An in-depth, naturalistic study of the regulation of learning in collaborative groups in upper secondary school classrooms

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This thesis is submitted for the degree of Doctor of Education

July 2021

Preface

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the preface and specified in the text. It is not substantially the same as any work that has already been submitted before for any degree or other qualification except as declared in the preface and specified in the text. It does not exceed the prescribed word limit for the Education Degree Committee of 80,000 words.

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Abstract

Regulation of learning has long been a significant area of research in education and beyond. More recently, attention has been focussed on social aspects of regulation. Regulation and the sharing of regulation of learning in social settings is seen as crucial in order to engage in effective collaboration and to make the most of social learning opportunities. A number of recent empirical studies have focussed on the nature of socially shared regulation, however, empirical studies of this phenomenon in naturalistic settings are scarce. This study is driven by the author's position as a practitioner in secondary schools and so sought to investigate the phenomenon in ecologically valid secondary classroom settings, in contrast to the more common experimental or otherwise tightly controlled designs. The present study takes a mixed-methods interpretive approach, exploring the regulation of learning displayed by upper secondary students aged 16 to 17, curriculum year 12, during classroom-based collaborative group learning activities. Four episodes were video recorded, and both verbal and non-verbal behaviour was transcribed and coded to identify regulatory acts from both students and teachers. This data was visualised using directed graphs and combined with analysis of stimulated recall interviews conducted within 24 hours of the recording.

Students and teachers were observed engaging in regulation of learning to varying degrees. A number of key themes were identified from the findings of the study. Students identified pre-existing social relationships as a key factor in successful sharing of regulation. The nature of the regulation of learning itself was dynamic and adaptive, responding to the needs of the group as well as strengths and weaknesses of individuals involved. This questioned the classical conception of regulation as cyclical in nature. Patterns and tendencies varied significantly between groups, although the interplay between monitoring and controlling functions was a notable commonality. The use of directed graphs in particular provided insight into the processes undertaken. The symmetry or otherwise of regulatory acts during collaboration highlighted the themes of authority and responsibility in these settings. Some individuals were found to have inherent authority over aspects of regulation of learning with significant implications for the regulation of learning that took place under these conditions. The thesis concludes with implications for theory and practice as well as recommendations for future research.

Acknowledgements

I am grateful to all the participants for their contributions and for engaging so willingly with the project, and to both the host school and Queens' College for their generous financial support. The five-year journey undertaken to complete this thesis would have been categorically impossible without the support of members of the Faculty of Education community. I have particularly valued the support of my cohort; Helen Barsham, John Harding, Ollie Hunter, Adam Holden and Robbie O'Driscoll. Our debates, beers and encouragement have been essential. I am grateful for the input of the wider EdD research community at Cambridge, under Tatjana Dragovic's thoughtful leadership. Thank you to the BERJ team for the very welcome distractions; Peter Fotheringham, Grace Healy and Gabby Arenge. Thank you also to Barry Rogers for his support and mentoring, particularly in the latter stages of writing. I am very grateful to all my friends and family for their support, for listening and putting up with my frustrations. In particular to my parents for their encouragement and understanding, Sue and Andy for the stimulating discussions and for accommodating me in Cambridge, Matt for the debates, Glenn for the encouragement, and of course to Emma for putting up with me throughout. Last but certainly not least, I am hugely indebted to Elaine Wilson for her supervision and guidance. Elaine has been a huge inspiration and influence in both my career and research, and I have been very lucky to be able to work with her in one capacity or another since starting teaching. Thank you.

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1 Introduction

1.1 Context

This thesis seeks to shed light on the intersection of collaboration and regulation, two substantive areas of research which have had a significant impact on classroom practice. Both areas have made significant contributions to our developing understanding of the processes underpinning learning, particularly learning through interactions in social settings.

The study was in part written during the COVID-19 pandemic, a time of unprecedented disruption and pressure on the education system in the United Kingdom and worldwide. Schools were partially closed and learning shifted to online settings across the country due to the continuing spread of the pandemic. An early draft of this introduction discussed the inherently social nature of school, the classroom and therefore school-based learning. It is poignant that the setting that students found themselves in changed so significantly over such a short time. Perhaps research into social learning has never been more relevant than now, as we emerge from the COVID-19 pandemic and as students return to school to resume face to face interaction.

1.2 Background

The focus of research in the realm of regulation of learning has shifted over the last decade or so, from a focus on self-regulated learning towards how these processes manifest in social settings, and the implications of collaboration on regulatory processes (Grau et al., 2018). However, as Panadero and Järvelä recognise in their review,

> *"compared to other regulatory concepts, such as [self-regulated learning] and co-regulation, the empirical evidence of regulatory processes in collaborative learning – this is to say, socially shared regulation of learning – is still minor and distributed."* (2015, p. 191).

For this reason, this study will add to the empirical evidence for the sharing of regulatory functions in collaboration, shed further light on the emergence of these functions, and as a result, inform classroom practice.

I am a full-time teacher and senior leader in secondary school. Consequently, this investigation is driven by the desire to find out more about this phenomenon in my own context in order to promote, support and foster the development of regulation of learning in collaboration, but also to harness the potential of regulation to maximise student learning. While there are a significant number of studies outlining factors and interventions which affect regulation of learning in settings from early years to university, reviewed in section 2.9, few explicitly look at the regulation of learning during the process of collaboration.

Mercer (2013) argues that regulation occurs through purposeful collaborative interaction, when *intermental*, exchanges take place which bring about learning. This research study will provide an in-depth analysis of the

regulation processes during close collaboration between older secondary school students in an authentic classroom context using a naturalistic research approach.

1.3 The Intention

The present study is borne out of the intention of an experienced classroom teacher to investigate and learn more about the phenomenon of regulation of learning in secondary school. When the present project began, the author had a heavy involvement in the leadership of a sixth form and a firm belief in the role of secondary education in providing the tools required for life-long learning alongside subject knowledge. The ability to regulate learning is widely acknowledged to be essential for effective learning. While there already exists an abundance of interventions intended to promote and develop regulatory processes within individuals, many of these target early years children or undergraduate students. However, in order to contribute to the development of a sustainable and research-informed change to practice, it is arguably more important to understand the phenomenon of regulation in classrooms than it is to develop further interventions. There is a paucity of research into social regulation of learning, particularly when considered in a naturalistic setting. This is in contrast to the potential for collaborative learning to support the development of individuals' regulatory proficiency.

This study aims to add to the understanding of how regulation of learning occurs in a naturalistic classroom setting. Drawing on existing knowledge of social regulation of learning and collaboration, it aims to address a gap in understanding and therefore work towards a deeper professional recognition of the role of regulation of learning in the classroom. In the process of the present study, the author has developed an understanding and recognition of the invisible landscape of regulation of learning in the classroom. Moving forward, this is a crucial development in teaching practice as professionals better understand and more effectively influence the development of executive functions in learning.

1.4 Thesis Overview

This thesis is structured into eight chapters, this introduction being the first. The titles and purpose of these eight chapters are summarised in table 1.1.

Chapter	Title	Purpose
1	Introduction	Outline of the purpose and context of the present study.
2	Regulation of Learning: A Literature Review	Review and discussion of existing research on the regulation of learning as well as the social classroom and collaboration.
3	Research Design and Methodology	Discussion of the research design and methodology, including research questions and considerations of trustworthiness.

4	Analytical Methods	Highlights the methods used to analyse data collected, including the development of an original coding scheme, the novel use of directed graphs and the integration of different types of data.
5	Results and Analysis	Presentation of the results and analysis of data in the form of four recorded episodes.
6	Discussion	Discussion of the key findings and themes from the analysed data, broaching the research questions outlined in chapter three.
7	Implications and Impact	Outline of the implications and impact of the present study from three perspectives, theory, practice, and for the author as an individual.
8	Conclusion	Final presentation of the key concluding outcomes of the study, and potential future directions.

Table 1.1: A chapter-by-chapter summary of the thesis structure.

Chapter two comprises a review of prior literature on key areas, including the development of views on both regulation of learning and collaboration. This chapter concludes by framing the contribution of the present study to these areas and introduces the emerging research questions. The third chapter develops the research questions further and discusses the methodology of the present study, justifying the decisions made in the design and implementation of the present study. This is followed by the fourth chapter which discusses in detail the data analysis employed in the present study. This fourth chapter includes details of the coding scheme developed and validated for the present study, descriptions of a novel application of directed graphs to the resulting data and crucially, discussion around how these varying data sources and analyses were integrated to broach the research questions. Chapter five reports the findings of the present study and is split into episodes, reflective of the recordings that were made as part of the data collection. Each of these sections illustrates the characteristics, themes and events of each episode and showcases the data collected from the individuals involved, from quotes, coded observational data and stimulated recall interviews. This chapter ends with a joint display of the themes that are evident from the findings when considering the research questions, which leads on to the sixth, discussion chapter which synthesises the findings into themes, outlines in detail the relationship between the existing body of literature, acknowledges the limitations of the present study and ultimately aims to answer the research questions introduced in chapter three. Chapter seven details the implications of the study, from a theoretical, practical and personal perspective, followed by the final chapter, in which the conclusions of the present study are drawn and discussed.

2 Regulation of Learning: A Literature Review

2.1 Introduction

Regulation, whether at an individual or a shared level, is a set of intentional processes which vary depending on the stage of the learning episode (Zheng & Yu, 2016). Whilst a number of models pertaining to the regulation of learning are discussed in detail in section 2.2, it should be noted that when considering regulation as a construct in social settings such as the classroom, it is essential to consider both self- and social forms of regulation (Hadwin et al., 2011; Iiskala et al., 2011; Volet et al., 2009). Therefore, moving forward, the inclusive term regulation of learning will be used to refer to all forms, be they self- or social in nature. As discussed in section 2.5, the existent literature on self-regulated learning is extensive in the form of empirical studies, theoretical models and reviews. However, the extension of these models to incorporate social settings, i.e. those which involve more than one individual, is still emergent, particularly with respect to ecologically valid settings in secondary schools. The present study seeks to go some way to contribute to these developments in the field by studying students' regulatory behaviours in naturalistic classroom settings during collaboration. This literature review, in advance of full discussion of the research questions, discusses the existing perspectives, both theoretical and methodological, on the study of regulation of learning, as well as on collaborative learning and associated topics. Firstly, a critical review of the present literature on self-regulated learning is presented, followed by the current theory and empirical studies into social regulation. Next, the relevant literature on collaboration and classroom-based learning is discussed and the relationship between the substantive areas of regulation of learning and collaborative learning highlighted. Finally, a review of methodological issues pertaining to the subject of the present study are discussed, followed by the introduction of the research questions that emerge from the literature review.

2.2 Defining Regulation

Regulation as a substantive theoretical construct is most often defined in socio-cognitive terms, as defined by Bandura (1991). Bandura suggested that existing models of learning failed to satisfactorily account for the environmental and social influences on an individual. He suggested that cognitive, internal learning processes influenced, and were influenced by, behavioural and environmental factors; "social structures are created by human activity, and socio-structural practices, in turn, impose constraints and provide enabling resources and opportunity structures for personal development and functioning" (Bandura, 2001, p. 15). Applied to the concept of self-regulation, this means an individual's regulation of their learning could be said to be a series of reciprocal interactions between cognitive and other personal, behavioural and environmental factors. The diagram in figure 2.1 shows this interaction, termed triadic reciprocal determinism (Bandura, 1986).

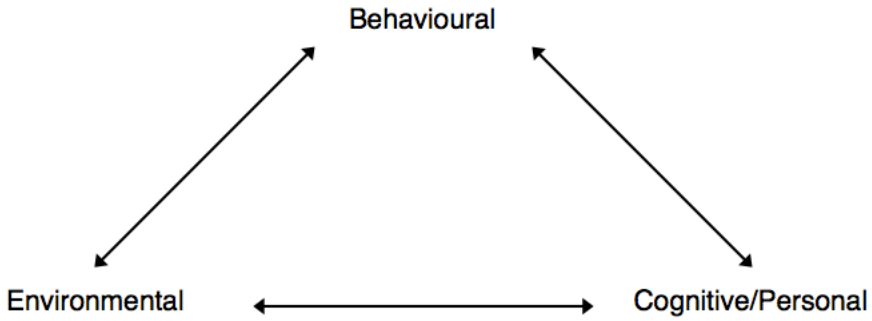


Figure 2.1: Triadic reciprocal determinism (Bandura, 1986)

Regulation is an undeniably complex concept. Historically, regulation has been conceptualised as an individual and largely internal set of processes under the guise of 'self-regulation'. This is an important starting point, but perspectives on regulation are evolving. In the all-pervasive social learning environment of the classroom, it is difficult to justify seeing learning processes as discrete and individual. It will be argued throughout this study that regulation ought to be considered more broadly as a set of processes which occur not only on an individual level, but nested within social and interactional planes, forming a network of interwoven processes. Within this network, individuals play roles with more or less authority over the socially shared regulation of the learning taking place.

Today, there is a variety of nuanced models of self-regulated learning in the literature, many of which have begun to diversify beyond self-regulation and consider regulation in social learning environments such as the classroom and workplaces. The remainder of this section discusses a number of these models and their implications for this study.

As a concept, the regulation of learning incorporates a number of ideas, from motivation to metacognition, and as such debate continues over the exact definition. It is, in any case, multi-faceted and complex. According to Zimmerman (2000, p. 14), self-regulation concerns "self-generated thoughts, feelings and actions that are planned and cyclically adapted to the attainment of personal goals." This broad approach to self-regulation has been applied to a vast range of contexts from clinical psychology to teacher training and education. The focus of this study is the regulation of learning, so reference to regulation from this point on is within an educational context.

Schunk and Ertmer (2000, p. 631) use a narrower definition of self-regulated learning with a list of components:

"…setting goals for learning, attending to and concentrating on instruction, using effective strategies to organise, code and rehearse information to be remembered, establishing a productive work environment, using resources effectively, monitoring performance, managing time effectively, seeking assistance when needed, holding positive beliefs about one's capabilities, the value of learning, the factors influencing learning and the anticipated outcomes of actions, and experiencing pride and satisfaction with one's efforts."

Specific definitions aside, it is generally accepted that regulation of learning comprises at least three phases which generally fit a preparatory, performance and appraisal framework (Puustinen & Pulkkinen, 2001), but the number of phases, labels and sub-processes vary depending on the specific model (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman & Schunk, 2011). Self-regulated learning is more often than not viewed as a process, frequently manifesting as a cycle, involving the characteristics identified by Schunk and Ertmer (2000). In the eyes of Zimmerman (2008) this cyclical process involves three distinct stages within a learning episode; forethought, performance/volitional control, and self-reflection (figure 2.2).

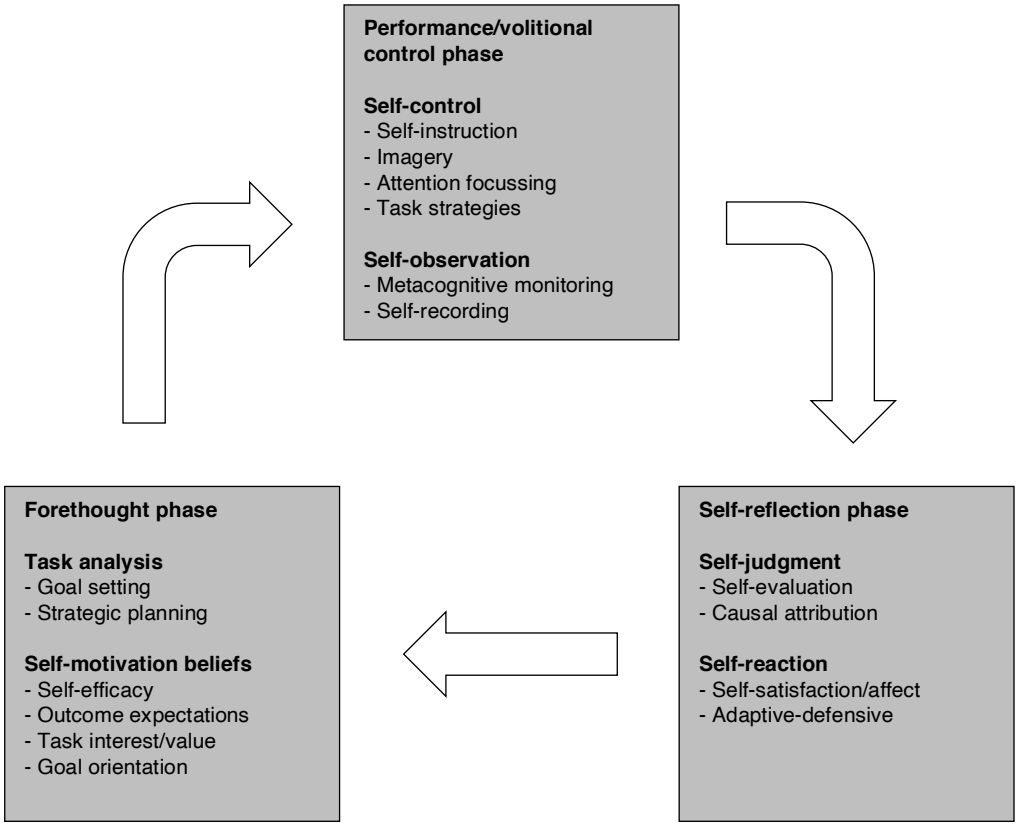


Figure 2.2: Three-stage self-regulation cycle adapted from Zimmerman (2008).

