see section 4.1.2 for an explanation of changes made to the pedagogic and/or research design

during the course of this study). However, participants always had some choice in the selection, and, as expected, participants did work with whoever became their partner. Following the selection process, each pair selected a topic to teach. An adjudicator was selected at random to aid the topic selection process; should a dispute arise as to which pair was assigned to a given topic, the adjudicator decided on the final arrangement.

#### 3.3.1.2 Teaching Cycle Stage 2

In stage 2, the Plan stage, the participants spent two or three lessons planning for the mathematics lesson they were to teach. On occasion, there was collaboration across pairs as required by the teaching sequence. For instance, in teaching cycle 2, similar 2D shapes were discussed by one pair and the next, who taught the extension of these shapes into similar areas and similar volumes. Providing an opportunity for the two pairs to collaborate allowed the second pair to build on the knowledge shared by the first pair; in this way, collaboration occurred both within and between pairs. This enacted pedagogic principle 4, that of mutual relations, as the participants had to develop ways of successfully sustaining the collaboration over time.

#### 3.3.1.3 Teaching Cycle Stage 3

Stage 3, the Share stage, is where the teacher participants shared their mathematics knowledge with the student participants. Each pair of teacher participants communicated knowledge of the mathematics concept to the

class explicitly while maintaining mutual relations. They negotiated with the rest of the class the number of lessons required to teach the topic; some topics lasted for one lesson, while others lasted for four. The emphasis is on sharing because, in line with the innovative pedagogy, I expected student participants to come to the lesson with some knowledge of the mathematics topic, and advance the knowledge of the classroom participants by sharing their knowledge through engagement in knowledge building (see section 4.1.2). Within this third stage of the teaching cycle, I shared my authority with that of the participants (see section 2.3.2.1), taking on the role assigned to me by the teacher participants. The assigned roles ranged from being a teaching assistant to being a student participant.

#### 3.3.1.4 Teaching Cycle Stage 4

The fourth stage of the teaching cycle, the Reflect stage, occurred after all teaching pairs had taught their mathematics topic to the class. At the start of the corresponding lesson, the participants and I spent time reflecting on the completed teaching cycle. We collectively and informally discussed what we did well and what we could do better. The discussion was typically chaired by myself. I posed problems that arose from my reflections on the previous teaching cycle, and invited participants to offer suggestions on these problems. Participants on occasion brought forward problems and proposals of their own for improvement. Regardless of the source of the problem, together we arrived at an ideal course of action. In this way,

our reflection informed the planning for the next stage of the teaching cycle.

I study this innovative pedagogy in the naturalistic setting of a mathematics classroom in a secondary school. The setting is essential, because the pedagogy needs to be enacted in a milieu of well-understood schools in order to isolate the influence of my experimental variables, answer the research questions, and meet the broader aims of the study.

### 3.3.2 The Research Cycle

The study took place over two action research cycles. Each cycle has five stages (see Figure 3.2) and comprises one or more teaching cycles. Stages 1-4 of the research cycle coincide with the corresponding stages of the teaching cycles, and are repeated as necessary before stage 5. The following sub-sections outline the research cycles and the respective data collection methods.

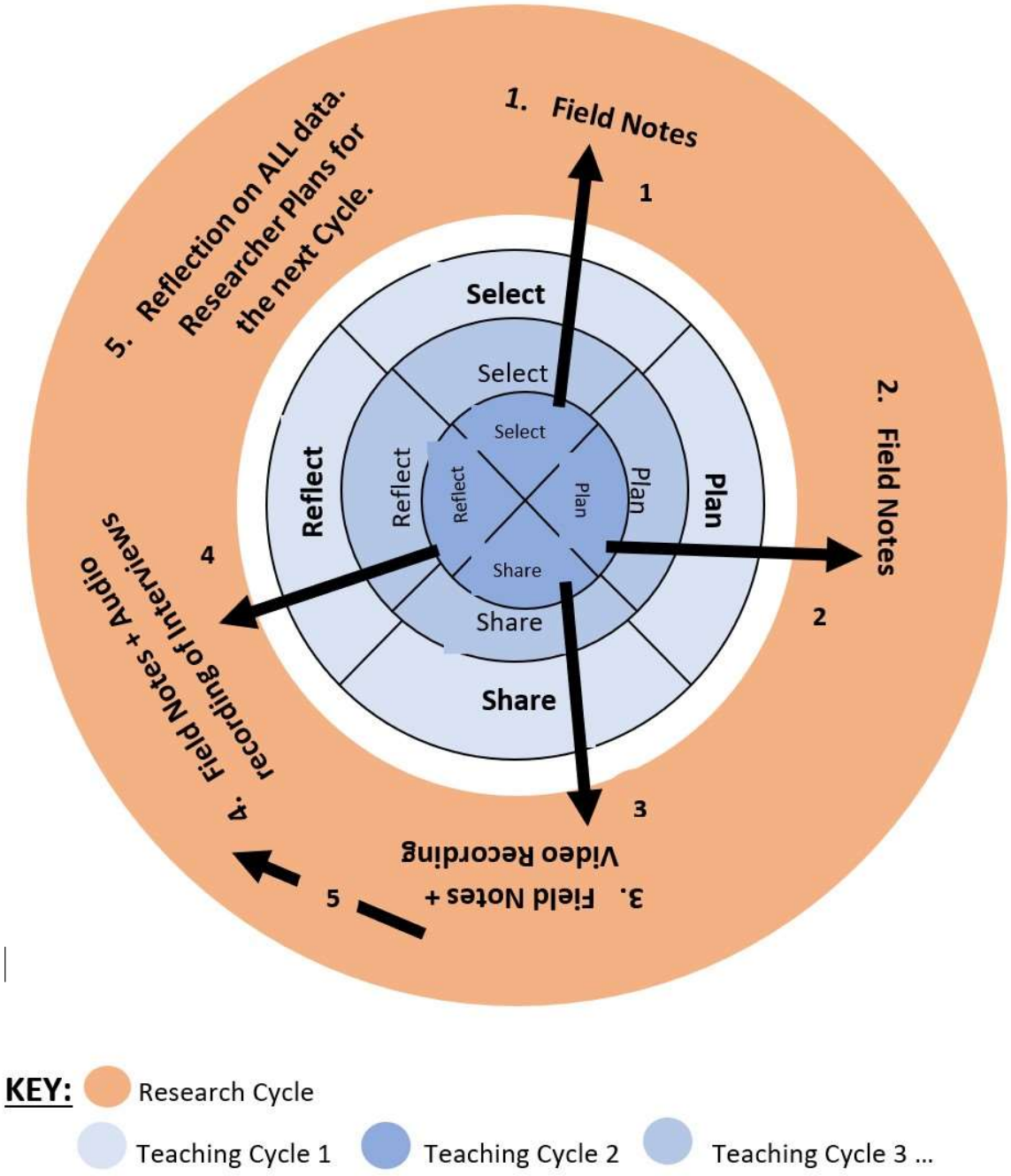



Figure 3.2 – Teaching cycles and research cycle interplay

### 3.3.2.1 Research Cycle Stage 1

This research stage coincides with the Select stage of the teaching cycle, wherein participants select their mathematics topic and their teaching pairs.

The research focuses on recording how topics were shared, how pairs were formed and unformed, and the mutual relations exhibited by the participants. I kept field notes during this stage of each teaching cycle (Figure 3.2, Arrow 1) as part of my ongoing observation and reflection.

#### 3.3.2.2 Research Cycle Stage 2

This research stage coincides with the Plan stage of the teaching cycle, wherein participants make sense of the mathematics knowledge and plan how to communicate it to other participants. The focus was on participants' Expertise, that is, the characteristic of shared epistemic agency that focuses on the process authority of the teacher participants as they plan the knowledge and reifications that will communicate their mathematics topic. Field notes recorded my observations, including descriptions of how the participants worked in pairs, what they did, how they extended their knowledge, and the reifications produced. I also noted what I did as the teacher to support the enactment of the innovative pedagogy (Figure 3.2, Arrow 2). My observations at this stage informed later interview questions (Figure 3.2, Arrow 5) and opened opportunities for me to document how participants experienced the pedagogy.

#### 3.3.2.3 Research Cycle Stage 3

This research stage coincides with the Share stage of the teaching cycle, wherein teacher participants and student participants interact to advance their individual and collective mathematics knowledge. The focus was on

illuminating the emergence of shared epistemic agency (in terms of characteristics A-F) in the classroom, and supporting the subsequent Reflect stage of the action research cycles. Observations were the primary means of data collection in this stage of the research cycle. I made video recordings of some of the lessons and kept field notes (Figure 3.2, Arrow 3) to provide valuable data on how the innovative pedagogy is enacted in real time to answer the research questions.

#### 3.3.2.4 Research Cycle Stage 4

This research stage coincides with the Reflect stage of the teaching cycle, wherein participants reflect on the lesson they taught and their actions leading up to the lesson (Figure 3.2, Arrow 4). The focus was on participants' thoughts, perceptions, and ideas for future cycles (pedagogic principle 5); this is tightly linked to the reflection stage of the action research. Field notes record my observations of this stage for most teaching cycles. Semi-structured interviews took place for teaching cycle 3 and teaching cycle 5 that were part of research cycles 1 and 2 respectively. The interviews were “anchored-interviews” (Merriam & Tisdell, 2015, p. 139), as I based the questions on what I wanted to clarify, having reviewed the field notes and listened to video recordings of the 'share' stage (Figure 3.2, Arrow 5). Following the interviews, I transcribed the audio recordings.

#### 3.3.2.5 Research Cycle Stage 5

This research stage does not coincide with the stages of the teaching cycle, but occurred at the end of each action research cycle. The focus was on my planning for the next research stage, which could be the next action research cycle or the analysis of the research data. This stage made use of all recorded data, and included my reflections on data collection methods and adapting either the pedagogy (see section 3.4.1.3) or the research design (see section 3.4.1.4). These adaptations did not always fall neatly at the end of an action research cycle; some adaptation occurred following reflection at the end of teaching cycles. However, they always informed the design of the following teaching cycle or research cycle. Reflection on all the data collected from all stages of the teaching cycle involved my watching the recordings, reading my field notes, noting what may need improvement, and taking the necessary action. It informed the plan that I subsequently fed back to the participants in the first stage of the subsequent action research cycle. Although the feedback originated from me, the researcher, participants negotiated its enactment.

### 3.3.3 Schedule of Action Research Cycles

The research project commenced on the first week of the academic year 2018-2019. In the first lesson, I explained the research to the participants and gave out consent forms to be signed by parents (see section 3.4.1.1). The first action research cycle started in week 1 of the academic year and

ended in week 26. The second action research cycle started in week 27 of the academic year and ended in week 41 (see Table 3.2).

| Weeks Beginning's of Academic year | Teaching Cycle (TC) | Stages of TC | | | | Research Cycle | | Action Research Cycle |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | Data Collection | Stage 5 | |
| 1 – 03/09/2018 | 1 | √ | √ | | | | | 1 |
| 2 – 10/09/2018 | | | | √ | | | | |
| 3 – 17/09/2018 | | | | √ | | | | |
| 4 – 24/09/2018 | 2 | √ | √ | | √ | Field notes (FN) | | |
| 5 – 01/10/2018 | | | | √ | | FN | | |
| 6 – 08/10/2018 | | | | √ | | FN | | |
| 7 – 15/10/2018 | | | | √ | √ | FN | √ | |
| Half Term | | | | | | | | |
| 9 – 29/10/2018 | 3 | √ | √ | | | FN | | |
| 10 – 05/11/2018 | | | | √ | | FN + video recording (VR) | | |
| 11 – 12/11/2018 | | | | √ | | FN + VR | | |
| 12 – 19/11/2018 | | | | √ | | FN + VR | | |
| 13 – 26/11/2018 | | | | √ | | FN + VR | | |
| 14 – 03/11/2018 | | | | √ | | FN + VR | | |
| 15 – 10/12/2018 | | Exams week | | | | | √ | |
| 16 – 17/12/2018 | 4 | √ | √ | | √ | FN | √ | |
| Christmas Break | | | | | | | | |
| 19 – 07/01/2019 | | | √ | √ | | FN + interview (I) | √ | |
| 20 – 14/01/2019 | | | | √ | | FN + I | √ | |
| 21 – 21/01/2019 | | | | √ | | FN | √ | |
| 22 – 28/01/2019 | | | | √ | | FN | √ | |
| 23 – 04/02/2019 | | | | √ | | FN | √ | |
| 24 – 11/02/2019 | | | | √ | | FN | √ | |
| Half term | | | | | | | √ | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 – 25/02/2019 | | | | √ | | FN | √ | |
| 27 – 04/03/2019 | 5 | √ | √ | | √ | FN | | 2 |
| 28 – 11/03/2019 | | | | √ | | FN + VR | | |
| 29 – 18/03/2019 | | | | √ | | FN + VR | | |
| 30 – 25/03/2019 | | | | √ | | FN + VR | | |
| 31 – 01/04/2019 | | | | √ | | FN + VR | | |
| Holiday | | | | | | FN + VR | √ | |
| 34 – 22/04/2019 | | | | √ | | FN + VR | √ | |
| 35 – 29/04/2019 | | √ | √ | √ | √ | FN + VR + I | √ | |
| 36 – 06/05/2019 | 6 | | | √ | | FN + I | √ | |
| 37 – 13/05/2019 | 7 | | | √ | | FN + VR | | |
| 38 – 20/05/2019 | | | | √ | | FN + VR | | |
| Half Term | | | | | | | | |
| 40 – 03/06/2019 | | | | √ | | FN + VR | √ | |
| 41 – 10/06/2019 | | | | √ | √ | FN + VR | √ | |
| 46 – 15/07/2019 | | | | | | | | |

Table 3.2 – Research design schedule of action research cycles

Answering my research questions required that I study the complex interactions of the participants in my classroom as they repeatedly enacted the pedagogy. The repetition of each stage of the teaching cycle allowed the participants (student and teacher participants), both individually and collectively, to renegotiate how to enact the pedagogy to meet the purpose of advancing their mathematics knowledge. This process of negotiation and renegotiation was carried out from lesson to lesson. As they enacted the pedagogy as both student participants and teacher participants, participants were able to experience the pedagogy from a unique variety of

perspectives, and to involve this experience in negotiating the future of the practice.

As a teacher-researcher, I studied the emerging practice, and, from our reflections at the end of each teaching cycle (see section 3.3.1.4) and my reflection at the end of each research cycle (see section 3.3.2.5), the participants and I took the opportunity to adapt the pedagogy and enact the improvements, then reflect upon them once more.

Research design should suit the purposes of the research. Other research into SEA, such as Damşa et al. (2010), with whom the concept first originated, employed indepth case studies to study the emergence of SEA. This design was suitable in its own research context, as it focused on studying a group of no more than four undergraduates' actions as they worked on an individual project over a 10-week period, throughout which the group met every other week. In contrast, answering my research questions involved studying the lesson-by-lesson interactions in the context of a secondary school classroom of eighteen participants and their teacher over 41 weeks, with four lessons per week. My action research design and methodology, therefore, are better suited to this research study into shared epistemic agency.

### 3.3.4 Ethics

Researching in my classroom, I was conscious of my role as a teacher whose purpose is to teach my students mathematics to the best of my

ability. Improving the mathematics knowledge of my students continued to be my priority.

My two roles as teacher and researcher shared the same purpose, values, and processes, but my engagement with educational research has transformed my beliefs about the best way to realise these factors. I undertook this research degree in order to formalise and organise my investigations into how my students can engage more with their classroom mathematics. Above all, I wanted my students to realise that the mathematics classroom was not necessarily structured by a pedagogy in which I, the teacher, was the sole source and fount of mathematics knowledge that they are to passively receive. They are to be involved, and, ideally, to take control of and make decisions about their education. Prior to starting my research degree, I changed the way mathematics learning took place in the classroom (see section 1.1.3.2); I felt that for the students to behave differently, the existing classroom pedagogy and my own role within it must change, so I sought ways for students to feel that the mathematics belonged to them. This change proceeded on the expectation that students learn for themselves and organise their learning sequence, using whatever learning tools they chose: the teacher, mathematics software, the internet, and fellow students. On occasion, the students led the whole classroom. As the teacher, I provided resources, explained misconceptions, and provided the mathematics curriculum map for the year, and was primarily the liaison between the students and the department. The outcomes for the students, in terms of the available measure of school assessments, was not significantly better or worse than

for other classrooms in the year group; however, this particular evaluation tool was not suitable to provide evidence that I could share with fellow professionals. At this point, I decided to take on a research degree to study what goes on in my classroom in a more systematic and theoretical way.

Furthermore, this would ultimately contribute to education and to knowledge. While carrying out this study, I continuously sought feedback regarding the participants' learning using the faculty assessment process. I hoped that engaging in the research as a teacher-researcher enhanced my capacities as a mathematics teacher. As I sought to improve mathematics learning in secondary school classrooms in both roles, there was no conflict of interest.