The forethought phase precedes learning, and involves processes such as planning, and belief that success is possible. The performance/volitional control phase involves the learning episode itself and therefore processes such as metacognition, self-instruction and monitoring of behaviour and attention. The self-reflection phase reviews the learning episode and informs the following forethought phase. This essentially forms a reflexive cycle through which the learner is constantly adapting themselves and their learning to improve the next cycle.

In another prevalent model, Winne and Hadwin (1998) proposed a four-phase cyclical model of self-regulation, which can be seen in figure 2.3. The four phases; task understanding, goal setting and planning, enactment, and adaptation, are underpinned by metacognitive monitoring which enables individuals to monitor their progress against each phase mid-cycle. Although external influences on the processes such as external evaluations and social contexts are considered, it is highlighted that metacognitive monitoring is essential for effective self-regulation. Whilst a detailed and exhaustive model for self-regulated learning, this model has been developed further as recognition of social factors has increased.

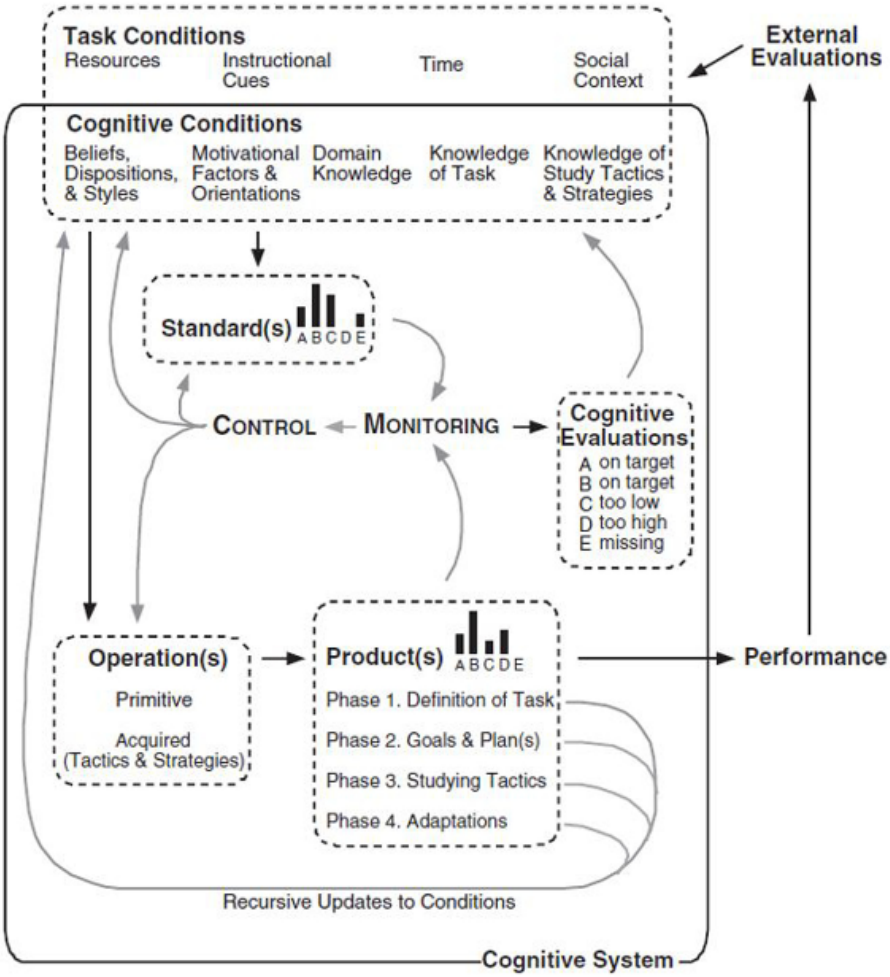


Figure 2.3: A graphical representation of regulation according to Winne and Hadwin (1998).

Much research into self-regulated learning suggests that learning processes can be classified as one of two tiers (Rozendaal, Minnaert & Boekaerts, 2005). Surface-level processing involves information-processing functions such as memorising, repetition and analysis. More complex deep-level processing involves strategies such as relating, structuring and critical thinking.

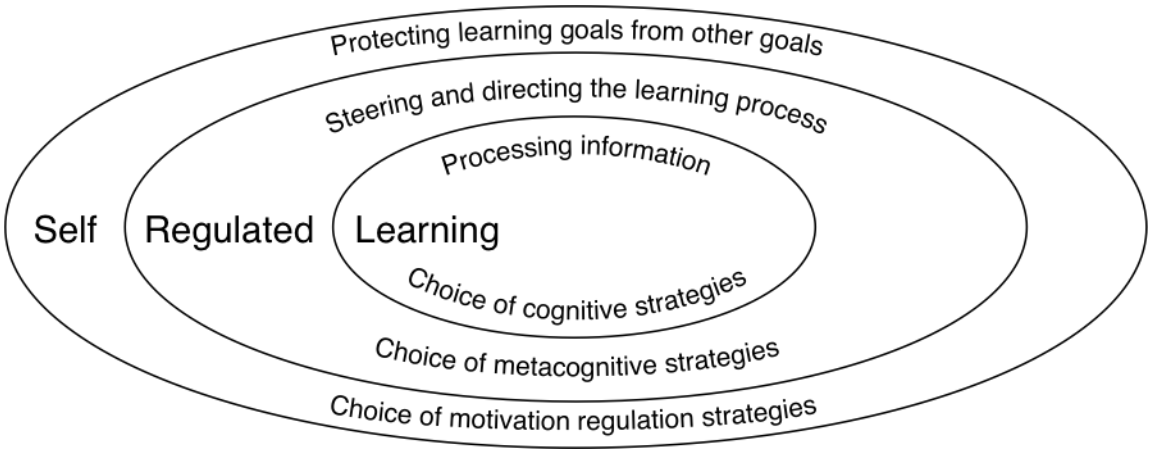


Figure 2.4: A model of the layers of SRL adapted from Boekaerts (2017).

Self-regulated learning processes such as those in the reflexive cycle in figure 2.1 are classified as the latter, deep-level. Vermunt & Verloop (1999) suggest that deep-level processing can be regarded as a number of separate cognitive, affective and regulative/metacognitive processes. They go further to say that a student is self-regulating when they initiate these processes themselves.

In a review, Puustinen and Pulkkinen (2001) compared models of self-regulated learning by their background theories, components and definitions. They recognised that most models fit a three-phase model, preparatory, performance and appraisal. By way of a summary, eight models are summarised according to this framework in table 2.1, including more recent models and a model of socially shared regulated learning (Hadwin, Järvelä, & Miller, 2016).

Self-regulated Learning Phases			
Model	**Preparatory Phase**	**Performance Phase**	**Appraisal Phase**
Boekaerts and Corno (2005): Two-layered model (top-down and bottom-up) comprised of metacognitive and motivational processes	Identification, interpretation, primary and secondary appraisal, goal setting	Goal striving	Performance feedback
Efklides (2011): The Metacognitive and Affective model of Self-Regulated Learning (MASRL)	Task representation	Cognitive processing, performance	
Hadwin et al. (2011): Model of self, co- and socially shared regulation	Planning	Monitoring, control	Regulation
Hadwin et al. (2016): Model of self, co- and socially shared regulation during collaborated learning	Negotiating and awareness of task	Strategic task engagement	Adaptation
Pintrich (2000): Framework of SRL incorporating motivation and goal-orientation	Forethought, planning, activation	Monitoring, control	Reaction and reflection
Vermunt & Verloop (1999): Integration of SRL models with student and teacher activity	Orienting & Planning	Monitoring, adjusting	Evaluating
Winne and Hadwin (1998): Complex model of SRL considering internal and external factors underpinned by metacognitive monitoring	Task definition, goal setting and planning	Applying tactics and strategies	Adapting metacognition
Zimmerman (2000): Sociocognitive, three-phase model of SRL	Forethought (task analysis, self-motivation)	Performance (self-control, self-observation)	Self-reflection (self-judgement, self-reaction)

Table 2.1: A summary of eight models of regulated learning according to Puustinen and Pulkkinen's three-phase framework.

All of the authors featured in table 2.1 seem to agree that regulated learning is cyclical and composed of different phases and sub-processes. First, Zimmerman's and Pintrich's models emphasise discrete processes, each having very distinct features for each phase. The other models communicate more explicitly that regulation is an open process, with recursive phases, and not as delineated as Zimmerman or Pintrich might suggest. For example, Winne and Hadwin's figure, shown in figure 2.2, does not make a clear distinction between phases and the processes that belong to each. Instead, the process is presented as a feedback loop that evolves over time. It is only through the text accompanying the figure that Winne and Hadwin (1998) clarified that they were proposing four distinct phases. One key implication from this distinctive difference in perspectives could be in how practitioners might intervene according to the different models (Panadero, 2017). The first group of models

might allow for more specific interventions because the measurement of the effects might be more feasible. For example, if a teacher recognises that one of her students has a motivation problem while performing a task, applying some of the sub-processes presented by Zimmerman at that particular phase might have a positive outcome. On the other hand, the second group of models might suggest more holistic interventions, as they perceive the regulatory process as more continuous and composed of inextricable sub-processes. This study in part aims to throw some light on how these phases and sub-processes manifest in the classroom as well as the impact of the teacher on these, if any.

The following section looks in more detail at the components that make up many of the models of regulation discussed here.

2.3 Components of Regulation

As discussed in section 2.2, the vast majority of models of self-regulated learning are based around a three- or four-phase model (Puustinen & Pulkkinen, 2001) loosely defined as preparatory, performance and appraisal. This has remained true of burgeoning models of socially shared regulation, for example Hadwin et al. (2016) propose a model of negotiation and task awareness, strategic task awareness and adaptation. As recognised by Winne and Hadwin (1998), metacognitive monitoring remains central to the vast majority of perspectives on regulation in collaborative settings, as it is in self-regulation. This process is necessary for the strategic enactment and adaptation of the processes required for effective regulation of learning. It is reasonable to suggest that the component processes of social regulation are analogous to those in self-regulated learning, the key differences instead being in the interaction of individuals rather than the nature of the processes undertaken.

In the present study, four key components of regulation of learning are referred to; (a) planning, in which learners orient themselves, set goals and strategise response in order to meet them, (b) controlling, wherein students control their focus and adapt according to progress, (c) monitoring, arguably the most important aspect in which learners compare learning and outcomes to goals while learning is ongoing, and (d) evaluating, in which learners appraise learning outcomes and processes in order to improve future learning (Hadwin et al., 2011).

Alongside the metacognitive aspects of regulation, emotional and motivational monitoring is a previously underemphasised aspect of regulation of learning, particularly in collaborative contexts. When working with others, learners experience a range of emotions influenced by a significantly increased number of stimuli, including the task, group members, group strategies, the context and environment and of course themselves (Volet, Summers, et al., 2009). In the present study, this aspect of regulation is considered separately to metacognitive monitoring to ensure it can be differentiated in analysis.

When viewing regulation of learning in a collaborative context as an iterative process, it is important to consider when individuals are not engaged as much as it is important to consider their contributions. Bryce and Whitebread (2012) recognised the importance of this and described and coded these behaviours as

maladaptive. This describes acts which suggest a lack of regulation as opposed to being neutral or regulatory in nature. In this study, this has been deliberately redefined as disengaged behaviour, as the negative connotations of the term maladaptive do not perhaps fully consider the role of disengagement in social regulation and appear to place responsibility on the learner for their disengagement from shared regulation. More recently, Bakhtiar, Webster and Hadwin (2018) refer to this type of behaviour in a similarly neutral manner as off-task.

In conjunction, the acts described here form one of the most important metacognitive functions for successful learning. Understanding the nature of these behaviours and how they occur in collaborative settings is crucial to developing how teachers and educators can better promote and support regulation of learning in the classroom.

2.4 Regulation as a Process

As research into, and understanding of, regulation of learning has evolved, it has been recognised that the regulatory process is inextricable from the context in which it takes place (Volet, Vauras, et al., 2009). Everything, from individual differences to the physical location, impacts on the regulation of learning taking place. Consequently, researchers have sought to understand regulation as a dynamic, contextualised process which evolves over time. As with any process, this means regulation of learning, be it socially shared or otherwise, can be conceptualised as a sequence of acts. This sequence of acts by a learner or learners, when considered in combination and in order, provides an insight into the process of the regulation of learning (Molenaar & Järvelä, 2014; Winne, 2014). Understanding has evolved from early models of self-regulation with defined routes, for example the forethought, performance and self-reflection phases of the prolific Zimmerman model (2002), and more recently it has been recognised that regulatory acts can happen in any order and rarely in a succinct, elegant cycle (Hadwin et al., 2011). The Zimmerman model holds strong, but as a macroscopic view of the nature of self-regulation rather than a process in practice. It seems more reasonable to posit that aspects of the regulatory process are enacted as and when required for the task at hand. When considering regulation in collaborative settings, the process is complicated further, as regulatory acts can be carried out not only in any order but by any number of several learners. This process is not yet well understood due to the increased complexity of the classroom compared with experimental scenarios.

2.5 A Social Perspective on Regulation

Along with much of the early literature on self-regulation, the models most widely used, such as those seen in section 2.2, continue to view regulation as an individual aptitude. From this perspective, the learner has absolute agency and is distinct from any social structures (Meyer & Turner, 2002; Post, Boyer, & Brett, 2006). In their historical review, Post et al. note this shortcoming in the early literature on self-regulation, saying it has “tended to focus on the individual learner, and does not dispose of the conceptual apparatus fully to take account of learning as social performance.” (Post et al., 2006, p. 75). Further than this, the literature on self-regulation appears to straddle two seemingly disparate perspectives on the social nature of the theory (Post et al., 2006). Allal (2011) suggests this stems from two key authors to whom the concept of self-regulation is widely credited.

Piaget (1975) focussed on the adaptation of internal processes in interaction with an environment. This focus on the internal has continued in contemporary research. In contrast, Vygotsky (1978) focussed on the effect of the guidance of a teacher or tutor on regulation of learning and so his perspective as more interactional in nature. There is a need for clarification of the nature of self-regulation with respect to individual agency and its juxtaposition with social and environmental context or structure (Thoutenhoofd & Pirrie, 2015). The interdependency between internal self-regulation and more socially mediated forms of regulation must be considered in order for researchers and practitioners to fully understand these processes in context. From a sociocultural perspective, the social environment acts as a mediator of self-regulation. Regulation is not a process solely in the mind of a learner, but is social in nature, and an individual self-regulates their learning by internalisation of regulatory processes from the social environment (Järvenoja et al., 2015; Nolen & Ward, 2008; Schoor et al., 2015). Both individual internalised processes and the externalised processes of other sources will have a hand in regulation of each individual's learning (McCaslin & Burross, 2011). For example, if the regulation of learning is considered in a collaborative context, there is a social dimension to metacognitive monitoring such as monitoring collective progress against shared goals, and ensuring the progress of peers (Hadwin, Järvelä & Miller, 2016).

These varied perspectives on the regulation of learning serve to reinforce the issue highlighted by Post et al. (2006). It has been argued that in order to fully understand regulation of learning, both the individual and social mechanisms must be considered (Hadwin & Järvelä, 2011; Järvelä & Järvenoja, 2011; Järvenoja, Järvelä, & Malmberg, 2015; Schoor, Narciss, & Körndle, 2015). When regulation is considered from a situational perspective, individuals are considered as part of a wider system. This assumes that individuals within a group can be considered both as individual self-regulating agents – in line with cognitive angles – and as constituents of a social entity which affords restrictions and opportunities for individual regulation – in line with sociocultural angles (Järvelä & Järvenoja, 2011). A model of this can be seen in figure 2.5. This perspective also accounts for the fact that the regulatory behaviours of a single individual may vary significantly dependent on context (Järvenoja et al., 2015). This is the perspective from which research on socially constructed regulation has emerged. Unlike the sociocultural perspective, wherein the individual's processes are influenced by the social context through internalisation (Nolen & Ward, 2008), from a situational perspective the individual is a component of an interwoven system. In literature from this perspective, the regulation of the system and that of the individual as part of a system are both considered with comparable significance, rather than the self-regulation of a discrete individual as would be found in more traditional research (Järvelä & Järvenoja, 2011; Schoor et al., 2015).

With recent developments in the theorisation of regulation, researchers have focussed more on the social nature of regulation and regulation during collaboration. Since this study focuses on how students regulate themselves during social learning episodes, which inherently involve collaboration of one kind or another, it is pertinent to define forms of regulation in context that will be referred to from this point forward. A classroom is a social learning environment in that it contains at least two collaborating individuals, namely a student and a teacher. It is reasonable to assume that in actual fact the social dynamic is more complex than this and frequently

includes collaboration between peers, but it is important to note that collaboration does not guarantee successful learning. Further to the phasic, process-based models summarised in table 2.1, models for socially shared regulation must consider the interaction of individual processes, but also processes shared, both equally and unequally between individuals.

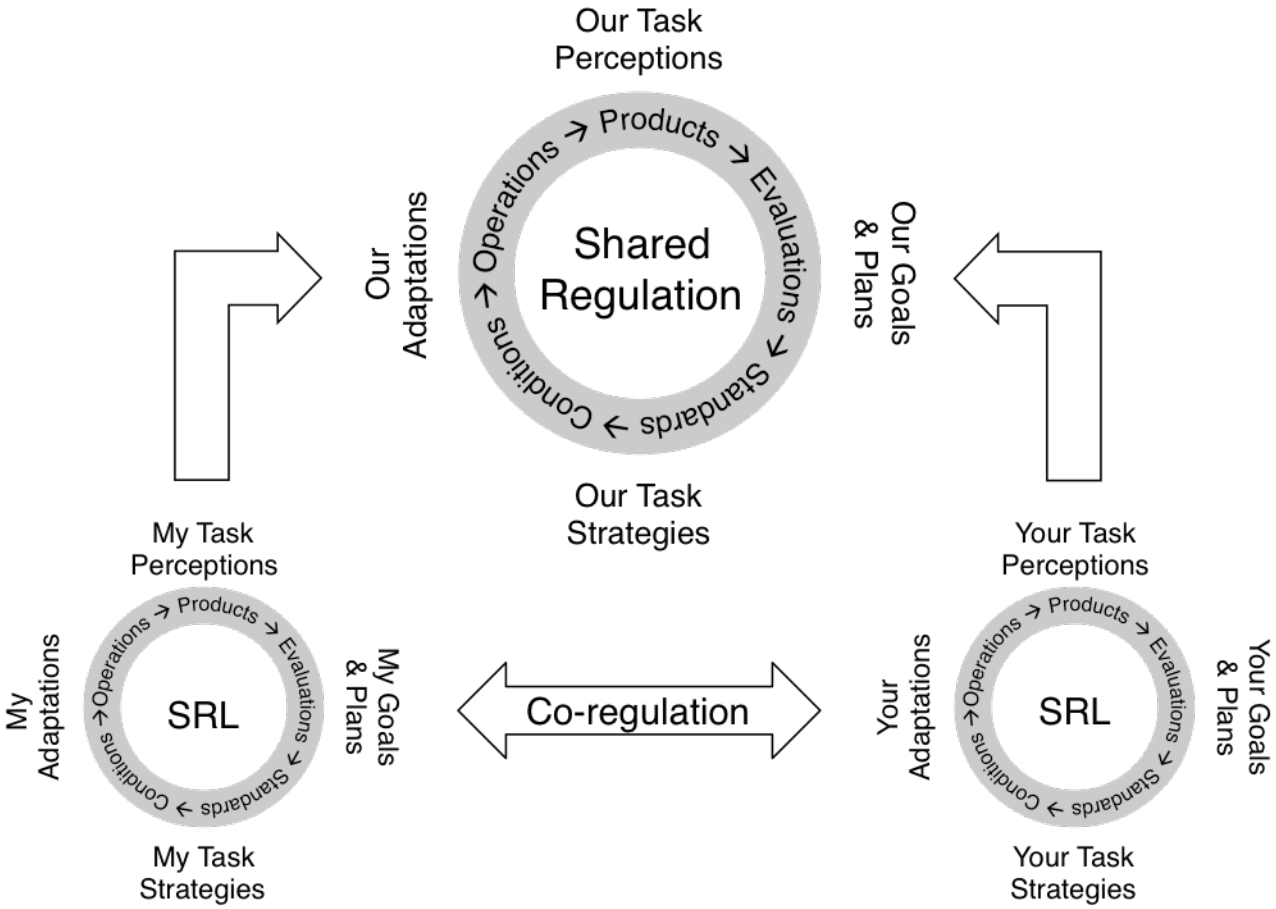


Figure 2.5: Socially Shared Regulated Learning model adapted from Järvelä and Hadwin (2013).

In the context of collaboration, self-regulation can be defined as having authority and control over ones own contributions to the learning episode. For example, it may reflect a student's progress against their own goals, but as such may not be explicitly visible to an observer or the rest of the group. Aspects of self-regulation may be externalised and therefore visible to an observer (Malmberg et al., 2017). Co-regulation occurs when a student's regulatory processes are guided, shaped, supported or constrained by another individual (Hadwin et al., 2011). This could take the form of prompting to offer ideas, or influence on an individual's internalised regulatory processes, for example. It should be noted here that co-regulation implies external authority of a learner's regulatory processes. Socially shared regulation, on the other hand, implies shared authority and control. This emerges when individuals collaborate to negotiate shared goals, co-ordinate enactment and monitor one another's process and products against shared objectives (Malmberg et al., 2017).

It has been suggested that all three of these manifestations of regulation are essential to successful social learning and collaboration (Malmberg et al., 2017). Success in social regulation involves multiple individuals

regulating themselves and others simultaneously (Järvelä et al., 2010) so self-, co- and socially shared regulation emerge simultaneously and reciprocally as part of successful learning dependent on physical, social and temporal context (Hadwin et al., 2011).

The development of regulation in the classroom has been the focus of many studies recently, and the present study seeks to learn more about the development and maintenance of socially shared regulation with a view to inform practice and future research. Before further consideration of this, it is timely to discuss the benefits of regulation and why it is important to see it in the classroom.

2.6 Regulation as a Keystone Concept

Whilst there is no shortage of literature on the benefits of self-regulation, it is important to consider why regulation of learning in the classroom is a concept worth further investigation. Undoubtedly a complex construct, it can arguably be considered as an intersection, linchpin or keystone of a large number of other behavioural, cognitive and environmental concepts. This section will touch on some of these and focus on a small number that are more central to this project.

Regulation is thought to be essential to the learning process (Järvelä & Järvenoja, 2011; Zimmerman, 2008) and even emotional maturity (Järvenoja et al., 2013). Self-regulated learners are often higher-attaining than those with poor self-regulatory skills (Vermunt, 2005). Kingir, Tas, Gok and Vural (2013) completed a large-scale data analysis project and found a strong positive correlation between self-regulation and achievement in science. From another perspective, it has also been noted that high-attaining students employ self-regulatory strategies more often than their lower-attaining peers (Tang & Neber, 2008). A student who is proficient at regulating their own learning is better able to adapt to a task or scenario to suit themselves as learners. This makes the correlation between self-regulation and attainment seem intuitive – a student who is persistently able to adapt better will surely learn more effectively and therefore attain higher. It is also important to note the high level of self-regulation expected of individuals beyond secondary education, such as in employment and university settings and the benefit therefore of fostering it early.

Motivation has been found to be very strongly positively correlated with attainment (Zimmerman, 2008). Further to this, motivation and self-regulation are not only correlated (Boekaerts, Zeidner, & Pintrich, 1999; Zimmerman, 2008), but motivation is inextricably linked with self-regulatory processes (Wang & Holcombe, 2010). If the forethought phase in Zimmerman's cyclical model (2008) shown in figure 2.2 is taken as an example, students' motivation will have a profound impact on the perceived value of a task and therefore how much effort students put into planning and carrying it out. If a student has low motivation, they are unlikely to invest as much time and effort in a task, and will see its value as less (Wolters, 2003). Similarly, higher self-efficacy has been shown to have a positive correlation with self-regulation (Pajares, 2008; Schunk & Ertmer, 2000). During the performance/volitional control phase, intrinsic motivation is required to maintain effort and concentration. Higher levels of motivation allow students to better execute self-regulated learning strategies, and more successful self-regulation will have a positive impact on motivation.

The relationship between engagement and regulation appears to be reciprocal. Definitions of engagement explicitly include self-regulation strategies and that definitions of self-regulation identify active engagement before, during and after doing a learning activity as a key component (Boekaerts, 2016). These concepts are not one and the same, however. They are both necessary to achieve long and short-term goals, but engagement does not imply regulation. A student can be highly motivated and engaged but reliant on the teacher for regulation of their metacognitive and emotional activity. In contrast, unless a student is engaged in a task or at least a goal for which the task is a necessity, many regulatory processes are not possible. Although not an explicit focus of this process, it is an interesting consideration that student engagement could be said to be essential to regulation and may be seen to have a significant effect on the regulatory dynamics of the social learning environment that is the secondary classroom.

Whilst causal links are difficult to draw, particularly considering the complexity of regulation and the many factors affecting performance, a relationship between socially shared regulation and academic performance is strongly implied by a number of studies. Three notable studies have directly sought to discover whether socially shared regulation of learning improves outcomes; Janssen, Erkens, Kirschner and Kanselaar (2012), Volet, Summers and Thurman (2009) and Järvelä, Järvenoja, Malmberg and Hadwin (2013). All three of these studies found the groups with the most socially shared regulation performed best in their respective tasks. In support of these, Grau and Whitebread (2012) found that higher shared regulation led to higher frequency of reflection on the most important features of the task.

This study seeks to acknowledge and build upon what is known about the intersection of regulation and the other concepts and factors discussed here. It will do so by investigating in depth the behaviours of students through the lens of the regulation of learning whilst they interact with peers and teachers in the classroom. Section 2.2 discussed the definition of self-regulated learning. It is increasingly important to make definitions and theory relevant to practice. The following sections will start to do so by approaching literature which discusses the manifestation of regulation of learning in classroom settings. In order to consider the processes taking place in the classroom, the ecology of this context must be considered. Before discussing existing perspectives on regulation of learning in the classroom and collaboration more broadly, ecological systems theory (Bronfenbrenner, 1981) is considered as an underpinning framework for a naturalistic study.

2.7 Ecological Systems Theory

The present study, generally speaking, investigates behaviours of individuals within a naturalistic learning environment. Ultimately, it therefore studies the behaviours of an individual within their environment, maintaining its natural ecology as far as possible. Bronfenbrenner (1981) conceived a model for the interaction between an individual and their environment that has significantly influenced the theoretical lens of the present study. The ecological systems theory (Bronfenbrenner, 1981) uses a nested structure to model the context of the individual within their environment, a representation of which is shown in figure 2.6.

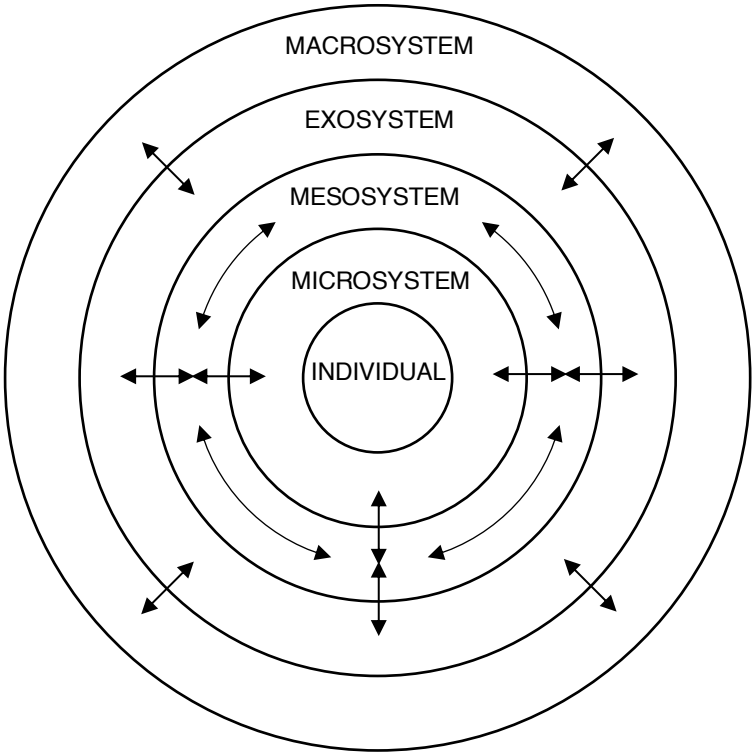


Figure 2.6: In the ecological systems theory (Bronfenbrenner, 1981), the individual must be considered as nested within layered and interacting systems.

Bronfenbrenner's model has an individual situated in the centre of their environment. Noted here are certain individualistic characteristics such as age, sex and so on. These are non-environmental characteristics. Immediately beyond the individual, the microsystem is found, consisting of the immediate environmental settings the individual is a participant within, such as school, family, peer groups and so on. This system is comprised of the closest direct links with the individual in question. The mesosystem describes interactions between two or more systems in the microsystem, i.e. systems in which the individual is a direct participant, such as the relationship between school and family. The exosystem contains settings wherein events may have an influence on the individual but in which the individual is not a participant themselves. Examples of settings in the exosystem may be local politics, a parental workplace, or a sibling's school. Finally, all of these systems are nested within a cultural setting, including cultural attitudes and ideologies. This surrounding layer is termed the macrosystem. The current project examines individuals and their behaviour within the classroom. Regardless of the focus of this examination, in this case regulation of learning, it must be considered in context. It is impossible to extricate an individual from their environment, just as it is not possible to extricate the type of research that is undertaken as part of the present study from its own context. In the present study, the individual in question is an upper secondary school student in the UK, and the microsystem in focus is the secondary classroom in which they are learning. The model shown in figure 2.6 is an elegant way to visualise the interaction between the setting of the classroom and the myriad of other interacting settings which have influence over the behaviour of the individual.

A salient point made by the ecological systems theory is that factors that affect the development of an individual may not be direct or obvious. For example, one of the most marked indicators of educational success is the nature of the employment of a student's parents, which would fall under the exosystem within the model shown in figure 2.6 (Bronfenbrenner, 1981). It should be noted that the present study does not aim to shed light on the development of student regulation of learning, but rather uses the ecological systems model to highlight the range of factors which affect this behaviour.

The ecological systems theory becomes particularly poignant when considered as a framework within which to consider collaboration. The present study is interested in the interactions between students and what these can elicit about the regulation of learning that is taking place below the surface. Bronfenbrenner (1981) goes on to consider collaboration and, in particular, reciprocal interactions, wherein individual A influences individual B and vice versa. The difficulty and importance of these situations from a regulatory point of view is alluded to by Bronfenbrenner.

> *"As a result, one member has to coordinate his activities with those of the other. For a young child, the necessity of such coordination not only fosters the acquisition of interactive skills, but also stimulates the evolution of a concept of interdependence, an important step in cognitive development."* (Bronfenbrenner, 1981, p. 57)

The balance of power is also considered, which will be seen to become a key theme in the present study. In other words, when interactions are reciprocal, but one member is more influential than another. This links strongly with the theme of agency, discussed in section 2.6.

2.8 Regulation in the Classroom

This section of the literature review attempts to bring together the sections already discussed in the context of the classroom – the pervasive formal learning context found across the world for centuries. The benefits of regulation on an individual level have been evidenced comprehensively in many contexts (see section 2.3), but because learning takes place naturally in increasingly interactive settings, it is necessary to consider regulation in conjunction with other constructs (Isohätälä et al., 2017).

Interaction in the Classroom

The traditional classroom is undoubtedly a context in which a myriad of interactions occur. Just considering interactions between individuals, as opposed to interactions between an individual and their environment, these must run into the hundreds or even thousands throughout the course of a lesson. The complexity of these situations is astronomical, so clarity of definition and concept is crucial. Mercer (2010) outlines two common perspectives on classroom interaction, namely linguistic ethnography and sociocultural research. The former involves detailed examination of interactions, nested within their cultural and social context and are often observational and qualitative in nature. The latter sociocultural approach emphasises the role of interaction as a link between the interpsychological and the intrapsychological, to use the language of Vygotsky (1978).

Approaches of this kind, among which sits the present study, are characterised by a psychological theoretical framework and often employ mixed methods. Emphasis is placed on the role of interaction in the joint construction of knowledge, mutuality, negotiation and reciprocity.

It is important to note that while the present study does not exclusively deal with talk, this type of interaction makes up a significant proportion of interaction in the classroom, and a greater proportion still of observable interaction. Mortimer and Scott (2003) have defined types of interaction in classrooms in two dimensions, summarised in table 2.2.