I sought and obtained committee approval for this study in which I view the participants as competent individuals whose opinions and views are valid. I personally asked the participants and their parents to give consent to take part in interviews and lesson observations. There is, however, a distinction between the classroom pedagogical practice that determines the experiences of the participant and the teacher-researcher's reflection on and collection of data through interviews and lesson observations. I did not seek consent for students to participate in the planning and delivery of lessons or the design of assessments, as this is how I, the teacher, involve my classes in mathematics learning. The way teachers design the classroom pedagogy is at their professional discretion. The planning and delivery of lessons by students occurs in schools, and is not subject to parental consent. In sending students to school, parents are giving

consent to the school (and therefore to the class teachers) to exercise good judgment in pedagogic design to the benefit of their children. I sought consent for interviewing and lesson observation as these are part of the research study and not part of day-to-day schooling.

Participants could opt out of video recording during lessons or the study analysis. Participants could also opt-out of their taught lesson being recorded or analysed as part of this research. However, participants who have opted out of the study may inadvertently be caught in video or audio recordings; data solely about them will not be analysed, nor will extracts containing their image or voice be shown to others.

However, they may be present in the reflections and views of their partners, as well as in the views of other participants in the class. Such reported data will be carefully anonymised.

The school has channels for students to request to move to another class, regardless of this research. One student opted to move to another classroom, and I received another student as a replacement. This new student did not complete the consent form, and was one of three students who did not take part in the study as they did not complete the consent form. Two of these students joined the class when the study was underway, while the third student opted out from the start of the study. As a result, I neither recorded their lessons nor interviewed them, and anonymised dialogue that pertained to them or made references to them. I refer to these students indiscriminately as Student A, or B.

A potential selection bias could arise from the students being allowed to opt out of the class. The students were allocated to my class based on the

alphabetic order of their surname. The 90 students in the ability bracket were placed in alphabetic order and assigned to teachers (see section 3.4.1.1). I had no input into the allocation of students to my class.

I maintained confidentiality throughout the research. As part of my duty of care as a teacher, I prepared for the unlikely event of a participant disclosing information that makes me feel they are in danger. Should this have occurred, I would have followed the school's safeguarding policy.

Given the power differences between the participants and myself, ethical issues could have arisen during the interviews. The participants may have not wanted to upset me by making negative comments about the class, or may have said what they thought I wanted to hear. Asymmetrical power relations always exist between teachers and students, and this would be the case even if another teacher interviewed the students. In any event, the interviews did not occur until the end of the first action research cycle; by then, the participants had experienced sharing authority, and seemed to speak freely.

The structure of the pedagogy had the potential to facilitate and perhaps even intensify social hierarchies that may have existed among the students. The fact that the class had not existed prior to the start of the research mitigates against this. Working in pairs could mean that student may have to work with someone they did not want to; in addition, quiet students might have felt more vulnerable than ever when they had to present to the class; or confident speakers might have had even more opportunity, in a democratic classroom, to assert their predominance. Dividing the students into groups based on their personalities might have

been unpleasant for some students, as certain pairings could have added to the anxiety of certain students. However, there was always an element of choice in the selection on pairings; in addition, the mutual relations that developed amongst the students meant that students were able to negotiate how they operated as teacher participants. They generally worked to their strengths. For instance, in some pairings one student focused on presenting while another focused on the PowerPoint and one-on-one interactions with the student participants. A further issue could be my reflexiveness as the researcher and the teacher. I have been explicit in subsequent chapters about how I analyse my data (see chapter 4) and how I reached my conclusions (see chapter 6) in order to reduce the impact of my values and beliefs in the research.

At the end of the study, I intend to provide the school with a verbal summary of the research findings. The summary will not refer to any individual students nor group of students. Furthermore, I ensured that all the data I collected was stored securely: I have stored video, audio recordings, and transcripts on an encrypted external hard drive with a backup copy on the cloud. I will store this data in the format in which I collected it for a further two years after my degree award; after two years, I will completely erase the recorded data, and will not archive it or use it for further research.

My position as a teacher and deputy headteacher could have had an impact on the participants' behaviour and my interpretation of outcomes. However, this study aims to turn control over to the students. As such part of the study involves how they deal with their behaviour in a classroom

environment. Significantly, the school's behaviour policy was available to be used by both the students and by myself. The interpretation of the research data is based on my subjective experience as a mathematics teacher for over two decades, as well as the knowledge gained from my critical engagement with the literature and with contemporary research.

## 3.4 Enacting the Research Design

The research involved studying a group of eighteen 13-to-14-year-old participants and one teacher – myself – in the mathematics classroom of one secondary school in London, UK. The participants in the mathematics classroom were in Year 10, and at the beginning of a two-year GCSE Mathematics curriculum. Data collection commenced at the beginning of the 2018/2019 academic year and lasted for the whole year. Having previously agreed with the school that Year 10 was the appropriate age group and curriculum for the research, the head of the mathematics faculty allocated participants to the classroom (see section 3.4.1.1). This allocation meant the start of a new relationship between the participants and me, as most of the participants were not in the same mathematics classes as each other during the previous academic year, nor had any of them been taught by me in previous years. I introduced the mathematics pedagogy (see section 3.4.1) to the participants at the start of the academic year, and I sought consent to participate in the research from parents and the school at the start of the academic year (see Appendix 2). I collected data from two action research cycles spread across the

academic year (see Table 3.2). The spread of each action research cycle was intended to time for shared epistemic agency to emerge to a significant extent. Practically speaking, it allowed me to analyse the data collected in each cycle in order to inform the next cycle.

### 3.4.1 Action Research Cycle 1

Action research cycle 1 comprised four teaching cycles, as shown in Figure 3.1. The mathematics topics taught by the participants and the duration of lessons are represented in Table 3.4 below. The topics broadly followed the sequence of the curriculum map laid out by the mathematics faculty. In line with the schedule, I did not collect any data during the first teaching cycle. At this early stage, the participants and I were coming to terms with the practicalities and realities of the research, such as the participants' anxiety about teaching lessons, or the delay in submitting consent forms. I started writing field notes in the second teaching cycle, but encountered unforeseen difficulties in sourcing video recording equipment and becoming acquainted with its proper operation and implementation. This difficulty delayed the event of the first video recording until the third teaching cycle. Recorded interviews and data analysis were carried out during the fourth teaching cycle, bringing the first research cycle to an end.

#### 3.4.1.1 Selecting Participants

The 18 participants in my mathematics class that took part in the research study were assigned to my class at the end of the previous academic year

by the head of the mathematics faculty (HOF). There were thirteen Year 10 mathematics teaching classes. The HOF ranked students from highest to lowest based on their end of Year 9 mathematics assessment scores in order to assign them to a mathematics class. The highest-achieving 25 students were placed in one class, and the students with the lowest scores were placed in two classes. Of the 180 remaining students, the top 90 were arranged in alphabetical order by surname in 5 teaching groups, belonging to a group known as the “upper higher band”. The process was repeated for the lower-achieving 90 students, referred to as the “lower higher band”. My class was in the lower higher band. Teachers were assigned to classes by the HOF and the Assistant Headteacher who had timetabling responsibility. I had not previously taught any of the students, so our relationship as participants started on the first lesson of the academic year, in September 2018.

18 students were given a consent form (Appendix 3), to be signed by themselves and their parents, and I verbally explained the research project to them. 15 participants returned completed consent forms and took part in the research. Of the 3 students who did not return completed consent forms, 1 opted out and I did not interview this student, nor were any recordings made of their lessons. 1 participant moved to another class and the replacement student was expected to bring in the forms but did not; I did not interview this replacement student, nor were any of their lessons recorded. The third student joined the class later on in the Autumn term, and did not complete the consent form. However, these 3 students participated in enacting the innovative pedagogy. All 3 participants were aware that they might be unintentionally included in the data analysis as part of the class but would not be identified, and effort was made, as far as possible, not to focus the camera on them. Any reference to them was as Student A, or B. All participants who consented to participate in the research were referred to by their chosen pseudonym, as shown in table 3.3 below.

| # | **Pseudonym** | # | **Pseudonym** | # | **Pseudonym** |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1 | Adam | 7 | Jayzee | 13 | Tom |
| 2 | Beyoncé | 8 | Jevonte | 14 | Ty |
| 3 | Crimson | 9 | No Miss | 15 | Jon |
| 4 | Daniel | 10 | Pearl | 16 | A/B |
| 5 | Deepz | 11 | Roan | 17 | A/B |
| 6 | James | 12 | Teesh | 18 | A/B |