	Interactive	**Non-Interactive**
Dialogic	Interactive/dialogic: The teacher and students explore ideas, generating new meanings, posing genuine questions and offering, listening to and working with others.	Non-interactive/dialogic: The teacher considers various points of view, setting out, exploring and working on different points of view.
Authoritative	Interactive/authoritative: The teacher leads students through a series of questions with the aim of reaching one specific viewpoint.	Non-interactive/ Authoritative: The teacher presents one specific viewpoint.

Table 2.2: A table to show the two-dimensional classification of interactions by Mortimer and Scott (2003).

Firstly, the interactive/non-interactive dimension concerns whether or not multiple people are engaged in the episode. An interactive episode will have multiple participants; a non-interactive episode will have one (usually the teacher).

The authoritative/dialogic dimension is concerned with whether or not attention is paid to more than one understanding or point of view. Mortimer and Scott (2003) describe dialogic interaction as when “attention is paid to more than one point of view; more than one voice is heard” (p. 35). It is important to note that more than one person talking does not make an interaction dialogic – the difference between authoritative and dialogic discourse is simply that more than one idea is represented and explored in the latter; more than one voice is heard in a figurative rather than a literal sense.

The idea of authority in classroom interaction has important parallels with the same idea of authority and reciprocity in regulation of learning. The authoritative/dialogic relationship described in table 2.4 could be presented as asymmetrical/symmetrical responsibility for exploring and constructing knowledge. This concept of symmetry can be applied with ease to regulation of learning. Symmetrical sharing of regulation would suggest individuals with equal responsibility for regulatory processes, whereas asymmetrical sharing suggests a degree

imbalance of authority or responsibility within a group of individuals within which learning is regulated (Grau et al., 2018).

Collaboration & Talk

Mercer (2013) discussed the links between dialogue and metacognition, noting that there is an increasing recognition that individualistic processes such as regulation and metacognition can be embedded within social interaction. Further than this, Mercer notes that collective metacognitive activity enables individual metacognition. This idea of intermental metacognition, to use Vygotskyan language, is the basis of the concepts of socially shared regulation discussed in section 2.5, but crucially, effective collaboration and classroom dialogue are based on the same concepts, namely that the classroom is a social learning environment, and individualistic learning processes can be embedded within social interaction itself.

The classroom is increasingly seen as a social space, and the interest in the use of collaborative learning activities in various settings has increased greatly (Ucan, 2017). Having said this, high quality collaboration remains a challenge and depends on the effectiveness of self and social forms of regulation by and between collaborators (Järvelä et al., 2016; Järvelä & Hadwin, 2013; Ucan & Webb, 2015). Further understanding in the role of language as part of regulation, but also in the development of metacognition and regulation is required (Mercer, 2013)

One of the challenges faced by researchers in addressing collaboration is the absence of a succinct definition. While the concept of collaboration is arguably intuitive, defining in academic terms it is more difficult, since it is insufficient to view it as simply more than one individual interacting. Mercer and Howe (2012) highlight the issue found in many classrooms of students working *in* groups but not necessarily *as* groups, with many instances of collaborative learning in fact being more aptly described as students working on parallel, individual tasks. Models such as exploratory talk (Mercer & Littleton, 2007), collaborative reasoning (Clark et al., 2003), accountable talk and critical discussion (Keefer et al., 2000) all seek to further define productive collaboration. Ultimately, they are all underpinned by construction of knowledge and understanding, and reciprocity.

A great deal of the research into interaction during learning has revolved around a constructivist theory of learning. Mercer and Hodgkinson (2008) see talk as one of the most important pedagogical tools, saying it guides development and allows learners to jointly construct knowledge. This co-construction requires the regulation of metacognitive processes, and of motivational and emotional aspects of learning (Järvelä & Hadwin, 2013). The present study seeks to shed further light on the mechanisms of the regulation of metacognitive processes that occurs during effective collaboration.

The Role of the Teacher

Contrary to conventional wisdom, self-regulated learning is not the same as simply working alone or being left to ‘figure it out’. It in fact involves a complex mixture of independent learning and self-initiated social learning, i.e. seeking help from peers and educators (Zimmerman & Schunk, 2011). Students who have more developed

regulatory processes are more autonomous and less reliant on the regulation of the learning process by the teacher (Boekaerts & Corno, 2005). Requesting support from peers and teachers allows for consideration of the social aspects of self-regulation, as highlighted by Jävenoja, Volet and Järvelä (2013), and could provide evidence for self- and co-regulation (Volet, Summers, et al., 2009). The role played by the teacher in the sharing of regulation in the classroom is discussed further in this section.

In the context of social regulation, it is interesting to consider the influence of the teacher on the socially shared regulation in a classroom. Assuming hypothetically there are only two regulatory bodies in the classroom for simplicity; the learner and the teacher, self-regulated learning can be considered learning which is more regulated by the learner, and less by the teacher. Shunk and Ertmer (2000) note that in order for the regulation of learning by students to take place, the learners must have some control over, and freedom within, their learning. In formal education settings such as schools and classrooms, this means returning some responsibility for the regulation of learning to the students. This idea of shifting regulation from student to teacher (Vermunt & Verloop, 1999; Vermunt & Minnaert, 2003) is represented in figure 2.7. As well as the teacher having the ability to promote regulatory process, it can be postulated that teacher authority over regulatory processes might disrupt student-led regulation and therefore the development of the associated skills. This is potentially one of the key factors affecting regulation in the classroom as it could be argued that the default position is likely to be high regulatory input by the teacher, to the left of figure 2.7. This is feasibly down to the teacher having an innate authority ion the classroom as the proficient and experienced learner and regulator.

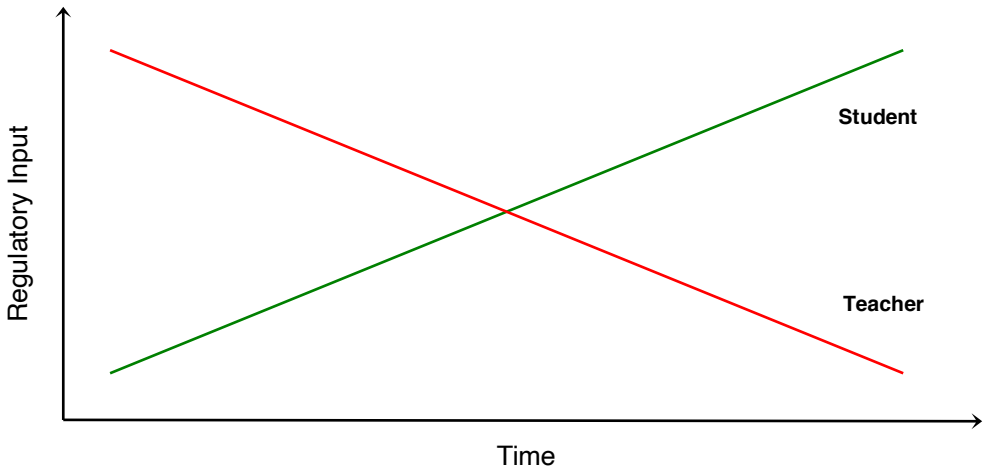


Figure 2.7: A graph to show the intended shift in classroom regulation over time.

Arguably, the role of the teacher is, put simply, to facilitate and optimise the learning of the students in the classroom and beyond. Teachers have an indispensable role in not only the regulation of learning in the classroom, but also the development of students' ability to do this themselves. Vermunt and Verloop (1999) discuss this balance in detail, from the authoritarian substitution of regulative processes by the teacher during a strongly teacher-regulated learning episode, to teacher input being limited to presenting information and assessing learning outcomes, forcing students to take on complete control of regulation. The third option discussed is the sharing of authority over regulation of learning. In this case, the teacher carefully uses their

regulatory authority to promote required processes both implicitly and explicitly, and students are encouraged to take on authority over their own regulatory processes where possible. Whilst the extremes; absolute teacher regulation and absolute student regulation, are unlikely in the classroom, the effective and prolonged sharing of regulatory authority is difficult to achieve. It is, however, arguably not only the most effective learning environment, but also the best way to develop students' regulatory proficiency as regulators of learning.

Vermunt and Verloop (1999) go on to define teacher behaviours which imply strong teacher regulation and those which are more conducive to effective shared regulation. These are summarised in table 2.5.

Regulatory process	**Teacher behaviours suggesting strong teacher regulation**	**Teacher behaviours suggesting shared regulation**
Orienting & planning	Introducing activities Ascertaining prior knowledge Informing students of objectives, contents and activities	Activating prior knowledge Giving students freedom of choice in subject matter, objectives and activities
Monitoring	Observing facial expressions Questioning Administering tests and practical problems Examining the kind and cause of problems with understanding	Encouraging students monitor each other's processes Encouraging students analyse the cause of problems with understanding
Adjusting	Giving additional explanations Changing tasks and assignments	Encouraging students to search for solutions on their own and persevere through difficulty Supporting students to tackle problems with peers
Evaluating	Administering summative tests Supplying model answers Giving feedback and suggestions for improvement	Allowing students to compose exams Facilitating comparison of students' approaches and outcomes with those of peers

Table 2.3: A summary of behaviours suggesting the degree of teacher regulation after Vermunt and Verloop (1999).

As can be seen in table 2.3, commonplace teaching practices often suggest strong teacher regulation. To use discourse, and more specifically questioning, as an illustrative example, many classrooms, particularly at secondary level, face a problem in that a recitation style of teacher dissemination seems to remain commonplace (Alozie et al., 2010). This recitation style of classroom talk revolves around three stages shown in figure 2.4 (Larson, 2000), also known as a triadic or Initiation – Response – Evaluation (IRE) model.

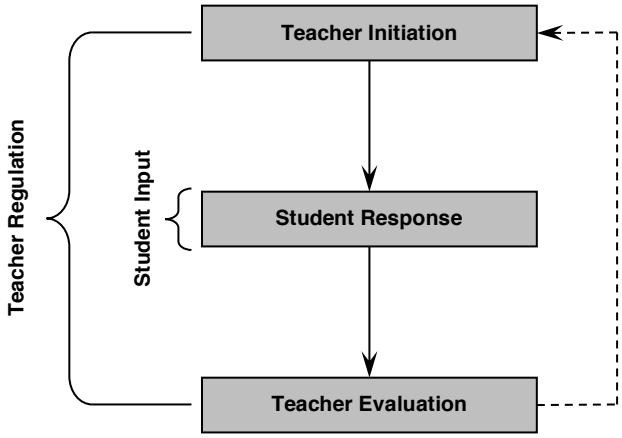


Figure 2.8: A schematic of the IRE model of classroom interaction.

In this type of classroom interaction, a question is posed by the teacher, then answered by a student, and the teacher evaluates the answer. A repeat of the process is possible, but repeated questioning from the teacher often implies incorrect student response, and repeats do not always happen. The evaluation phase can quite often become simply a correction phase (Larson, 2000).

This is clearly at odds with the cyclical, adaptive nature of the self-regulated learning processes discussed in section 2.2. Both the starting point and direction of this kind of linear exchange are strongly teacher-regulated, and the whole interaction is authoritative (Mortimer & Scott, 2003). Further to this, Day and Bryce (2011) found that discussion in science classrooms is often focussed much more on the use of discussion as an outcome, whereas the emphasis in humanities classrooms is towards discussion as a method of instruction. This outcome-focussed discussion tends to be more teacher-mediated and focussed on the development of communication skills, whereas discussion as a method of instruction is more of an open-ended enquiry and as such becomes a method for transfer and development of knowledge as well as a learning outcome in itself (Day & Bryce, 2011). With reference to socially shared regulation, Malmberg, Järvelä and Järvenoja (2017) found that a focus on task execution tended to lead to higher quality metacognitive co-monitoring and co-planning. Interestingly, they also found that asymmetrical co-regulation occurred far more often than socially shared regulation, reinforcing the idea that there is an element of authority over regulatory processes and that these processes are infrequently truly shared.

Overall, there seems to be consensus that the regulatory situation in the classroom, in contrast to the situation in psychological tests or reduced contexts, is extremely complex and involves a nuanced combination of self and socially shared regulation and everything else in between (Malmberg et al., 2017; Volet, Vauras, et al., 2009). There is also consensus that there is considerable room for further investigation into how regulation manifests itself and what factors affect this manifestation, which is discussed further in chapters five and six.

2.9 Promotion and Disruption of Regulation

There is a significant amount of literature broaching the subject of how regulation, and self-regulation in particular, can be promoted in the classroom. These tend to conform to one of two substantive perspectives, either programmes or interventions designed to explicitly develop regulation in students, or a more general approach to pedagogy and teaching practices which can promote regulation in the classroom.

Explicit Promotion

There is a significant amount of research and literature covering programmes and interventions used to promote and develop regulation of learning of all kinds at all levels of education, from early years to university. Dignath and Büttner (2008) categorised interventions at primary and secondary level by both their theoretical background and intervention type. Firstly, interventions were classified as grounded in metacognitive, socio-cognitive or motivational theory. Secondly, the instruction type was defined and programmes were put into four categories. Broadly speaking, these can be seen as four different approaches to explicit promotion of regulation in the classroom; instruction of cognitive strategies, instruction of metacognitive strategies, instruction of motivation strategies, and promotion of metacognitive reflection. Three of the four categories relate to explicit instruction of strategies, identified by type; metacognitive, cognitive and motivation. The fourth category refers to interventions which promote metacognitive reflection. The range of different approaches is broad and varied across both primary and secondary phases.

From their meta-analysis, Dignath and Büttner (2008) conclude that the most effective interventions at secondary level focus on building on students' strategic approaches which they have already developed by this point. Importantly for this study in particular, another key finding was that across both primary and secondary levels, "long-term interventions should provide enough opportunities to practice and automate strategy use in order to facilitate transfer to other learning situations." (Dignath & Büttner, 2008, p. 258)

Indirect Promotion

A summary of some practices which can be used to promote the development of regulatory proficiency over time can be found in table 2.4. It is pertinent to consider that, as discussed in section 2.5, the teacher has a great deal of regulatory authority in the classroom, and that it is reasonable to assert that the teachers actions can disrupt as well as promote the manifestation of all kinds of regulation. An example of this can be seen in the IRE model seen in figure 2.8. The effect that teachers have on the manifestation of socially shared regulation is an area of research with a lot of potential for development alongside the effects of other socio-emotional factors (Isohätälä et al., 2017). Where the present study fits into the existing literature is discussed in depth in section 2.12. The present study aims to contribute to this area.

	Strong Teacher-Regulation ('spoon-fed' learners)	**Teacher-Student Shared Regulation (Independent learners)**	**Key action to shift teaching approach**
Regulatory Function	Teaching Activity		
Orienting / Planning	Giving introductions, ascertaining prior knowledge. Informing learners of the learning objectives, contents and activities	Activating students' prior knowledge. Giving students freedom of choice in subject matter, objectives and activities.	Independent learning opportunities.
Monitoring / Testing / Diagnosing	Observing students' facial expressions, asking questions. Administering tests, making students solve practical problems. Examining the kind and cause of problems with understanding.	Making students monitor each other's process. Let students invent test questions. Making students analyse the cause of problems.	Peer and self-assessment. Share criteria and mark schemes.
Adjusting / Controlling	Giving additional explanations, changing tasks and assignments.	Encouraging students to search for solutions on their own with difficulties, having them tackle problems together	Independent learning. Access to resources. Group work.
Evaluating / Reflecting	Administering summative tests, supplying sample exams. Giving feedback on learning and suggestions for improvement in the future.	Letting students compose an exam and take one another's exam. Instructing students to compare their own approach with that of others.	Independent learning. Assessment for learning. Group work.

Table 2.4: A table of approaches to promote self-regulated learning (Wilson, unpublished) .

Control and Disruption of Regulation

Just as teachers have the capability to promote and explicitly teach regulatory behaviours and metacognition more broadly, the opposite can be true. It is perhaps too easy to consider the influence of the teacher on a scale from neutral moving in a positive direction in terms of influence on learning. In fact, the level of control teachers exert on students' learning autonomy has been found to have negative effects on regulation of learning. In these cases, teachers take on control of motivational, cognitive and metacognitive functions (Vermunt & Verloop, 1999) so removing both control over and responsibility for regulatory processes from students. In fact, it has been observed that students display greater amounts of regulatory behaviour when they perceive themselves as in control of this process rather than it being controlled by teachers (Eshel & Kohavi, 2003). Conversely, when the evaluation phase of regulation is perceived by students as a controlling mechanism rather than informative, other regulatory behaviours are reduced (Grolnick & Ryan, 1987). It is clear that a fuller understanding of these influences is required, as teachers navigate a complex landscape of cognitive and metacognitive factors whilst attempting to share specific knowledge.

Teachers might display controlling behaviours such as; setting out sources of motivation, not explaining teaching decisions, using pressuring language such as should and have to, displaying impatience for students to produce correct answers, inducing guilt for incorrect answers and reacting to students' negative expressions and complaints with power assertions (Reeve, 2009). Three conditions need to be met for students to feel supported in their autonomy, according to Reeve (2009); the adoption of students' perspectives, the welcoming of students' feelings, thoughts and behaviour, and the support of students' motivations and capacity for self-regulation.

Furthermore, some studies have even found just the physical presence of a teacher to have an impact on the regulatory behaviours of young children in classrooms. For example, Timmons, Pelletier, and Corter (2016) found that kindergarten students displayed more regulatory behaviours when engaging in independent play or small peer group activities compared to during whole-class instruction. Similarly, Whitebread et al. (2007) found that three- to five-year-olds displayed more regulatory behaviours while working in unsupervised pairs or small groups, rather than when working alone or in groups with the support of adults. While the effect the presence of the teacher might have on older students is unclear, this serves to emphasise the implicit authority the teacher holds in the classroom. Teachers do not appear to need to display controlling behaviours as described by Reeve (2009), for example, to have a controlling effect on regulatory behaviours by teachers.

Similar control over processes but by peers rather than a teacher is a reasonable suggestion, though not well-documented. While less inherently asymmetrical than a teacher-student relationship, social relationships between peers could involve similar power dynamics. These are likely to be less automatic and more fluid, but it seems reasonable to hypothesise that the impact of authority of this kind would be comparable. It is certainly plausible, if not likely, that many of the controlling behaviours outlined by

Reeve (2009) are present in peer-to-peer interactions and have the same effect on regulatory behaviours.

While there is a significant amount of research supporting a link between student autonomy or perceived autonomy and regulatory behaviours, it is important to emphasise that this relationship cannot be assumed and it is not sufficient for students to simply have complete autonomy and for regulation of learning to be assumed. Only autonomy that is learning oriented is conducive to regulation of learning (Perry, 2013) and students need to be supported and equipped to regulate their learning alongside being afforded the freedom to do so.

In order for more to be learnt about the phenomenon of regulation, various ways to measure or observe it have been developed. The following section will outline the existing literature on this topic.

2.10 Measuring Regulation

The multi-faceted nature of regulation of learning has meant it has proven an extremely challenging construct to measure. There are numerous documented approaches, including self-report questionnaires, interviews, diaries and direct observation (Winne & Perry, 2000). Panadero, Klug and Järvelä (2016) define measurement in three waves which aptly describe the existing literature and the recent developments in the field. The first, oldest wave is the use of self-report lenses.

An Overview of Approaches

Three of the most prevalent self-report measures are outlined in table 2.5.

Name	Reference	Description
Motivated Strategies for Learning Questionnaire (MSLQ)	Pintrich, Smith, Garcia and Mckeachie (1993)	Self-report questionnaire. Seven-point Likert scale with 81 items. Scores in 14 diagnostic scales are comprised of mean values of question scores.
Learning And Study Strategies Inventory (LASSI)	Three editions; Weinstein, Schulte and Palmer (1987), Weinstein and Palmer (2002), Weinstein, Palmer and Acee (2016)	Self-report questionnaire. Five-point Likert scale with 72/80/60 items depending on the edition. Edition 3 is available as a digital questionnaire. Scores in 10 diagnostic scales are comprised of mean values of question scores.
Self-Regulated Learning Interview Scale (SRLIS)	Zimmerman and Martinez-Pons (1986)	Structured interview scheme coded for references to 15 elements of SRL.

Table 2.5: A summary of three self-report measures of self-regulated learning.

Whilst slightly different in their conceptual framework, these three examples aptly illustrate one of the most prevalent approaches to measuring regulation. The two questionnaire-based measures are retrospective in that they ask about past performance, though LASSI probes student learning in general compared to the domain-specific MSLQ. SRLIS is an example of an interview-based measurement tool, and as such is more predictive as it enquires about future performance. Generally, this wave is characterised as highly structured, dependent on student attitudes and beliefs and relatively static in terms of conceptual framework (Panadero et al., 2016). Self-report measures such as these rely on accurate information from students, which is not always forthcoming. It could be argued that the static nature of the perceptions measured limits the usefulness of these measures, particularly in isolation, as they do not capture changes in student behaviour in particular contexts or due to particular interventions. This is a limitation of what could be defined as aptitude measurement, wherein the focus is on the aptitude or aptitudes of an individual as opposed to the interpretation of actual events (Endedijk et al., 2016). Having said this, self-report measures have a key role to play in the measurement of regulation when tailored sufficiently to context, when used in conjunction with other methods and when limitations are properly considered (Samuelstuen & Bråten, 2007; Veenman, 2011).

The second wave of measurement as defined by Pandero, Klug and Järvelä (2016) stemmed from a change in perspective. This wave resulted from a shift from regulation as relatively consistent traits which could predict future behaviour, to a time- and context-bound event affected by individual, task and other characteristics (Winne & Perry, 2000). This reconceptualisaton of regulation into a temporal and fluctuating entity underpins a set of measures that seek to follow the behaviours of learners while they are completing a task. These event measures include think aloud protocols, observation-based measures and so on (Boekaerts & Corno, 2005; Veenman, 2011). This second wave of measurements seeks to minimise the impact of measurement on the regulation itself in order to maximise the objectivity of the measure. As such, the second wave has included abundant psychological tests whereby individuals are observed completing specific, carefully designed tasks. Examples include the Pre-school Self-Regulation Assessment (PSRA) (Smith-Donald et al., 2007), which comprises a mixture of 10 structured tasks that assess effortful control, conflict resolution, and compliance, followed by a more open observation protocol including 28 items. These structured tasks are by far the most common form of observational measure of regulation but fall short of the requirements of the present study in that they require specific tasks to be carried out by the subject and have been designed for young children – usually between the ages of 3 and 9 (Ponitz et al., 2008). The Children's Independent Learning (Ch.Ind.Le) coding scheme (Whitebread et al., 2009) was developed in order to measure students' metacognitive and emotional/motivational regulation through a scheme with six categories across two domains; planning, monitoring, control and evaluation in the cognitive domain and monitoring and control in the emotional/motivational domain. Further developed to include maladaptive behaviours, a similar scheme was used to analyse children's behaviour during a problem-solving task (Bryce & Whitebread, 2012).

	Online	Offline
Aptitude	None found	• Self-report questionnaires • Interviews • Teacher/parent/peer judgements
Event	• Think-aloud protocols • Direct and indirect observation • Performance assessment through concrete study tasks, situational manipulations or error detection tasks • Trace analysis	• Stimulated interviews (recall/task/hypothetical) • Portfolios, diaries and logs

Table 2.6: A summary of some measures of student regulation adapted from Endedijk et al (2016).

In table 2.6, common measures are categorised in two dimensions; by measurement of either aptitude or event, and either online or offline. Online measures are defined as those measurements which take place while the regulation or learning is occurring, whereas offline measures are completed in retrospect, or otherwise independently of the regulatory process itself.

The third wave, as discussed by Panadero et al (2016), includes measures which combine intervention and measurement. This might include learning diaries, whereby students record their reflections, for example. This method would provide data on the quality of reflection and so forth, but would also allow students to develop their self-reflection skills and is therefore both a measure and an intervention. Whilst these increasingly popular measures undoubtedly provide an opportunity for the collection of incredibly rich data, they are not without their share of methodological issues. Reactivity is the primary consideration here, namely changes that occur in an individual when they are aware of particular aspects of their behaviour due to metacognitive monitoring (Zimmerman, 2002). Metacognitive monitoring plays a significant role in regulation (see section 2.1) so measurement becomes particularly complex and convoluted when researchers seek to induce reactivity in the subjects (Panadero et al., 2016).

In summary, the utility of all of the approaches described here, however they are categorised or defined, depends heavily on the aim of the measurement itself. Does the researcher aim to investigate or alter the status quo? Are generic traits or acute events the focus of the study? To what context does the question refer? The possibilities are numerous to say the least, and it is worth noting at this point that nuanced and careful combination of different kinds of measures will allow for an even greater range of questions to be broached and perhaps a more complete picture of regulation to be painted.

Measuring Regulation in a Social Context

It is worth noting that there are many more protocols for the detection or measurement of self-regulation than there are for regulation from a social perspective. Whilst social regulation is a significantly younger

concept, capturing shared regulation is also arguably inherently more challenging. It is reasonable to argue that the metacognitive process involved must arise from an individual, so capturing the collective sharing of these processes is especially difficult (Winne, 2014).

Considering literature on self-regulation initially, there has been a relatively recent shift towards considering self-regulation as inextricably contextualised and social in nature (Butler, 2011). This has led to a growing trend in the use of microanalyses to target self-regulation. This method is defined succinctly by Cleary, Callan and Zimmerman (2012, p. 4) as "highly specific or fine grained forms of measurement targeting behaviours, cognition or affective processes as they occur in real time across contexts." The application of approaches fitting this description is an attempt to minimise response biases and errors associated with retrospective self-reports about behaviour. In fact, it has been found that a microanalysis involving questioning students during activity was far better at predicting subsequent academic performance than a self-report questionnaire (Cleary et al., 2015). The same study, perhaps more interestingly, found very limited correlation between the findings of the two types of measure. It is difficult to suggest that this study, with a limited sample size and its own unique context, refutes the value of self-report measures as a whole. Nor is it reasonable to assert that microanalyses are more effective, but there is clearly the potential for the use of both these approaches as appropriate to the questions asked to form a detailed and rich picture of the self-regulation of individuals.

An example of an early study which involved microanalysis used real-time observation and event analysis to assess student self-regulation during writing activities (Perry, 1998). Whilst the observation protocol developed focuses on self-regulation rather than co-regulation or socially shared regulation as defined in section 2.5, it begins to consider social influences and suggests how these tools could be used in social contexts. Originally developed to assess student self-regulation during individual writing tasks, 19 classes of students were surveyed and from this, students were elected for in–depth investigation involving observation and interviews. The present study looks to use a similar approach to investigate behaviours across classrooms and activity types. In the study by Perry (1998), behaviours and sub-processes related to those in the models discussed in chapter two were coded for. For example, the writing processes; planning, drafting, editing/revising can be seen as a proxy for the three phases in table 2.1; preparatory, performance and appraisal. The executive processes are more generally applicable to other learning episodes; making choices is most likely a display of evidence of forethought, controlling challenge and persisting are clear evidence for volitional control and self-evaluating is an explicit sub-process in the self-reflection phase. This study found that students' regulatory processes and behaviours were affected strongly by their peers and teachers and recommended further investigation in this area.

Discourse analysis has been used in a similar way to observations to assess regulation. Volet, Summers and Thurman (2009) went further and used it to look at self- and co-regulation by developing a two-dimensional model shown in figure 2.6.

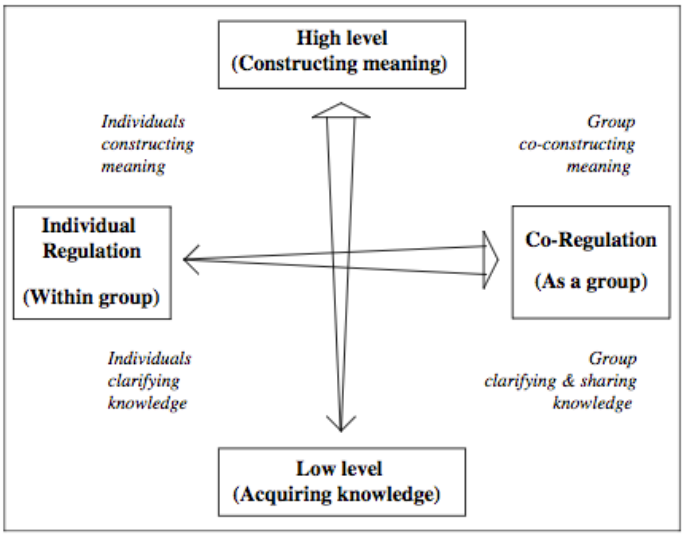


Figure 2.9: A model of regulation of learning in social contexts (Volet, Summers, et al., 2009).

This differs fundamentally from the overarching theoretical frameworks discussed in section 2.2 as it is inherently event focussed, not aptitude or process based. It provides a clear basis for measurement of regulation in social contexts in two dimensions, however.

Observing Regulation

The present study seeks to create new knowledge about regulation of learning by observing its manifestation in the classroom. This is problematic, as it requires the observation of outward behaviours or events and inference of aptitude as a result. Having said this, there is precedent. Self-regulated learners are often more engaged with their learning, and research has shown that self-regulated learners are more likely to sit at the front of the classroom, voluntarily offer answers to questions and seek out additional information and resources to tackle tasks (Elstad & Turmo, 2010). Self-regulated learners are better able to cope with unfamiliar problems and tasks and will display more independence. When given the freedom to do so, those with strong self-regulatory skills will take control of a task and its outcome, often assigning roles in groups or adapting a task to suit their own learning processes. Self-regulation is the chief factor which dictates the question-asking and answering behaviour of students in the classroom (Cano, García, Berbén, & Justicia, 2014), and it has been found that high-level regulation is most commonly observed in dialogue after a question or explanatory statement (Volet, Summers, et al., 2009). This understanding of the effects of self-regulation on behaviour allows it to be qualitatively observed and inferences made. Further detail on this and how it will be applied in this case can be found in section 4.1, where the development and proposed use of an original coding scheme is outlined.

An Analogy for Measuring Regulation through Observation

It is important to be clear at this initial stage the nature of what the present study is attempting to do, alongside many preceding projects. In attempting to observe regulation of learning there are significant

methodological and conceptual challenges. An appropriate analogy is hard to come by. Attempting to understand a complex, multi-faceted process through glimpses of behaviours which suggest underlying processes is problematic as the behaviours viewed are just the tip of the iceberg. On reflection, the iceberg analogy is unsatisfactory as it only goes so far as to represent the disproportionately small amount of data available to be observed, the tip of the iceberg, compared to the vast nature of the underlying process that is happening beneath the surface. The nature of regulation of learning as an often internal, dynamic process is poorly represented. Instead, consider a pod of dolphins. In this case, the surface of the water as a boundary continues to be a convenient representation of what is observable, above the surface, and what is not observable, or internalised, below. The image of a pod of dolphins more accurately represents the nature of the phenomenon being studied. In contrast to a static, unchanging iceberg, when observing a pod of dolphins, an observer would catch glimpses of the dynamic behaviours above the surface of the water, jumps, twists and turns, but would not be able to see the behaviour of the dolphins and the processes taking place under the water. The dolphins breaching the water might represent the behaviours that indicate regulatory processes which can be observed. The behaviours of the dolphins underwater must be inferred from the observable behaviours, much like the metacognitive processes. The multiple dolphins and their interaction can be seen to represent the interactions between learners as they carry out the regulation of learning required by the group.

This analogy hopes to clarify some of the difficulties of observing often internalised processes such as regulation of learning. In taking this path in research, an observer is attempting to infer the behaviour below the surface from what can be observed above. This is inherently difficult, but the more inferences are made and the more inferences are tested, agreed or challenged, the richer the picture we build of the invisible processes and the more accurate we can be when drawing inferences from observations and looking beneath the surface of the water.

2.11 The Trajectory of the Literature

The emerging literature agrees on the importance of regulation in various guises in a collaborative contexts such as classrooms. The focus of previous studies has been validating the processes and models of social shared regulation (e.g. Grau & Whitebread, 2012), or exploring the nature and manifestation of regulated learning (e.g. Isohätälä et al., 2017; Ucan & Webb, 2015; Volet, Summers, et al., 2009). Less is known about how regulation of learning develops over time (Ucan, 2017) or is affected by social factors (Isohätälä et al., 2017), and Panadero (2017) calls for further research to understand regulation mechanisms more precisely, in different contexts and so on. In fact, several authors agree on the importance of further investigation into regulation of learning in naturalistic setitngs (Boekaerts & Cascallar, 2006; Butler, 2011; Perry & Rahim, 2011; Winne & Perry, 2000; Zimmerman, 2008). In concluding their own study Isohätälä et al. (2017) suggest that socially shared regulation of learning has a hand in the dynamics of collaborative learning. With specific relevance to the present

study, the same paper goes on to call for more research on the influence of socio-emotional aspects on socially shared regulation of learning and collaboration. Similarly, but from a different perspective, Dignath et al. (2008) conclude their meta-analysis of regulation-promoting interventions by suggesting the influence of teacher behaviour on the process of regulation of learning requires further investigation.

2.12 The Present Study

By way of an appropriate summary of the aims of this project;

> *"We need to know more about congruence and friction between learning and teaching strategies, the way in which different levels of self-regulation and external regulation of learning processes operate upon one another and whether this interplay occurs differently in different kinds of learning environments. Forthcoming research should also be directed at the way the transition of teacher-regulation to student-regulation of learning processes can be concretely realized in different learning environments."* (Vermunt & Verloop, 1999, p. 277).