Table 3.3 – Participants' selected pseudonyms

#### 3.4.1.2 Selecting Teacher Participants

My initial thought was that the make-up and selection of the participant teaching partnerships would not impact the outcome of this research, as the focus was on sharing mathematics knowledge and learning as a community. Thus, in the first teaching cycle, the participants selected one or two teaching partners without any restriction. In the first teaching cycle, I noted uneven participation within the threepartner teaching participants. This uneven participation started in the planning stage and carried through to the teaching stage. The classroom layout (see Figure 3.3) placed physical restrictions on participants' movement, making working in a group of three especially difficult. In addition, the uneven distribution of friendships within the group tended to exclude a participant, as exemplified in an extract from field notes (see Appendix 4). I posed this problem to the participants during our collective and informal discussion at the reflection stage (see section 3.3.1.4). The outcome was that pairs became the optimum size for teaching partnerships. After the first teaching cycle, to ensure participation in all aspects of the pedagogy, in subsequent cycles I gave participants the option to change teaching partners and explicitly

limited teaching partners to pairs. Pairing up was not always straightforward; in teaching cycle 2, after participants had chosen their partners, I made the last 2 participants partners as no other participant chose them as a partner, nor did they make a choice.

| **TEACHING CYCLE ONE** | | | |
|---|---|---|---|
| **Teacher Participants (TP)** | **Topic Taught** | **Start Date** | **# Days** |
| All | Allocation/Selection/Planning | 07/09/18 | 3 |
| Crimson + Student A | Inverse/Direct proportions | 13/09/18 | 1 |
| Jayzee + Beyoncé | Proportions<br>Recipes and ratios<br>Questions | 14/09/18 | 1 |
| Teesh + Student A | Exchange rates | 17/09/18 | 1 |
| No Miss + Student A | Best Buys | 18/09/18 | 1 |
| Deepz+ Ty + James | Sharing ratios | 20/09/18 | 1 |
| Adam + Roan + Pearl | Ratios and fractional problems | 21/09/18 | 1 |
| Jevonte +Daniel + Tom | Percentage change | 24/09/18 | 1 |
| **TEACHING CYCLE TWO** | | | |
| All | Allocation/Selection/ Planning | 25/09/18 | 3 |
| Crimson + Pearl | Compound interest and depreciation | 01/10/18 | 1 |
| Beyoncé + Jayzee | Reverse percentages | 02/10/18 | 1 |

| | | | |
|---|---|---|---|
| No Miss + Student A | Similar shapes | 04/10/18 | 2 |
| Student A + Teesh | Inverse and direct proportions | 08/10/18 | 2 |
| Deepz + James | Speed, distance, and time | 11/10/18 | 1 |
| Jevonte + Tom | Area of similar shapes | 12/10/18 | 1 |
| Roan + Adam | Volume of similar | 15/10/18 | 1 |
| **TEACHING CYCLE THREE** | | | |
| All | Planning | 16/10/18 | 2 |
| Student A + Student B + Ty | Linear equations | 01/11/18 | 2 |
| Deepz + Jevonte | Solving quadratic equations | 05/11/18 | 3 |
| Teesh + Pearl | The quadratic formula | 08/11/18 | 1 |
| Daniel + Jayzee | Completing the square | 12/11/18 | 2 |
| James + Adam | Inequalities | 15/11/18 | 3 |
| A + No miss | Forming equations | 19/11/18 | 2 |
| Tom + Beyoncé | Linear and quadratic simultaneous equations | 22/11/18 | 4 |
| Crimson + Roan | Solving simultaneous equations graphically | 29/11/18 | 2 |
| All | Sketching and drawing quadratic equations | 03/11/18 | 2 |
| Myself | Regions | 06/12/18 | 2 |
| **TEACHING CYCLE FOUR** | | | |
| All | Planning | 19/12/18 | 2 |
| Tom + James | Rearranging formulae | 09/01/19 | 2 |

| | | | |
|---|---|---|---|
| Roan + Crimson | Algebraic fractions (+/-) | 11/01/19 | 4 |
| Deepz | Simplifying algebraic fractions | 18/01/19 | 4 |
| Beyoncé + Jayzee | More algebraic fractions (x/÷) | 25/01/19 | 4 |
| No Miss + Pearl | Surds | 04/02/19 | 4 |
| Student A + Student C | Solving algebraic fractional equations | 11/02/19 | 3 |
| Teesh + Daniel | Iteration | 15/02/19 | 1 |
| Teesh + Daniel | Iteration | 26/02/19 | 2 |
| Jevonte + Adam | Algebraic proof | 01/03/19 | 2 |

Table 3.4 – Teaching Schedule for teaching cycles 1-4

In the third teaching cycle, the problem I posed to the participants concerned extending our experiences of participation. The outcome was that I selected the teacher-participant pairs to support learning by experience (see section 2.2.2) by getting participants to work outside of their usual friendship groups. This experience improved mutual relations, an essential characteristic of shared epistemic agency (see section 2.4.3).

In the fourth teaching cycle, I once again allowed participants to choose their partners. I wanted them to be as comfortable as possible with their partner, to improve the collaboration, and to reduce limitations. For instance, it was easier for friends or participants in the same tutor group to meet up outside the lesson to finish their planning.

As stated in section 3.3.3 above, the research design allowed for a continuous cycle of reflection and improvement to the innovative pedagogy to answer the research questions and improve the student's relationship

with and their learning of secondary school mathematics. Hence, I experimented with the pairings in order to best encourage teacher participants to work together (pedagogic principle 4), extend their knowledge (pedagogic principle 1), and share this knowledge effectively to advance the community knowledge (pedagogic principle 2).

#### 3.4.1.3 The Quality of Mathematics Knowledge

Following teaching cycle 1, I observed that teaching participants were unsure of the limits of the topic or the content they were to teach; they did not have the mathematics knowledge for teaching (see section 2.3.2.1) that teachers develop through their experience in the profession. This experience produces knowledge of such factors as the topic sequencing and types of examinations questions. Field notes extract 3.1 gives an example of the teacher participants' lack of knowledge of typical GCSE questions.

**Date: 21/09/2018 (TC1). Topic: Ratio & Fractional Problems**

**Teachers: Adam + Roan + Pearl**

The participants researched the topic during the planning stage (Vignette 1) using mainly 'MathsWatch'; this exposed them to an understanding of ratios as fractions such that they included in their lesson questions such this:

1. In a box of chocolates, the ratio of pink chocolates to white chocolates is in the ratio of 2:5.

   What is the fraction of pink chocolates in the box?

The participants prepared a work sheet with similar questions involving the concept of ratios as a fraction of a whole. In essence, they did not extend mathematics beyond what was taught in the previous lesson (see Table 3.4).

The reason was that they did not know where to research. They typed in the topic and did not go beyond what was available on the MathsWatch package. This left the participants in the class unable to solve the now routine ratio problem where they are expected to combine ratios – questions such as:

*Given that A: B = 1: 6 and B: C = 2: 5*

*a) Find the ratio of A: B: C*

*Give your answer in its simplest form.*

Field notes extract 3.1 – Teacher participants knowledge of GCSE questions

To make this knowledge available to the teacher participants, from TC2 onwards I provided the topics' mathematics questions, as well as further content, extensions, and problem-solving exercises. I experimented with various ways of doing this while still sharing authority with the teacher

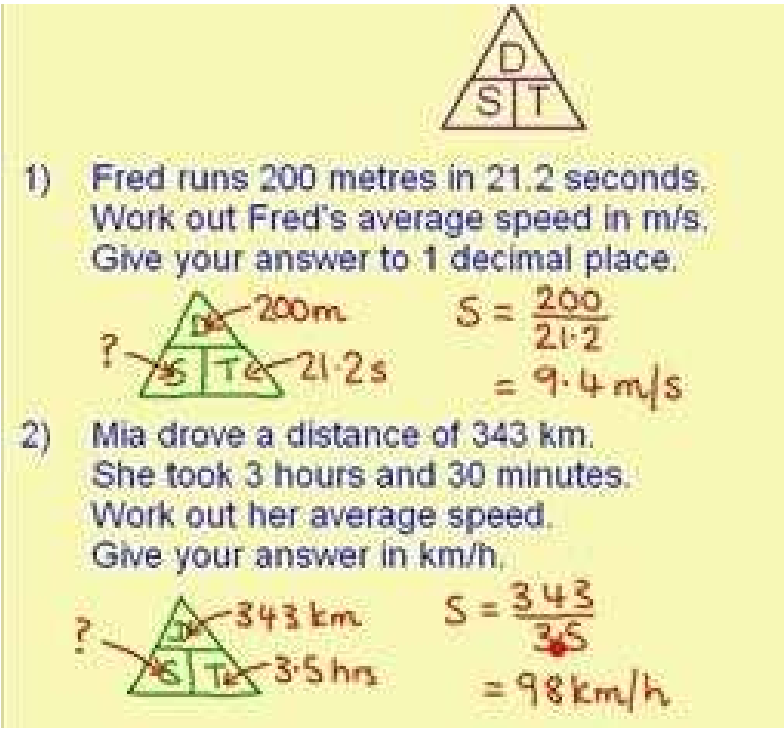
participants. Producing a booklet of questions at the start of each teaching cycle was most efficient. It allowed participants to use their limited planning time to focus on gaining knowledge rather than sourcing questions – a lesser priority, as teachers have historically most often used mathematics textbooks with answers at the back to prepare lessons. Most teacher participants came to their lessons with solutions to the questions in the booklet: a reification of their expertise as participants.

Reflecting on teaching cycle 2, I observed that some teacher participants copied and pasted worked examples and used these as part of their explanations. This copying method adversely impacted the quality of mathematics knowledge shared, as the teacher participants tended to focus on procedural knowledge at the cost of conceptual knowledge, limiting their ability to problem solve, as shown in field notes extract 3.2.

**Date: 11/10/2018 (TC2). Topic: Speed, Distance, and Time.**

**Teacher Participants: Deepz + James**

This is a screenshot of what Deepz and James, the teacher participants, explained on the board.




The process was explained, but the reasoning behind the process was not. The student participants were able to answer similar questions; however, the teacher participants' lack of knowledge was exposed when the students encountered questions such as question 5 below:

*Question 5*

*A car takes 15 minutes to travel 24 miles. Find the speed in mph.*

In calculating the solution to question 5, the teacher participants used the time in seconds without appreciating that it needed to be converted into hours.

Field notes extract 3.2 – Screenshot of worked examples.

To mitigate this, and in keeping with pedagogic principle 2, we discussed the problems of copying and pasting worked out examples during the reflection stage; I encouraged teacher participants to work out and explain questions in real time.

In the third teaching cycle, I found time before each teacher participant pair's lesson to assess their mathematics knowledge to assure the quality of the mathematics. This pre-meeting ultimately proved unnecessary. The teacher participants had prepared sufficiently and knew their content, at least as far as I could decipher in the short meeting. Moreover, in the classroom, participants asked questions that I could not have anticipated; in essence, meeting before the lesson was of no benefit. I discontinued this practice.

It was my professional responsibility to maintain the proper pacing and quality of mathematics study in my classroom. The futures of the participants, myself, and the school depended on the GCSE Mathematics examinations' results in May 2020 (21 months from the start of the project). My class was not in isolation; their performance would impact my appraisal as a teacher. In a faculty of thirteen Year 10 mathematics classes, my class's performance was to be judged against that of other classes, as was the performance of the mathematics faculty judged against that of other faculties. Introducing a new pedagogy was a risk; thus, the selection of the teaching pairs, the questions, and the explications had impact beyond the interests of research, and required considerable thought, commitment, experimentation, and adaptation during the initial teaching cycles.

### 3.4.2 Data Collection Methods

Answering the research questions required studying the participants as they enacted the pedagogy over and over again, lesson by lesson. Hence, methods of data collection employed needed to suit that purpose, and consider participants' reflections on their enactment. To this end, the two methods of data collection employed were lesson observations and participant interviews. The observation included video recording and written field notes; these methods were sufficient to collect data that provided evidence for the emergence of shared epistemic agency and answer the research questions. I collected data over 10 months, from September 2018 to June 2019.

#### 3.4.2.1 Observation

Observation is a suitable strategy for this research. It is a data collection method that is more than just looking at a social situation; it involves the researcher systematically noting people, events, settings, behaviours, routines, and how the observed phenomena exist in their natural social setting (Cohen, 2018,p. 542 ). It allows the researcher to collect valid and authentic data that can reveal mundane routines and activities, provide rich contextual information, and offer opportunities to document verbal, non-verbal or physical phenomena that occur as the classroom participants enact the innovative pedagogy.

As my research was over an academic year, observations allowed me to collect rich, first-hand, and *in situ* data about the complex interactions of participants as they engaged in the classroom practice of the innovative pedagogy. This data, in the form of video recordings and field notes, identified the characteristics of shared epistemic agency as they emerged over time.

Video recording as an observation method of data collection involve using a camera to record the observed phenomena, that is, the epistemic interactions in my classroom, in real time. Video recording had the advantage of giving me a more “external” view of what occurred in the lesson than if I had to base the data on my recollections alone. It also has the advantage of allowing me, as a teacherresearcher, to carry out my responsibilities as a teacher in the classroom while still collecting data from our interactions. Video recording collects both visual and audio information, including body language, gestures, and facial expressions that are important for interpreting participants' communications as they interact and give meaning to their actions and reifications (Silverman, 2016) that illuminate the characteristics of shared epistemic agency. The limitations of this data collection method are that the camera cannot be everywhere at once or record all interactions in the classroom. I note in the following section that it was preferable to manipulate the positioning of the camera to collect useful data rather than record all interactions from one perspective during the Share stage of teaching cycle 3.

#### 3.4.2.1.1 Classroom Layout and Decisions about Video Focus

A description of the classroom layout will give context to some of the decisions made regarding video recording. The camera I used was fixed, instead of a roving camera, as the focus was on the details of participants' social interaction (cf. Heath, 2010).

However, the design of the learning environment – the classroom and the seating positions of individual participants – affected the interactions that were to be captured in the camera's view, and therefore influenced decisions regarding the camera's position. Figure.3.3 below shows the classroom layout where I recorded the Share stage of teaching cycle 3.

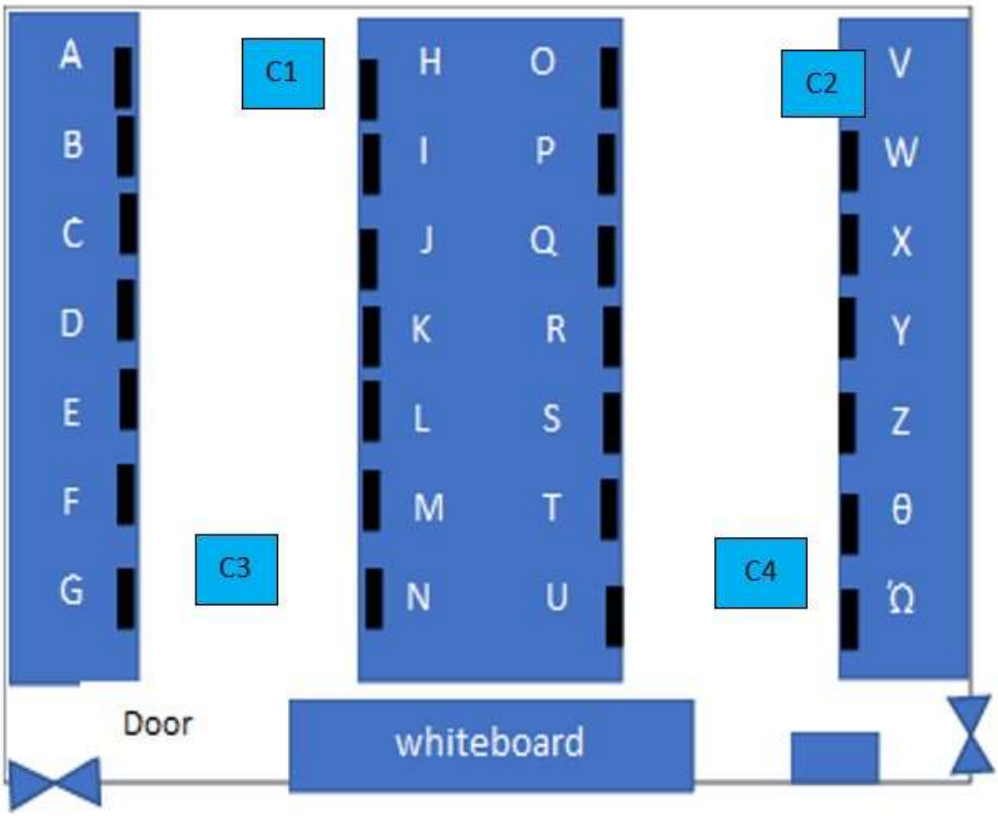


Figure 3.3 – ICT Classroom layout with seating positions (A-Ώ) and possible camera positions (C1-C4)

The classroom was a computer suite, with 28 computers in 4 columns of 7 computers each. As shown in the diagram below, this room layout created two corridors in the classroom: one directly opposite the entrance, and the other after the third column of computers. The 18 participants exercised choice over where they sat during the lesson. Over time, most participants became identified with a particular seating position, as is typical in a conventional classroom. The majority of the participants sat in positions O to Ώ, along the second corridor, though some participants, typically those who were less inclined to speak up, preferred to sit elsewhere.

Given that I desired to record what happens on the board, and but also to avoid obstructing participants' view, the layout and the seating positions of participants limited the positions available for placing the single recording camera to either of the two corridors. Photo 3.1 below shows the view from each of the four available camera positions.

| | |
|---|---|
|  |  |
| Camera position C1 | Camera Position C2 |

| | |
|---|---|
|  |  |
| Camera Position C3 | Camera Position C4 |

Photograph 3.1 – Camera positions for the ICT Suite recordings.