While this quote is from over two decades ago, it very much remains relevant. The present study targets the dynamic regulatory process in situ as students learn collaboratively in the classroom. Classroom-based regulation is not only more complex than tightly controlled experiments but is also arguably more difficult to measure. With this challenge could come great reward. A deeper understanding of the nature of this dynamic process will provide a more solid theoretical grounding from which knowledge of factors affecting the process, longitudinal development and classroom practice can be developed.

In contrast to much of the previous research discussed in this chapter, the present study takes a mixed methods, interpretive approach to case study. In doing so, the intention is to bring the concept of regulation of learning into the real, dynamic, functioning classroom and investigate the intersection between theory and the manifestation of regulation in this scenario. The use of mixed methods as described in chapter three has allowed the collection of incredibly rich data, with minute-by-minute information on regulatory acts taking place in working collaborative groups. Alongside novel analysis methods described in chapter four, a somewhat unique insight into the landscape of regulation of learning during collaboration is provided.

The extensions to prior research this study provides can be described from two perspectives. Firstly, in-depth analysis of the manifestation of regulation during collaboration within an ecologically valid classroom setting provides opportunities to learn more about this phenomenon in the most common educational setting across the globe. Observing regulatory behaviours across multiple classroom context also allows for tentative identification of trends and patterns. Secondly, from a methodological perspective, the application of graph statistics to collaborative settings provides a novel method for the

analysis and visualisation of the regulatory process and allows for temporal analysis with minimal loss of fidelity. The following chapter outlines in detail the methodology and research design of the present study.

3 Research Design and Methodology

3.1 Introduction

This chapter outlines the methodological approaches taken and justifies decisions made in the design and implementation of this investigation. In this chapter, the philosophical positions and assumptions that underpin this study are discussed. Next, the case study format of this study is outlined and justified. This is followed by a thorough discussion of the research design, beginning with sampling and research context. Data collection procedures are examined, followed closely by an examination of analytical methods. Ethical considerations and ways in which trustworthiness has been designed into this project can be found throughout this chapter, but a summary discussion of these topics is found in section 3.8. The chapter ends with a summary in section 3.10.

3.2 A Mixed Methods Interpretive Approach

Since the present study aims to learn more about the process of the regulation of learning in collaborative groups in the classroom, it looks to move away from an experimental approach seen frequently in prior literature discussed in chapter two. A naturalistic approach that provides access to the dynamic process of regulation in a real-life classroom is consistent with this aim and underpins the design decisions made in the present study.

In keeping with the aim to explore the behaviour of students on an individual level, an emphasis on qualitative data seems appropriate. The intention of qualitative approaches is to provide “an in-depth and interpreted understanding of the social world of research participants by learning about their social and material circumstances, experiences, perspectives and histories” (Snape & Spencer, 2003, p. 3). The use of the word interpreted in this quote is key, as this approach to research is commonly associated with the interpretive research paradigm, which, generally speaking, aims to understand subjective experiences. This is contrasts with the positivist paradigm, which relies on the possibility that information can be gathered objectively. The subjectivist epistemology that is assumed in an interpretivist approach to research suggests that the researcher and the subject are inextricably linked, and that transactional, subjective knowledge of the subject of research is created as part of this relationship (Guba & Lincoln, 1994). Transposing this to the study in hand, an interpretivist approach to this project suggests that an understanding of the subject is constructed by the researcher through interpretation of the interactions between the researcher and the participants as part of the research process. Within this paradigm it is impossible to consider the researcher as anything other than a pivotal part of the research itself and this must be considered throughout the design. This last point is particularly important to consider in the present study. Alongside continuing to practice, the researcher in this case is researching within their own professional context. These two roles, or the hybrid role of researcher-practitioner, researching practitioner or practising researcher, compound the fact that the researcher is part of their research themselves. This is not just as an interpreter, but as a dimension of

the context in which the research itself takes place. Rather than attempt to artificially remove this dimension of the research, a naturalistic, interpretive approach allows this positioning of the researcher to be embraced. With careful design, it can be ensured that this adds value to the research rather than undermining it. This approach can allow the researcher to 'place emphasis and value on the human, interpretive aspects of knowing about the social world and the significance of the investigator's own interpretations and understanding of the phenomenon being studied' (Snape & Spencer, 2003, p. 7).

Whilst the emphasis is certainly placed on qualitative data in this project, aiming for in-depth understanding of a small number of individuals, traditionally quantitative methods are also implemented in order to best answer the research questions. The mixing of these paradigms, often known as mixed-methods research, is increasingly employed in a bid to answer research questions as best as possible, but mixing of methods has challenges and must be no less rigorous than perhaps more traditional approaches. The use of quantitative analysis may initially seem at odds with the principals of interpretive studies, but such incongruence may arise from ways in which quantitative methods are applied to social and cognitive phenomena rather than any inherent characteristic of the methods themselves (Vann & Cole, 2004). After Erickson (1986), it is more appropriate in this study to avoid labels such as qualitative and refer to interpretive methods, because 'it avoids the connotation of defining these approaches as essentially non-quantitative' (Erickson, 1986, p. 119). Quantification of sorts is used throughout this study. In terms of mixed methods definition, this is in the form of triangulation, wherein traditionally quantitative and qualitative methods are carried out concurrently, or within the same time frame, and interpreted to address the same research question(s). This research design most closely resembles the convergent model variant (Cresswell & Plano Clark, 2017), which is discussed in more detail in section 3.4.

In summary, an interpretive case study approach is well-suited to address the research questions in the present study. Within the field of regulation of learning research, this sort of approach can provide rich, holistic descriptions to address 'what, how, why and when' questions, emphasising the social context in which the studied phenomenon is nested (Patrick & Middleton, 2002). An interpretive approach reveals and investigates the complex nature of these phenomena, delving into the details of individual experience (Ellefson et al., 2019). It is reasonable to conclude that the approach outlined in this chapter aligns well with the intentions of the research questions outlined in section 3.4. An interpretivist investigation into the regulation of learning in collaborative learning episodes can provide rich, contextualised descriptions of students' regulatory behaviour, providing insight into individual experiences and differences, with an emphasis on the social context of the regulation of learning observed.

The research questions of the present study seek an in-depth exploration of the manifestation of regulation of learning in a range of contexts for a small sample in a naturalistic setting. This is in contrast with studies which aim to identify and explain factors which affect these behaviours in controlled,

experimental contexts. The latter approach is characterised by the use of a quantitative-led, positivist designs. In this case, a qualitative-led, interpretivist perspective is deemed more appropriate for the research questions in section 3.4. Perhaps more importantly, this design provides a rare opportunity for insight into the individual experiences of students within these contexts. This can provide details which can support and contrast the more common quantitative-led approaches, building a richer picture and deeper understanding of the phenomenon of regulation of learning in collaboration on an individualistic level.

3.3 Case Study

Within the interpretive framework, the most effective way of achieving the aims of this project is through a case study. This section outlines the rationale for this design. Case study is used to describe a vast range of research with varying degrees of reference to social science literature on case study methodology (Tight, 2010). Before going into the details of the present study, it is pertinent to define a case study. As a starting point, Punch (2005, p. 144) states,

> *"The basic idea is that one case (or perhaps a small number of cases) will be studied in detail, using whatever methods seem appropriate. While there may be a variety of specific purposes and research questions, the general objective is to develop as full an understanding of that case as possible."*

There is some agreement that case study can take many forms, using whatever methods seem appropriate. Bryman (2004) clarifies that the frequent association of case studies with qualitative research is inappropriate. In fact, there is some agreement that case studies are a forum for the use of whichever sources of data best answer the question at hand (Demetriou, 2013). Again, the use of the term interpretive in place of qualitative may be appropriate here (Erickson, 1986). The flexibility of case study as a methodology could be cited as a key advantage of the approach, but is not conducive to a succinct definition. Perhaps more fittingly for a project such as this one, Bassey defines case study from a more applied and practical perspective:

> *"[Case study is an empirical inquiry] conducted within a localised boundary of space and time; into interesting aspects of an educational activity, or programme, or institution, or system; mainly in its natural context and within an ethic of respect for persons; in order to inform the judgements and decisions of practitioners or policy-makers; or of theoreticians who are working to these ends; in such a way that sufficient data are collected for the researcher to be able …to explore significant features of the case … create plausible interpretations … test for the[ir] trustworthiness … construct a worthwhile argument …[and] convey convincingly to an audience this argument."* (Bassey, 1999, p. 58)

In essence, case study is defined here not simply structurally but in terms of its intention. This is also seen in the categories defined by Yin (2013), namely exploratory, explanatory and descriptive case studies, which intend to investigate, rationalise and detail cases respectively. Stake (2005) identifies three alternative categories; intrinsic, wherein the researcher seeks a better understanding of the case in particular, instrumental, wherein the case is studies as a means to provide an insight or redraw a generalisation, and collective, wherein multiple cases are studied to investigate a phenomenon, population or general condition.

With regards to the present study, the description of case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2013, p. 13) aptly illustrates the reasoning behind designing this project as a case study. Case studies are often used to answer 'how' and 'why' questions to understand complex social phenomena with many variables over time, and utilising multiple data sources (Yin, 2013). When case studies are conducted in naturalistic settings using multiple data sources, they can provide a rich picture of the phenomenon being investigated. The case study methodology arguably has a capability of unearthing and defining causal links, mechanisms and interaction effects where other approaches may not (Demetriou, 2013), though it should be noted that identifying causal links is not an intention of this interpretive case study.

Interestingly, Tight (2010) argues that labels such as exploratory, explanatory and descriptive (Yin, 2013) or intrinsic, instrumental or collective (Stake, 2005) aren't necessarily helpful, but that a succinct, descriptive statement is more valuable. This concern is no doubt borne out of the liberal and often unqualified use of the term case study. In this spirit, the research design is outlined in detail in section 3.4. With regard to the use of case study, the points outlined by Bassey (1999, p. 58) are used as a framework to summarise the rationale behind the case study methodology of this project in table 3.1.

Characteristic	Application to Current Study
Conducted in a localised boundary of space and time.	Conducted in a limited number of upper secondary classrooms in a single school over the course of nine weeks.
Investigating interesting aspects of an educational activity…	Investigating how regulatory processes manifest in collaborative groups…
…in its natural context and within an ethic of respect for persons.	…in the upper secondary classroom without intervention. See section 3.8 for ethical considerations.
Conducted in order to inform the judgements and decisions of practitioners and theoreticians.	Conducted in order to contribute to knowledge of regulation and indirectly improve teaching and learning as a result. See section 3.9 for further discussion of intended impact.
Sufficient data are collected for the researcher to be able to construct a worthwhile argument.	Data was triangulated and analysed, and cases analysed in detail to construct a rich picture of the phenomenon.

Table 3.1: A summary of the correspondence of aspects of this project with the case study format according to Bassey (1999).

In terms of outcomes, as an interpretive, naturalistic and small-scale case study, the present study is not concerned with generalisability of outcomes. This aim is reserved for other large statistical or experimental studies. That said, naturalistic generalisation by the reader is encouraged, specifically assessing the relevance of the findings here for new contexts, perhaps that of the reader (Stake, 2005). The case study in hand does aspire to analytic generalisation, in which research findings can inform, elaborate or question theoretical concepts which can be more generally applied (Yin, 2013). Limitations of a case study methodology are outlined later in this section.

In sum, it seems apparent that an interpretive, naturalistic case study methodology is appropriate for the fulfilment of the aims of the present study. More specifically, a collective or multiple-case study design was deemed the most appropriate. Case studies can broadly be defined as intrinsic, instrumental or collective (Stake, 2005). In contrast to intrinsic case studies, wherein a case is selected because of some sort of intrinsic quality, i.e. a unique or unusual situation which makes it an interesting case to be studied, or instrumental case studies, wherein a representative case is chosen to investigate an issue or phenomenon, collective or multiple-case studies focus on an issue or phenomenon by selecting multiple cases. While not intended to be generalisable, multiple-case studies can interpret contrasting or similar results from different studies even on a small scale such as in the present study (Yin, 2013). A key reason for the employment of a multiple-case study design was the fact it allowed

focus on individual differences between students as cases. Whilst not intending to allow direct comparison, it further allows the development of a deep understanding of similarities and differences in the deployment of regulatory behaviours in collaborative settings. This cumulative approach to data collection and interpretation, using information from a number of cases to build a rich picture of the phenomenon, both aligns with the intention of the research questions of the present study and enhances its robustness and reliability (Freebody, 2003). On a practical note, the use of multiple cases also reduces potential impact of disruption of the research project as other cases can be relied upon if a case drops out or is somehow compromised. Whilst in no way a reason to follow a multiple-case study design in and of itself, this practical benefit did have a significant impact on the present study in light of disruption caused by the COVID-19 pandemic in 2020, as discussed in section 3.5.

Limitations of Case Study

Many of the criticisms of case study as a methodology rest on issues around extrapolation or generalisation of findings. Critics often argue that what is learnt from an individual case cannot be extrapolated as it is not possible to achieve absolute typicality or representation. Proponents would argue that the validity of extrapolation and the worth of knowledge produced by case study 'depends not on the typicality or representativeness of the case but on the cogency of the theoretical reasoning.' (Mitchell, 1983, p. 207)

Case study has also been criticised for lack of construct validity in particular, leading to subjectivity of the researcher. As a well-documented methodology, many authors have reported ways to remedy issues. Yin (2013) proposes the relatively intuitive solution of the use of multiple sources of evidence, establishing a chain of evidence, and allowing key informants or stakeholders to review draft findings.

In response to concerns that case study methodologies cannot be generalised, or are more suited to development of hypotheses rather than theory, Flyvberg (2004) argues that all knowledge in social sciences is context-dependent. In education, the value of context-dependent knowledge is as valuable if not more valuable than context-independent. Researchers have a responsibility to both consider and communicate their sampling and data collection carefully. Flyvberg argues that confirmation bias is a concern for all social science research and is not reserved specifically for case study. In the present study, triangulation has been employed to limit and question the potential of confirmation bias.

Researchers undertaking case study research, in its many guises, have a responsibility to draw on these discussions to ensure their design is as rigorous as possible. Careful thought in particular must be given to how the case and the data emerging from it is communicated and presented to the reader.

> *"The problems in summarising case studies, however, are due more often to the nature of the reality studied than to the case study as a research method. Often it is not desirable to summarise and generalise case studies. Good studies should be read as narratives in their entirety." (Flyvberg, 2004, p. 402)*

How this will be done in this case is discussed in section 3.4, after the structure of the proposed project is outlined further.

3.4 Research Design

The following section serves as an overview of the design of this project. First, the research questions are outlined in more detail, including the focus and contribution to the aims of the project of each question.

Research Questions

The research questions that underpin this project are driven by a desire to investigate and better understand the phenomenon of regulation of learning in social settings, and to improve classroom practice as an indirect result. This section frames and outlines the rationale behind the research questions, as well as more closely defining the questions themselves. The questions here are discussed in light of the restrictions placed on the present study by the implications of the COVID-19 pandemic. The effects of this, and adaptations made to the research design as a result, are discussed in section 3.5.

In broad terms, the aim of this project is to investigate and improve the understanding of regulation of learning in the classroom during collaborative learning. It is crucial that this is naturalistic in approach as the present study looks to build understanding in the context of the ecologically valid classroom, a setting in which the vast majority of children across the world complete their formal learning. Beyond the present study, a deeper understanding of the phenomenon will support the development of a greater understanding of the factors affecting the quality of regulation in collaborative settings, individual differences in its emergence and nature, and ultimately will support the development of teaching practice. An indirect aim, therefore, is to contribute to the development of teaching practice to better support and maintain the development of learners into proficient regulators of learning in the classroom and beyond. However, to improve classroom practice in a targeted and evidence-driven manner, it can be argued that first the understanding of the nature of regulation of learning in collaborative groups must be improved. As such, the research questions pertaining to this direct aim are summarised as follows:

1) Under what circumstances do students display regulatory acts during collaborative learning in small groups?

2) What relationship exists between regulatory acts observed during collaborative learning in small groups and what patterns and tendencies are evident?
3) What are the individual differences in students' use of regulatory acts during collaborative learning?
4) How does a regulatory process emerge and function during collaborative learning?

Before a further discussion of the methodology and methods used to broach these questions, it is important to highlight the motivation, focus and nature of the questions themselves. As such, the four questions are discussed in more detail in this section.