In teaching cycle 3, the first recording cycle, I experimented with different camera positions to find the optimum position. Over the 10 recorded lessons, the camera was positioned at C1 twice, C2 three times, and C3 four times. The camera was placed in position C4 once in cycle 3 when its connector to the tripod was missing, and I needed to keep it safe from interference. Another consideration was to avoid recording the 4 participants and teaching assistants who had not signed the consent form. In line with the research design, following recording, I prepared for an interview with the participants to reflect on the previous cycle and plan for the next cycle. The preparation necessitated my watching over the video recordings. Watching the recordings from the first recording cycle allowed me to judge the positions against a revised criterion. Recordings from camera positions, C1, C3, and C4 had limited visibility of the more interactive participants. C2 was the optimum position. The camera had in its scope the majority of the class, and especially the most interactive participants. I realised that valuable data came from participant interactions, thus it was important to position the camera so that I could

observe where this interaction was more likely to occur and be heard and seen. The trade-off was that some participants were excluded from the data in the seated position, but came into view as teacher participants. This is appropriate and inevitable; in a naturalistic setting, it is essential to maximise to the greatest extent possible the quality of the data (Heath, 2010), accepting trade-offs if they offset losses with greater gains.

The presence of the camera in the classroom and the awareness of the participants that I was recording them could have caused them to act differently, thus contaminating the data. However, from my experience and from the testimony of other researchers, I note that participants cannot sustain a change in behaviour in a social setting unless it is extreme, and will ultimately return to their natural behaviours (Creswell, 2018). The camera became all but invisible in the classroom after the participants became accustomed to its presence.

#### 3.4.2.1.2 Field Notes

Field notes are research diaries that are used to chronicle the researcher's thoughts and reflections and record what happens during the research project. They can be highly descriptive or less so, depending on the research design. In the best case, field notes should be written as the phenomena being observed are unfolding, or at least soon after the event. Being a participant-researcher, I could not write notes during lessons. In line with best practice, I wrote up my notes as soon after each lesson as was possible. The field notes were especially helpful for recording the

participants' interactions that were not recorded on video. The notes were not a detailed account of the lesson, but rather a record of occurrences that I judged to be significant at the time. A limitation was my lack of awareness of which phenomena would be most relevant during the final analysis or the write-up of the research. Moreover, field notes are highly subjective; human perception can be unreliable, and must be selective given the ubiquity of data (Patton, 2015). The field notes I kept were nevertheless descriptive and helpful as extracts to support some of my findings and discussions, and to illuminate aspects of the thesis.

#### 3.4.2.2 Interviews

Interviews are a way of collecting data through conversation, by asking questions and listening to the answers. It is a conversation with a purpose and structure determined by the interviewer. Interviews are used to determine what is "in and on someone else's mind, what we cannot directly observe" (Patton, 2015, p. 426). They are thus useful for discovering people's experiences, hopes, and feelings – information about the world they live in or about the past that cannot be replicated or clearly discerned in other ways.

My research design included interviewing the participants at the end of each action research cycle. As part of the reflection stage, the interviews aimed to gain insight into participants' experiences of and perspectives on the innovative pedagogy – that is, what they have learnt, what they would avoid, and what they would do in the following action research cycle. As the study aimed to improve their relationship with and learning of

mathematics, it was essential to gain information from the participants enacting the pedagogy and who had experienced and were experiencing other pedagogies in their schooling. In addition, answering the research questions necessitates observing participants' perspectives on their increased participation and responsibility for their own and others' learning.

My interviews were semi-structured, as the questions I asked required the participants to explore their action and thoughts; though I thought out the questions beforehand, as participants gave their individual perspectives on events, I had to ask follow-up questions to clarify information. After the first action research cycle, I interviewed participants and transcribed the interviews from the audio recordings in preparation for the analysis.

The first set of interviews took place as planned, after teaching cycle 3. In line with the research design, the idea was to complete the interviews before the end of the action research cycle, so that information from the interview could form part of the planning for the following action research cycle. The interviews took place in the morning, during the school day to ensure attendance. I chose participants from the class list based on the proximity of their form room to the interview location. I started by interviewing the participants whose form room was nearest to my location, and I withdrew them from their morning registrations and the non-curricular Physical, Social, and Health Education (PSHE) lessons. In this way, I minimised the impact on their curriculum time. Registration and PSHE are consecutive lessons on Thursday mornings, so I had 75 minutes to conduct the interviews; these took place over two consecutive Thursdays (see Table 3.5).

| **Action Research Cycle** | **Date** | **Participant interviewed** |
|---|---|---|
| 1 | 10/01/2019 | Jayzee, Nomiss, James |
| | 17/01/2019 | Jevonte + Deepz, Crimson |
| 2 | 02/05/2019 | Adam, Daniel, Jevonte |
| | 09/05/2019 | Pearl, Teesh, Tom |

Table 3.5 – Interview timetable for action research cycle 1

Five participants had individual interviews, while Jevonte and Deepz were interviewed together in the second week. I decided to interview a pair of teacher participants together, reasoning that such participants may trigger each other to remember more or that the ensuing discussion may provide more insightful answers. The participants agreed with each other's accounts of events or responses to questions. Jevonte only spoke if I asked him to speak first; barring that, Deepz dominated the interview and Jevonte agreed with him. As this paired interview did not generate fruitful insights, and seemed to be affected by social and personal factors, I decided on individual interviews only in the next research cycle. To prepare for the interviews, I watched the lessons and selected parts of the recordings that I intended to bring to the attention of the participants being interviewed for clarification and discussion. This elaboration did not materialise. The participants generally did not like watching themselves, so after two of them requested not to watch themselves in the first week, I stopped showing clips of video recordings during interviews.

The interview questions (Appendix 5) focused on eliciting the teacher participants' experience of and perspectives on their enactment of the characteristics of shared epistemic agency, with a particular focus on the characteristics of Extension and Expertise. I based my questions on Damşa et al.'s (2010) discussion of actions that indicate SEA; hence, my focus was on the teacher participants and their preparation for the lessons, in keeping with pedagogic principles 1, 2, and 5. Following reflection on

the research, I changed this approach to interviewing; I discuss the changes in the following section.

### 3.4.3 Reflecting on Action Research Cycle 1

At the end of the first action research cycle, that is, during stage 5, I reflected on the innovative pedagogy and on the data collection methods. This reflection involved watching the video recordings and reading the field notes and interview transcripts. The purpose of the reflection was to evaluate the innovative pedagogy and its enactment, and, from this evaluation, to make necessary adaptations to the next teaching cycles in order to support the emergence of shared epistemic agency. This is where my research aims most influenced the pedagogy, as I wanted to enhance the emergence of shared epistemic agency in order to improve the students' relationship with and learning of mathematics. I also evaluated the data collection methods and adapted them to the particular environment of our secondary school to improve the quality in the data in the next action research cycle, gearing its collection towards answering the research questions.

#### 3.4.3.1 Reflecting On the Pedagogy

Following the first action research cycle, having watched the video recordings, read the field notes, and listened to the audio recordings of the interviews, in order to help with answering the research questions, I decided on two aspects of the pedagogy that required a greater focus at stages 2 and 3 of the teaching cycle, and posed this to the participants

during the discussion at stage 1 of the fifth teaching cycle. The first focus, concerning stage 3, the Share stage, was to improve the quality of epistemic interactions. This required improving the knowledge that the student participants brought with them to the lesson (pedagogic principle 3), which would better facilitate the emergence of shared epistemic agency, as they could engage in more productive dialogues with the teaching participants. The second focus, concerning stage 2, was for teacher participants to include strategies to assess student participants' learning in their planning. This focus referred to pedagogic principles 1, 2, and 3. These two foci, I hoped, would improve the mathematics knowledge shared by both teacher and student participants during their epistemic interactions, which make visible the characteristics of shared epistemic agency. Making the characteristics of shared epistemic agency visible contributed to answering the research questions.

### 3.4.3.2 Reflecting on the Data Collection

Initially, the research design included collecting audio recordings of participants' actions and reifications during the select and plan stage of the research cycle (see Table 3.6).

Table 3.6 – Planned and actual data collection

| Stage | TC | Planned Research Cycle Activity | Actual Research Cycle activity |
|---|---|---|---|
| 1 | Select | Field notes + Audio recording | Field notes |
| 2 | Plan | Field notes + Audio recording | Field notes |
| 3 | Share | Field notes + Video recording | Field notes + Video recording |
| 4 | Reflect | Field Notes + Interviews – Audio recorded and transcribed | Field Notes + Interviews – Audio recorded and transcribed |
| | | Reflection on all data +planning | Reflection on all data +planning |

The rationale behind this decision was the desire to collect various forms of data across the teaching cycle similar to other research into SEA (cf. Damşa et al., 2010; Damşa, 2014); in addition, collecting data from different sources should increase opportunities to trace the emergence of shared epistemic agency. However, my study differs from those of Damşa et al. and others, as it is a study of participants' epistemic interactions across more than 150 one-hour lessons over an academic year, as opposed to a group of 4 students over five lessons. Over time, I came to realise that the amount of data I was collecting was unmanageable.