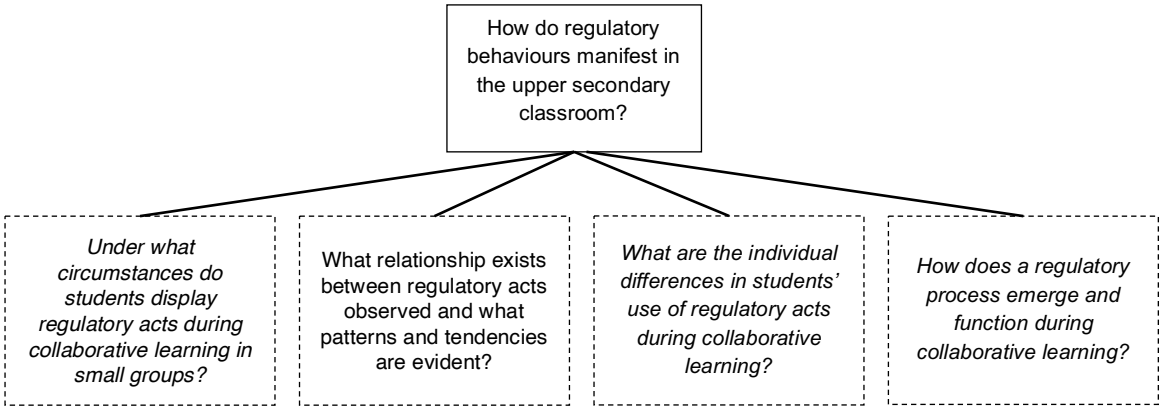


Figure 3.1: The relationship between the four research questions and the overarching enquiry.

Under what circumstances do students display regulatory acts during collaborative learning in small groups?

This initial question aims to explore the circumstances under which behaviours defined as regulatory in the present study can be detected within collaborative learning episodes in a naturalistic classroom environment. Regulation of learning in collaboration has been observed in numerous experimental settings as seen in section 2.10, but when and to what extent can these same behaviours be seen in a naturalistic classroom setting? The motivation behind this question is one concerned with practice, as if these acts are observable and give information about the process of regulation of learning, this is a potential area for development in terms of teaching practice and professional development.

What relationship exists between regulatory acts observed during collaborative learning in small groups and what patterns and tendencies are evident?

This second question aims to identify and analyse patterns and trends in the emergence of regulatory behaviours in collaborative learning. To clarify, it does not aim to address the development of regulation of learning competency over time, but by addressing patterns, aims to provide further insight into what happens during collaboration in terms of regulation of learning. This requires analysis both within and between recorded episodes, but the small sample means discussion cannot directly compare instances

of interest, but rather identify and discuss inconsistencies, similarities and anomalies without recourse to causal links. This question targets the development of knowledge on the nature of regulation of learning in the case(s) featured in the present study. These findings do not focus on causes or factors affecting the nature of acts observed, but rather the interrelation of the acts themselves.

What are the individual differences in students' use of regulatory acts during collaborative learning?
The third research question, following on from whether students display regulatory behaviours, and then what patterns and tendencies are emergent in their use, focuses on the theme of individual differences. This question capitalises on the multiple case study format of the present study to look into whether differences in behaviours and patterns in behaviours can be identified in the recorded episodes. Once again, this aims to build on understanding of how regulation of learning takes place in the classroom, with the idea of differences between students being central and often overlooked in favour of broad-strokes, general models. In part owing to the restrictions on the present study caused by the COVID-19 pandemic, the findings related to this question stop short of explaining factors affecting individual differences with any certainty, but refer to a small number of rich cases which exemplify the nature of individual differences in from the perspective of the regulation of learning in collaborative groups.

How does a regulatory process emerge and function during collaborative learning?
The final research question aims to draw upon the first three to build a picture of the nature of the process of regulation of learning in the context(s) of the case(s) of the present study. There is a crucial definition to be made here between regulatory acts and the regulatory process. In broaching this final, more complex question, observations of regulatory acts have to be tied together to build a picture of the process, i.e. a series of acts. This attempt to glimpse the underlying, dynamic process of regulation of learning by considering multiple acts as parts in a storyline draws strongly upon the second question too, as analysis of patterns and tendencies builds into the construction of a process from observed data. Once again, this question seeks to examine both the emergent process itself, and the extent to which it is possible to elicit a picture of a regulatory process from the data in the present study. This has significant implications for developing the depth of understanding of the nature of regulation in a naturalistic classroom, as well as for practice and professional development for those who may work in settings similar to those described in the present study.

Design Summary
By way of a summary, figure 3.1 visually represents the design of the present study. All four research questions discussed in section 3.4 can be appropriately addressed with the same data sources and as such will be broached concurrently.

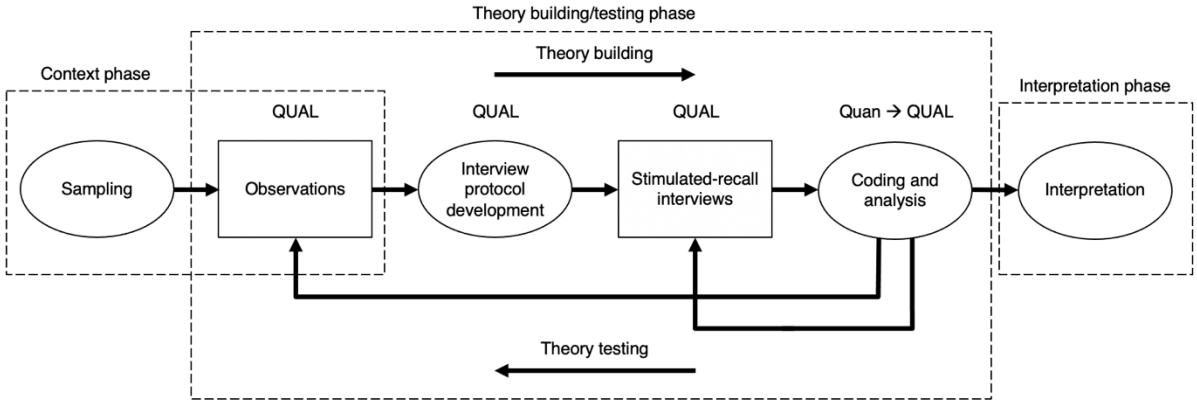


Figure 3.2: A summary of the research design

Figure 3.1 represents the research design by way of a flow diagram with three primary phases, the context phase, the theory building/testing phase, and the interpretation phase. These three stages consist of multiple steps, which figure 3.2 attempts to summarise. Within the diagram, data collection stages are noted with an oblong, and data handling such as sampling, analysis and so on, are noted with an oval. The traditional characterisation of data or data analysis as either qualitative or quantitative is noted. For example, QUAL, noted above the observations phase denotes the collection of qualitative data, and QUAL noted above the development of and interview protocol denotes qualitative analysis, which is detailed further in section 4.5. QUAL is noted in uppercase letters as the qualitative data has greater emphasis placed on it in the present study (Morse, 1991).

The notation above the final analysis stage, Quan → QUAL indicates a sequential approach to analysis (Morse, 1991). This fits an explanatory mixed methods design which can be used to provide a deeper insight into a phenomenon (Plano Clark, 2019). Each stage is outlined in more detail below.

The reciprocal design is a challenge to succinctly visualise, so a thorough description of figure 3.2 seems appropriate. As can be seen in figure 3.2, the initial stage, sampling, is part of the context phase of the research. As discussed in section 3.7, contextualisation is crucial for a trustworthy and meaningful interpretive study on any topic. In this case, sampling refers to the initial selection of students, the sample of lessons recorded, and the collection of contextual data on these, such as the identity of the teacher, the topic covered and so on. The outcomes of this stage frame the rest of the data and can be seen throughout chapter five as contextualising the episodes that were recorded. The second item in figure 3.2 is the observations, which refers to concurrent observation and video recording of selected lessons, discussed in detail in section 4.4. This aspect of the research design further explores the context through the collection of field notes. The second, most substantial phase of the design is the theory building/testing phase. In this notation, theory refers to small-scale, highly contextualised understanding of the specific cases studied and does not allude to the creation of generalisable, overarching theory per se. This phase consisted of four key stages, the first of which is observation and simultaneous video-recording of a lesson. The live observation led directly into development of the

interview protocol for stimulated-recall interviews which took place within 24 hours of the observed lesson. Finally, the video data was coded and quantitatively analysed including the use of directed graphs, followed by full analysis and complete integration of data from the stimulated-recall interviews. The final stage of the research design is the interpretation of the data produced from the previous stages.

It is important to note that the analysis stage of the design will inevitably influence subsequent stimulated-recall interviews and even the focus and interpretations of the observer as more is learnt about the tendencies emerging with respect to regulation of learning. This was an opportunity to test theories emerging from data already collected, but it should be noted that complete transparency was required to ensure trustworthiness of this aspect of the research design. The coding scheme for graphical analysis of the video recordings was not adapted once the data collection phases started, but as more recordings were collected, inevitably a richer picture of the phenomenon was built and interpretations are inevitably a product of this deeper understanding. The final, interpretation phase, draws together all of the analysis of all of the data collected as part of all observations, recordings and stimulated-recall interviews.

Figure3.1 represents the idea that live observation and video recording data will inform the stimulated recall interviews, before all three work alongside each other to broach the research questions. This triangulation of mixed data sources was, as discussed in section 4.6, deemed to be the most appropriate design for the questions and context at hand.

Overall, through these questions and data sources, this study seeks to get the best picture of what is happening through a mixture of what could be considered primarily quantitative and primarily qualitative measures. Plowright (2011) rejects these traditional labels and refers to numerical and narrative measures, and mathematical and narrative analysis. This proposal uses a mixture of methods of both collection and analysis, for example coding will be used to produce numerical (mathematical) data and to gain a deeper qualitative understanding of the video observations made. According to Erickan and Roth (2006), the use of mixtures of methods allows the choice of the best combination of methods to fit research questions.

3.5 Context and Sampling

The Context of the Study

The present study took place in a medium-sized comprehensive secondary academy in south London. The school has a significant proportion of students with English as an Additional Language, and those in receipt of Pupil Premium. Exam results are generally good, and students make very good progress from Key Stage 2 to GCSE. The school has a sixth form (curriculum years 12 and 13) and a significant proportion of students choose to stay at the school for these final two years after their GCSE exams.

Progress over these two years also tends to be good, but not at the same level as GCSE and anecdotally in the experience of the researcher, students struggle with the independence afforded to them in this final phase of their secondary education. The present study is nested within this context aiming to find out more about the regulation of learning that does take place within these classrooms

Sampling

Sampling is an important issue in social science research as it directly impacts the trustworthiness and conclusions of a study. Traditionally, random sampling in small scale, interpretive case studies is unusual. The potential for random sampling to produce statistically representative data requires large sample sizes and extensive data sets. The present study focuses on only a handful of students, so representation is near enough impossible. It has been suggested that purposeful sampling in interpretive research is key to select "information rich cases for study in depth" so that "one can learn a great deal about issues of central importance to the purpose of the research" (Patton, 2014, p. 169).

There were 42 students available to be focus students. This number was approximately a third of the curriculum year 12 cohort, reduced to those who could be observed in at least two lessons by the researcher, alongside the researcher's teaching responsibilities. While initially it was intended that these students would be profiled in terms of attainment and self-report regulation surveys, it was decided that this additional stage would not add to the contribution to the research questions. As such, three students were selected from the 42 available students who had different attainment profiles based on their GCSE performance and who studied a range of different subjects. Attainment was chosen as a dimension as it has potential implications for regulation of learning, as discussed in section 2.6. Each of the three students shown in table 3.2 was followed throughout a number of their lessons. While these three students were the focus of the study, because they would be working with several others in their collaborative groups throughout the study they can be seen as 'threads' around which other individuals were introduced.

Student	Prior Attainment	Subjects Studied
A	Low	Biology Health & Social Care Chemistry Spanish
G	Medium-High	English Chemistry Psychology
R	High	Biology Chemistry History

Table 3.2: A summary of the sample of students who were followed throughout their lessons

All three students agreed to be part of the study. The intention was that these three students would be followed through their lessons over 12 weeks. A randomly selected lesson of each student would be recorded, and video data recorded in those lessons analysed. It should be clarified here that the selection of a small number of focus students to follow through their lessons was effectively a method of sampling the groups that were recorded. Whilst both staff and students involved were all asked to provide informed consent for this data collection, neither staff nor students were told which lessons this would take place in. Teachers were not given any particular instructions around how students should be grouped, or what sort of activities would be looked for within lessons. The idea being that the ecological validity of the setting was preserved as far as possible. The recording and analysis of contrived or artificial activities or contexts was not seen as valuable in contributing to the aims of the present study. This does, however, lead on to potential concerns around validity of conclusions that might be made from this data. The recording of the same student but in a different context, i.e. with a different teacher, peer group, mood, task type and so on provides a significant list of potentially confounding factors and could mean that drawing out conclusions associated with contributing factors is very difficult. It should be emphasised once again that the aims of the present study are not to elucidate causal links, wholly generalisable conclusions or new wholesale theoretical models, but to contribute to the existing knowledge through a small-scale interpretive case study which can challenge and contribute to existing literature. The aim was that trends, tendencies and patterns would be identifiable and contributing factors may be interpreted. In fact, the intention was that each student was recorded during six lessons of eighty minutes each, totalling 480 minutes of recording per student and 1440 minutes of recording overall. Whilst the amount of time coded and fully analysed will depend on the sections of these recordings which fit the data reduction criteria for collaborative learning, outlined in section 5.2, this is a significant amount of rich, contextualised data, the analysis of which was deemed to directly contribute to the investigation of the research questions found in section 3.4.

Not every minute of the recordings was coded. Only periods of interaction longer than three minutes, deemed to be about the learning opportunity and including more than two individuals were fully transcribed and coded. This system ensured that only significant periods of interaction were coded and that spurious interactions were not included. This data reduction was deemed necessary partly due to the sheer volume of data collected, but it was also clear that patterns and tendencies are only possible to elicit from extended periods of interaction beyond a handful of utterances. There were very few sections of the recordings that were anything other than fully transcribed, absent of interaction, or representative of teacher instruction. Where relevant to the context of the episode, examples of these ostensibly extraneous interactions are detailed in chapter five. For example, a phase of questioning by the teacher in episode two is detailed in section 5.4. In this case, it was deemed relevant to the context of the primary phase of transcribed and coded interaction presented in detail in that section. Similarly, episode one was absent of any phases of interaction fitting these data reduction criteria, so a section of the recording was transcribed and coded around a single interaction of interest, identified during the

concurrent observation. This served to highlight and investigate the notable lack of collaboration in said episode, discussed in section 5.3.

An outline of the selected recordings is shown in table 3.3. As all recordings, observations and interviews were conducted by the one researcher, who also worked full time in the case school, lessons were chosen at random from those for which the researcher was available. The aim of recording each student a total of six times was planned over nine weeks to ensure there was time to complete the necessary recordings and the follow-up stimulated recall interviews. This also allowed for some room for cancellation or postponement of recordings caused by, for example, student absence. Unfortunately, while leeway was planned in, some events cannot be prepared for. Nationwide disruption and school closures due to a global pandemic fall into this category. The following section outlines the impact of the COVID-19 pandemic on the research design and methodology of the present study.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
A		Biology	Chemistry	H&SC	Biology		H&SC	Chemistry	
G	English		Chemistry			Psychology	English	Chemistry	English
R		Biology	Chemistry		Biology	History		Chemistry	History

Table 3.3: An outline of the planned recordings for the three students A, G & R followed through their lessons.

The Impact of the COVID-19 Pandemic

Unfortunately, as can be seen from the shaded section of the timeline in table 3.3, whilst the first three weeks of recording went ahead as planned, the fourth week did not go ahead due to staff absences and the case school closed at the end of week four. This was a national school closure from 23rd March 2020 due to the COVID-19 pandemic which meant that completing the cycle of data collection was not possible. This is of course problematic from an analysis point of view, as the following of the same students in different lessons was intended to reduce the impact of other contributing factors to regulatory behaviour and expose patterns and tendencies. This is of course a frustration, but categorically unavoidable. This is particularly true as the researcher, having resigned their post at the case school in August 2020, no longer had access to the focus students to continue data collection, albeit in a vastly different context taking into account policies resulting from the pandemic. The data therefore consisted of two recordings of each focus student. Noting the crossovers seen in table 3.3, e.g. student A and student R were recorded in the same biology lesson in week two, this amounted to three 120-minute recordings, totalling 360 minutes. Whilst far from an ideal situation, it was not feasible to restart data collection in a new case school given the timeframe of the present study and the continuing disruption and limitations caused by the COVID-19 pandemic and the resulting guidance and regulations. Instead, the limited data collected was analysed and interpreted as planned. The impact on this process was significant, with the limited amount of data meaning that the design of the project now lacked mitigation for confounding factors in the regulation of learning observed. Comparison between recorded episodes

and between students was not feasible. Having said this, interesting themes emerged from analysis and the richness of the data collected, albeit in a limited number of cases, was such that sufficient interpretations of data could be made with sufficient validity so as to contribute towards the research questions in section 3.4.