At the end of the first research cycle, I listened to the audio recordings of stages 1 and 2 (see Table 3.2) and reflected upon them. While I found the recordings interesting, as they gave me insight into what the participants

deem necessary about learning mathematics, two main issues arose that caused me to discontinue the recordings, namely, with selecting participants and with the data's reflexiveness and usefulness.

Before the first research cycle, I had trialled recording audio in classroom discussions. Listening to the recording and transcribing the audio recording made me realise the importance of where the recording device is placed; I trialled different positions. Carrying it on my person made it difficult to hear conversations between participants. When I stood near participants to hear what they were saying, my presence disrupted and changed the content of their conversation. Placing it at the front of the class rendered the conversations at the back of the class inaudible. The solution I came to was to choose a pair of participants as the focus of the recording and place the recording device near them.

At the start of the first teaching cycle, I chose participants randomly, as I could not develop a fairer selection criterion, and placed the recording device near them. In the first planning lesson, I placed the recording at position U, next to Roan, and on the second planning day, I placed it at position Y between Beyoncé and Jayzee (see Figure 3.3).

Listening to the recording of the transcribed below in Transcript Extract 3.3, I realised the significance of the participants' use of the computer on audio recordings.

**Date: 25/09/2018 (TC2). Topic: Reverse Percentages**

**Teacher Participants: Jayzee + Beyoncé**

**Planning Session 1**

Jayzee: “It’s basically take-away…”

Beyoncé: “Ah, you take away that by that, ah like how miss showed us on the board.”

Jayzee: “Some people think you find 10% of that and you add it on, I’m guessing you take it away …”

Beyoncé: “Yeah”

Jayzee: “… because they’re asking for the original price so …”

Beyoncé: “Yeah…”

Transcript Extract 3.3 – Transcript of audio recording during the planning session.

During the planning stage, participants learned from a video and discussed what was on the screen. In the second line of Extract 3.3, Beyoncé said “Ah, you take away that from that … “ ; the conversation referred to what I could not see. The computer was a central focus of the communication, and I had no access to that part of the conversation. Resorting to using memory and experience to fill in the gaps in the conversation affected the validity of the data, as I would have to have made assumptions.

In addition, discovered early on that recording audio stage one of the teaching cycle would not be feasible. It was a whole class activity, and the recording device could not pick up all the participants’ contributions. The device recorded conversations of those within range while not recording

those out of its range. Ultimately, I decided to limit data collection in the first two stages to field notes.

In hindsight, I could have overcome these issues, but at that time, I was overwhelmed by the amount of data I was collecting, the different technologies in use, and my roles as teacher, school leader, and researcher. I became concerned that the research would become unmanageable, so by the end of the first research cycle, I decided that the data for the research would come from the video recording of the lessons and the strict verbatim transcription of the audio-recorded interviews.

### 3.4.4 Action Research Cycle 2

The second action research cycle began on 5 March 2019 and lasted eight teaching weeks. It consisted of three teaching cycles and ended on 13/06/2019. The faculty curriculum map dictated the topics to be covered, the delivery sequence, and the placement of assessments. Some of the topics, such as surds, which required up to four lessons, in conjunction with the home learning quiz that took up half of the Friday lessons, meant that I had to extend the research period from seven teaching cycles over two terms, as originally planned, to seven teaching cycles across the entire academic year (Table 3.2).

The end-of-year assessment added a sense of urgency to the research project. Teaching cycle 5 ended on 03/05/2019, leaving four teaching weeks until the first exam. Circle theorems and revision of all the mathematics topics taught from the start of Year 9 had to be covered within

this period, and necessitated my changing the structure of the teaching cycles. I cut out in-class planning time and required teacher participants to plan outside of lesson time, and also restricted the Share stage to a single lesson per topic.

During the first stage of teaching cycle 5, I shared with the participants the new foci from the reflection on action research cycle 1. The foci aimed to improve the advancement of mathematics knowledge of the classroom participants through epistemic interaction. Epistemic interactions were strongly supported by participants coming to each lesson with prepared mathematics knowledge. In line with these foci, the plan agreed upon by the participants during the first stage of teaching cycle 5 was for teacher participants to inform the student participants of a question they had to attempt before the lesson.

#### 3.4.4.1 Selecting Teacher Participants

By the fifth teaching cycle, the classroom practice had become established, as evidenced by the effort that both student participants and teacher participants put into the Share stage. To bolster the communicative abilities of teacher participants and their authority within the classroom, I negotiated with the participants a final change to the pair selection process that was based on each participant's personality.

I discerned from the video recordings that participants fell into two broad categories: the quiet participants and the confident speakers. This distinction had more to do with their Expertise as teacher participants than

with their mathematics knowledge. The quiet participants were soft-spoken, introverted, and communicated best with those closest to them. They were very good at working with participants individually, but appeared overwhelmed in the classroom, with the 17 other participants vying for attention. Ethically, as a teacher, I wanted the best opportunity for all participants to learn, and felt that this would be realised if I could prevent the pairing of two quiet participants.

Following a discussion during the selection stage, an agreement was reached that each pairing should have a single confident speaker. To this end, I split the class into 2 groups: quiet participants and confident speakers. I suggested that each teaching pair should constitute one participant from each category. The participants organised themselves into seven pairs; five of the seven possible pairings agreed with the suggestion while two groups did not, as one group comprised two quiet participants and the other two confident speakers (see Table 3.7)

| **TEACHING CYCLE 5** | | | |
|---|---|---|---|
| **Participants** | **Topic Taught** | **Start date** | **# Days** |
| All | Planning | 05/03 | 2 |
| Deepz, Ty | Bounds | 11/03 | 2 |
| Crimson + Beyoncé | 3D Pythagoras's theorem | 14/03 | 3 |
| No Miss + Student A | Sine rule | 19/03 | 2 |
| Teesh + Student A | Cosine rule | 22/03 | 2 |
| James + Crimson | Home learning | 26/03 | 1 |

| | | | |
|---|---|---|---|
| Tom + Daniel | SOHCAHTOA | 28/03 | 2 |
| Roan + Jevonte | 3D trigonometry | 01, 04 | 2 |
| All | Exact values | 02/04/ | 1 |
| Jayzee + Pearl | Area of any triangle | 23/04 | 2 |
| Adam + James | Functions | 29/04 | 3 |
| **TEACHING CYCLE 6** | | | |
| Student A + Teesh | Circle theorem 1 | 06/05 | 1 |
| Tom + Daniel | Circle theorem 2 | 06/05 | 1 |
| Roan + Jevonte | Circle theorem 3 | 07/05 | 1 |
| Pearl + Adam | Circle theorem 4 | 07/05 | 1 |
| Crimson + James | Circle theorems 5 & 6 | 09/05 | 1 |
| No Miss + Student A | Circle theorem 7 | 09/05 | 1 |
| Deepz + Ty | Circle theorem 9 | 10/05 | 1 |
| **TEACHING CYCLE 7** | | | |
| James | Tree diagrams | 13/05 | 1 |
| Roan + Daniel | Similar area & volume | 14/05 | 1 |
| Deepz + Ty | Area & perimeter of sectors | 16/05 | 1 |
| Adam + Jevonte | Regions | 17/05 | 1 |
| Jayzee + Beyoncé | Proportions | 03/06 | 1 |
| Daniel + K | Recurring decimals | 04/06 | 1 |
| Tom + Jevonte | Quadratic sequences | 06/06 | 1 |
| Wilmer + Deepz | Completing the square | 07/06 | 1 |

| | | | |
|---|---|---|---|
| D + No Miss | Angles in polygons & parallel lines | 10/06 | 1 |
| C + Teesh | Rearranging equations | 11/06 | 1 |
| Crimson + Pearl | Algebraic fractions | 13/06 | 1 |

Table 3.7 – Teaching schedule for teaching cycles 5-7

### 3.4.5 Data Collection Methods

In the second research cycle, the data collection methods used in research cycle 1 continued – observations and participant interviews. However, changes in the school's requirements and offerings impacted the data collection.

#### 3.4.5.1 Observations

Written field notes and video recordings continued into the second research cycle. In the fifth teaching cycle and the seventh teaching cycle, I recorded the Share stage. This was an adaptation to the original research design in which I had intended to have three action research cycles; however, as the academic year was coming to an end, there was no time for reflection after the second research cycle, so I amalgamated teaching cycle 7 into the second action research cycle.

##### 3.4.5.1.1 Video Recordings

As discussed in section 3.4.2.1.1, a limitation of video recording is the position of the camera. Learning from research cycle 1, position C2 (see Figure 3.3) was the favoured recording position of the camera, as it

allowed me to see the teacher participants and epistemic interactions amongst participants, in which shared epistemic agency is visible.

In teaching cycle 7, the class moved to a different classroom, and the position of the camera impacted data collection. In the new classroom layout shown in Figure 3.4 below, the room was wider than it was long. The participants sat in groups around the peripheral areas of the classroom, and this made it difficult to hear what was being said; this impaired my ability to follow participant conversations, especially as they moved around the classroom freely.

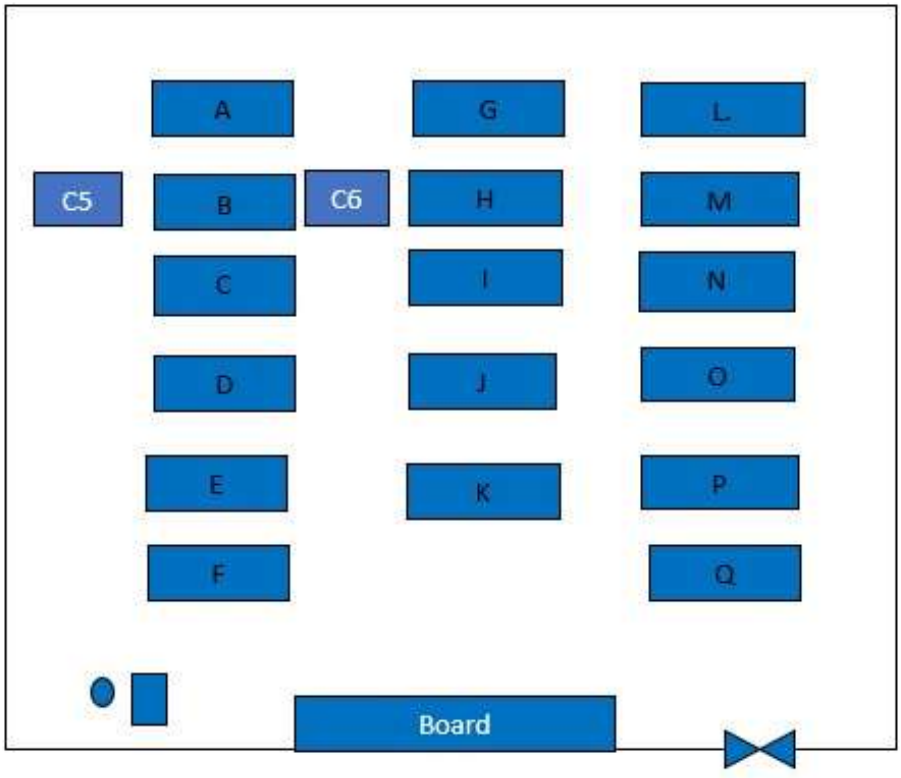



Figure 3.4 – Layout of teaching cycle 7 classroom

|  |  |
|---|---|
| Camera View from Position C5 | Camera View from Position C6 |

Photograph 3.2 – Camera positions for the teaching cycle 7 classroom

My responsibilities as a senior leader meant that my focus during that period was on Year 11 attendance to the GCSE examinations; I believe this caused me to forget the lessons I had learnt about positions of the camera, and even when I did attempt to rectify this by moving the location of the camera, the participants were too spread out to be able to both hear and see complete interactions. When located at positions C5 and C6 (see Photograph 3.2), I had a good view of the more interactive participants seated at positions N, O, and P; however, I could not hear their interactions due to the room's width, as the camera was too far away. When the camera was at position C5, I could only see and hear the interactions at seating positions C and D. In both positions, I could hear most of the conversations at the board.

The impact on the research was that it limited the quality of recordings. The viable recordings used in this paper were those where I could both see and hear participants' interactions. Of the four Episodes (see section 4.1) selected for this teaching cycle, three were at the board, and one occurred around seating position D when the camera was at position C5.

Teaching cycle 7 was the last recording for the academic year, as end-of-year examinations followed soon after, and there were no more recording opportunities. Had there been more recording opportunities, I may have taken decisions to improve the quality of the recording by taking control of the seating arrangement and clustering the participants together. This change could create a viable position for the camera such that I would both see and hear more participant interactions. Nevertheless, when I realised that the participants were not in the full view of the camera, I did not change the seating arrangements, as I was concerned that it might compromise the research had hitherto been achieved; additionally, I would be teaching the same class through the next academic year, and would have liked for the shared epistemic agency to continue to emerge. Having spent the whole year enacting a pedagogy that required participants to take responsibility for their learning, it included giving the participants choice and freedom of movement within the classroom; this had become an essential feature of the practice.

#### 3.4.5.2 Student Interviews

Following the second action research cycle, I conducted individual interviews using the same time slots as in the first interview, eliminating the potential for impact on other curriculum subjects. The main change in the two interviews was my interview questions. I had conducted the first round of interviews at an early stage of the research, when I was less certain of its direction and which questions would be helpful. By default, I focused on what I would like to know; as a teacher and as a researcher, I asked

practical questions about how they prepared and why they did what they did (see Appendix 6). The interview was informal and semi-structured, as I followed up on participants' responses, and asked further questions about particular things that happened in their lessons.

The interviews positively impacted the research from a pedagogic and ethical perspective, giving me insight into how the participants thought about the roles of teachers and students. When interviewed, the students all said that they learnt more and worked harder as teacher participants; when asked the question "What is the purpose of learning?", all students' responses identified this purpose as the achievement of good grades so that they could have a promising future. These responses constantly reminded me of my ethical responsibility as a teacher and how the research supported this responsibility.

Regardless of these positives, by the end of the first research cycle, I became increasingly concerned about the value and rigour of these interviews with respect to the research, which had an impact on their usefulness for analysis. Unlike the lessons and their recordings, which offered many opportunities to put improvements into practice, I had to get the interviews right the first time I carried them out. I found myself in a catch-22 situation. I was carrying out action research with a methodology of incremental improvements towards an uncertain outcome, but as a result, I was carrying out interviews to shape this research without knowing their final contribution

to it.

While sharing the transcripts with my supervisors, they pointed out that I interviewed the participants as a teacher rather than as a researcher, and this was true. On reflection, the participants were apprehensive about the interviews, and, subconsciously, I wanted to reassure them that they were doing a great job. I became the teacher. Interview Transcript Extract 3.4 is a section of the interview with Adam, a quiet but hardworking student. When he taught his lesson, he showed his strengths as a hardworking and caring individual. Line 1 and line 7 of the extract show me as the teacher trying to build his confidence, and answering the questions for him rather than, as a researcher, asking in a bid to extend my own knowledge.

| | | |
|---|---|---|
| 1 | Me | Yeah, and then you did. This last one was. What was this last one? Functions. |
| 2 | Adam | Yeah, functions. |
| 3 | Me | Good, so we're talking about functions. So, talk to me about that lesson. The planning, how did you plan it and everything? |
| 4 | Adam | Erm I, so I went home and researched on MathsWatch and tried to understand the clips and did some questions as well. And then I just like, put some questions in the PowerPoint, and then I just tried and told myself how to teach the class, but I didn't understand some of the questions, and then…<br>But James… James helped me and then, yeah, I understood the questions and I could help everyone. |
| 5 | Me | Do you think the lesson went well? |

| | | |
|---|---|---|
| 6 | Adam | Yeah. |
| 7 | Me | Good, so what was your plan? I see how you prepared, and I guess you were preparing so that you would be able to help people understand. |
| 8 | Adam | Yeah. |

Interview Transcript Extract 3.4 – From transcript of interview with Adam

Having received this feedback, and having decided on Episodes as the unit of analysis, I made the decision to focus only on analysing the video recordings of lessons, though it had taken a long time to decide on a legitimate method for analysing them, and de-emphasising the interviews. For one, there would need to be different a unit of analysis for the interviews, and it is not evident how the two data sources would inform each other. I also questioned whether the interviews would add substantially to the research. Considering these two points, the interview transcripts did not form part of my analytical framework.

In hindsight, I should not have scheduled the interviews at the points in the research at which I did initially. With the wisdom of hindsight, having gone through the research, the interviews would have been best placed at the end of the project, if they were to effectively contribute to the research findings. Having said this, the interviews did serve a purpose for both the participants and myself. Most notably, they were an opportunity for me to find out the lengths to which the participants went to prepare for stage 3 of the teaching cycles. It also gave me the opportunity to acknowledge them individually and let them know that they were doing very well. It was, above all, my capacity as a teacher that was more concerned for how the

participants felt that led to my decision not to analyse the interview data.

Following action research cycle 2, I began analysing all the elected data.

The analytical methods I employed are outlined in the next chapter.