3.6 Data Sources and Collection

Responding to suggestions that more research is required in how students' regulation of learning manifests as a process in naturalistic cases using multiple interpretive data sources (Boekaerts & Cascallar, 2006; Butler, 2011; Perry & Rahim, 2011; Winne & Perry, 2000; Zimmerman, 2008), the present study uses video observation of classroom behaviours and stimulated recall interviews with individual students to build a rich picture of the process of regulation during collaborative learning. Given the context-specific nature of regulation of learning as a process, this data is heavily contextualised and field notes on the lessons structure, types of activity and so on also played a significant role in the understanding of the processes observed. Such triangulation provides the depth of understanding and insight that makes such small scale interpretive studies so valuable in furthering the understanding of both researchers and practitioners of the naturalistic processes of regulation in the classroom (Ellefson et al., 2018; Järvelä et al., 2010; Volet, Vauras, et al., 2009).

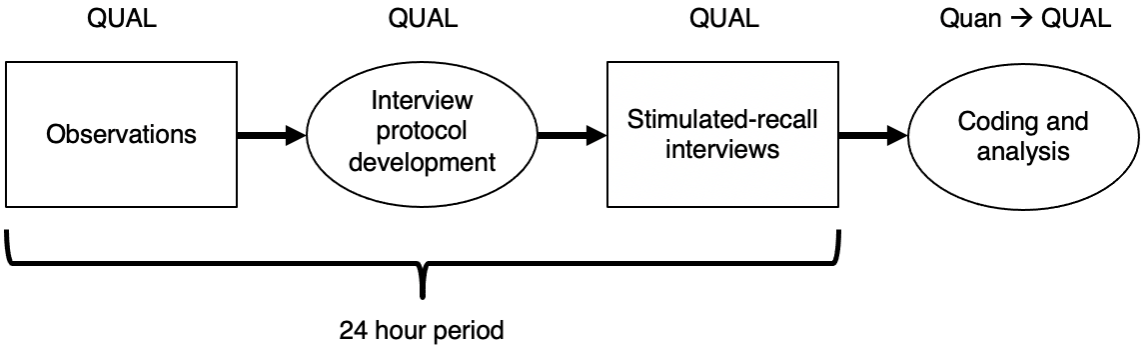


Figure 3.3: A flowchart of the data collection process.

Video Observations

The coding and analysis of video observations formed a key component of this study. Observation has been a fundamental part of the development of teaching and learning for a considerable amount of time, but the development of audio-visual technologies over the last two decades or so has allowed growth of video observation as part of classroom-based research. A summary of advantages and limitations of video-based observation is shown in table 3.4 (Hargreaves & Wolfe, 2007).

Strengths	Issues	The Present Study
Video allows reconstruction of aspects of the social situation or activity observed.	Video may not capture all the information necessary to categorise behaviours accurately.	In order to provide the richest information possible, classrooms were video-recorded, and groups all had individual audio recorders to ensure clarity of recording.
Video can be reviewed and considered many times, from alternative perspectives and different disciplinary backgrounds.	Video can affect or inhibit the people being observed. Although they may appear to acclimatise quickly, the camera's presence may then change the interaction involved.	Recording lessons is common in the context of the present study, so although some utterances and behaviours acknowledging the camera or microphone can be identified, students are likely to be somewhat used to this set up.
Video enriches the record of speech. It allows observers to track body language and note mediating artefacts, for example.	Video raises ethical issues in relation to ownership, anonymity, confidentiality, and future use of the video. Permission must be sought in advance to deter possible abuse or misuse of video data.	See section 3.8 for a full discussion of ethical considerations.
Video with reflective dialogue can raise awareness, enhance reflection and promote professional dialogue.	Video requires a high level of trust and mutual support for shared reflection.	All students gave informed consent to take part in stimulated-recall interviews, during which they reflected on the video clips to the degree they felt comfortable.
Video offers a tool for assessment, monitoring language development and making cognitive and metacognitive processes visible.	Video can suffer from technical problems, such as poor-quality sound and shortage of power supplies.	Following a pilot of the coding scheme and recording protocol, additional microphones were assigned to each group containing a focus student to ensure sufficient quality for transcription and analysis.

Table 3.4: A summary of advantages and issues with video observation after Hargreaves and Wolfe (2007, p. 219) including contextual information from the present study

The video recordings made as part of the present study aimed to capture verbal and non-verbal behaviours indicative of regulatory processes. Whilst informed consent means students and teachers were all aware that audio-visual recordings were taking place, these were as discreet and unobtrusive as possible in order to minimise its detrimental effect on ecological validity. A camera was placed at the edge of each classroom with the group or groups being recorded in shot, but with the camera far

enough away so as to reduce the disruptive influence of the presence of the camera. In an initial trial it was found that the directional microphone of the camera was not sufficient to collect audio data of a high enough quality to transcribe and code, so sound recorders were also used concurrently with the camera, with one audio recorder placed in the centre of each group to be recorded. Whilst it is possible that these recording methods did impact the behaviour of individuals in the classroom, both students and teacher, the acknowledgement of the recording devices was only observed at the beginning of the lessons. Recording is not uncommon in lessons in this school as it is regularly used for teacher professional development and training.

The researcher stayed in the back of the classroom, not interacting with any other individuals in the classroom and collecting general observations or field notes. These consisted of descriptions of phases of the lesson, learning activities and notes of timings of seemingly important events to refer to in the stimulated recall interviews. The researcher's role in this case can be described as a participant as observer, in that the sole purpose was to collect data, but all others in the classroom were aware of the observer's presence (Adler & Adler, 1994).

The observations made in this project were coded according to the scheme developed and outlined in section 4.3. As described in section 4.2, the observation data described here relies on overt behaviours which can be attributed to regulatory processes. It is therefore important that these data were triangulated to improve the reliability of inferences and interpretations made about the underlying internal and therefore invisible processes (Järvelä et al., 2010; Patrick & Middleton, 2002; Perry et al., 2002). Reliability of the analyses made were enhanced through the use of stimulated-recall interviews, and the inter-rater reliability of the coding scheme was tested as seen in section 4.3. Details of the stimulated-recall interviews are outlined in the following section.

Stimulated-Recall Interviews

In order to cross-examine the findings from analysis of the audio-visual recordings, individual focus students underwent stimulated-recall interviews following each recorded episode of collaborated learning. Stimulated recall interviews have been used in the present study to examine the findings from video and live observations in more detail by eliciting what cannot be observed, namely students' reflections, emotions and intentions during collaborative learning and while displaying regulatory acts. This form of interview allows participants to reflect on their actions and feelings while their recall of these is stimulated by video episodes of themselves performing the original task or activity to be reflected upon (Boekaerts & Corno, 2005). This contribution is invaluable in the present study as it allows triangulation of the inferences and interpretations of the video observations by the researcher and provides further insight into not only the actions themselves, but the intentions and decision-making behind them.

This aspect of data collection also aims to increase trustworthiness by corroborating and questioning findings. This could be seen as a form of microanalysis, defined as “a strategic, co-ordinated plan of administering context specific questions targeting multiple cyclical phase sub-processes as students engage in authentic activities” (Cleary et al., 2012, p. 4).

During each recording, the researcher was present in the lesson, allowing them to identify and note timings of key moments that could then be used to stimulate recall in the interviews. In line with procedures for stimulated-recall interviews in other studies, time codes noted during the live observation were used to expediate the selection of video episodes prior to each interview. These short video episodes were selected on the basis that they were indicative of representative regulatory acts suggesting regulation of learning by the interviewee or group as a whole.

Interviews took place a maximum of 24 hours after the recording to ensure that recall was as unaffected by time passing as possible. This is again in line with the recommendation that this kind of interview takes place as soon after the focus event as possible (Denley & Bishop, 2010; Schepens et al., 2007). The schedule of interviews that took place is shown in table 3.5.

Student	**Interview One**	**Interview Two**
A	Interview following biology lesson 21m	Interview following chemistry lesson 16m
R	Interview following biology lesson 19m	Interview following chemistry lesson 17m
G	Interview following English lesson 14m	Absent for interview following chemistry lesson -

Table 3.5: A summary of the stimulated-recall interviews undertaken as part of the present study.

Open-ended questioning was used during the stimulated-recall interviews, such as “can you talk me through what is happening here?”, “talk me through what you were thinking at this point?”, “can you explain why you did that?”. Video episodes were often played more than once and paused where required to allow participants to expand on their answers. Where more direct or closed questioning was employed, which was rare, the interviewer took notes of thoughts and responses to catalogue the reasoning between the line of enquiry. This reasoning is included in discussions in chapter five. Interviews were audio-recorded for subsequent transcription and analysis.

Interview responses were analysed for agreement and discord with the coded data from the video recordings. A layered, iterative approach to analysis allowed this data to contribute to answering research questions one to four and to build a rich and detailed understanding of the regulatory behaviours of the students. In particular, this method provided a means for the researcher to look below

the surface and explore how student reflections correspond and relate to the underlying regulatory processes of planning, controlling, monitoring and evaluating which are inferred from the video observation data. The process for analysing the qualitative data from the stimulated recall interviews is outlined in section 4.5 and figure 4.13.

As with all data collection methods, but particularly with these stimulated-recall interviews, there is a significant chance of the data collection method influencing subsequent behaviour. In other words, heightened awareness of the project and its aims may cause students to behave differently, specifically to behave according to perceived expectations, or to otherwise act out or avoid behaviours directly because of their awareness of the project. This 'data collection as intervention' effect is arguably unavoidable in this case, and the benefits afforded by the triangulation of data are judged to outweigh the negative impacts on validity caused by the impact on student behaviour. This was considered in the longitudinal aspect of analysis, i.e. differences in behaviours or responses at the start of the present study in comparison to behaviours or responses towards the end. While participants were made aware of the format and function of the stimulated-recall interviews during their first one, this introduction was carefully considered so as to avoid explicitly revealing research questions and any positive or negative connotations to behaviours observed in an attempt to prevent significant influence on future behaviour. The introduction did, however, serve to ensure that consent to participate was informed and that the students' responses were relevant and focussed from the outset. See section 3.8 for full ethical considerations regarding consent from participants.

Overall, the stimulated-recall interviews were an indispensable insight into reflections not normally available to the researcher, or the teacher in the classroom. They provided a crucial dimension to the data, providing information on intentions and reasoning far beyond what is possible to gleam from observation alone.

3.7 Trustworthiness

Having outlined in detail the methods and methodology of the present study, it is crucial to discuss in detail the measures that have been put in place, or considerations that have been made to ensure the present study is as trustworthy as possible. This section highlights these aspects of the design of the present study, particularly in light of the limitations imposed on the original design by the advent of the COVID-19 pandemic, the specifics of which are outlined in section 3.5. Trustworthiness is used in this instance as an overarching term to incorporate the various aspects of the rigour of the present study. As a naturalistic, interpretive study, it is fitting to draw on the criteria of trustworthiness established by Lincoln and Guba (1985), credibility, transferability, dependability and conformability. These four areas are defined and discussed in more detail in this section, along with design features and approaches that can be used to help ensure these aspects of trustworthiness are maximised, such as triangulation, member validation, audit trail, multiple coding and reflexivity (Lincoln & Guba, 1985).

Credibility

Credibility refers to the confidence in the truth of the findings of a study (Lincoln & Guba, 1985). This is particularly important when considering the scale of the present study and the truncated data collection phase resulting from school closures. In the present study, prolonged engagement and triangulation were utilised to ensure maximum credibility.

The former of these, prolonged engagement, is effectively a consequence of the status of the researcher as a practitioner in the same context. Prolonged engagement seeks to allow researchers to understand the culture, social setting or phenomenon through spending sufficient time within the context itself. This is, of course, true of an individual who exists as part of this context themselves. The rapport and trust that already existed between the researcher and students and staff facilitated co-construction of meaning. The other side of the coin, however, is that prolonged engagement, particularly in the case of a researcher-practitioner, endangers the ability to rise above their preconceptions when interpreting data. Particularly as an existing part of the context being studied, a researcher-practitioner may be less able to approach data interpretation from a new perspective.

The second design feature used in the present study to maximise credibility was triangulation. The intention of this approach is to elicit a deeper understanding of a phenomenon by considering multiple sources of data. In the present study, the nature of triangulation employed can be defined as methods triangulation (Patton, 2014). Mixed methods, namely observational data and stimulated-recall interviews are used to elucidate complementary aspects of the same phenomenon. When these data agree, or often more interestingly when they diverge, the account of the phenomenon in question becomes richer, more robust and more comprehensive. In the present study, stimulated-recall interviews provided an opportunity to triangulate interpretations of observational data and to investigate whether or not these interpretations accurately and credibly reflected the perspectives of the students involved.

Transferability

Transferability, or external validity, describes the extent to which findings can be transferred to, or are applicable within, other contexts (Lincoln & Guba, 1985). In contrast to experimental or quantitative research, wherein transferability can be ensured through representative sampling, the present study does not intend to be generalisable. Instead aiming to be an in-depth investigation into a small number of interesting cases rather than a generalisable project. There are inherent issues with generalisation of study to theory from case studies. This is often because of limited sample size and the importance of context to the design and outcomes. The present study seeks to understand better a specific context, not every context. In naturalistic, interpretive studies, whether the findings or methods of a study can be applied to other contexts is a judgement for which the reader tends to hold responsibility. The

responsibility of the researcher is therefore to provide “sufficient descriptive data to make such similarity judgements possible” (Lincoln & Guba, 1985, p. 298). Originally coined within the tradition of ethnography, the term thick description refers to a detailed account of experiences by the researcher in which patterns of cultural and social relationships are put into context (Holloway, 1997). This thick description, in contrast to a thin, superficial account, furnishes the reader with sufficient contextual insight to effectively evaluate the extent to which conclusions drawn are transferable to other times, settings, situations and people. In the present study, thick description was ensured by the use of multiple data sources and thorough description of the contexts in which observation took place. Triangulation and the use of multiple data sources adds to the richness of the picture provided to the reader.

Dependability

A description of the quality of the integration of the processes of data collection, analysis and theory generation (Lincoln & Guba, 1985), dependability is also concerned with the consistency and stability of the findings of a study over time (Erlandson et al., 1993). Essentially, dependability describes the extent to which results are consistent and could be repeated. This is arguably the greatest threat to the trustworthiness of a study such as the present one. The ability of a research design to ensure consistent results over time is limited when the phenomenon studied is dynamic in nature. Regardless of consistent application of the methodology, student behaviours, perspectives and interactions with their environment are likely to change due to factors outside the control of the researcher or methodological design. Rather than judge dependability by repetition of results, the same thick description discussed in relation to transferability was applied to methods and procedures to allow replication of this study, recognising that identical results may not be obtained. Regular meetings and discussions between the researcher and their doctoral supervisor, or the researcher and colleagues on the doctoral programme formed an inquiry audit trail. These external checks provided an opportunity for someone further outside the study but with sufficient knowledge of its objectives and context to challenge the process and findings of the study. This external feedback was also supported by a presentation at the European Association of Research into Learning and Instruction (EARLI) Conference 2019 and submission to a peer-reviewed journal, both of which provided invaluable feedback on preliminary findings from external experienced researchers. Whilst external auditing appears at odds with the interpretive perspective that there is no objective reality to which the findings of the study can be compared, the introduction of alternative perspectives served to strengthen the dependability of the findings of the present study.

Confirmability

The final of the four aspects of trustworthiness deals with the extent to which results and findings are shaped by the participants of the research as opposed to researcher bias or other motivations or interests (Lincoln & Guba, 1985). In the present study, a number of strategies were used to maximise confirmability. Not unlike ensuring dependability, transparency in terms of application of methods and interpretation of themes goes some way to ensure confirmability. This has been ensured throughout

the present study. Further than this, critical discussions with colleagues and other researching professionals following a presentation at European Association of Research into Learning and Instruction (EARLI) Conference 2019 and submission to a peer-reviewed journal provided a great deal of constructive feedback with regard to the research process and application. With specific regard to the coding scheme and use thereof, inter-rater reliability was conducted with two experienced researcher-practitioners who were not involved in the present study itself. The full results of this analysis and resulting actions are discussed in section 4.3.

The researcher believes that reflexivity and transparency are crucial for high-quality research, regardless of the focus or design. “A researcher’s background and position will affect what they choose to investigate, the angle of investigation, the methods judged most adequate for this purpose, the findings considered most appropriate, and the framing and communication of conclusions.” (Malterud, 2001, p. 483). This admission is central to the belief that it is a researcher’s responsibility to be transparent about the processes made and the route to the conclusions drawn. These will inevitably be impacted by preconceptions, which Malterud (2001) asserts “are not the same as bias, unless the researcher fails to mention them” (p. 484), but complete transparency around what these preconceptions may be provides the reader with the information they require to be appropriately critical. This is also part of ensuring maximum confirmability. As part of the present study, the researcher has endeavoured to be as transparent about their position throughout the study as it has developed, and kept a reflective journal throughout the project to clarify decisions made and the temporal setting of positions and perspectives taken. The position of the researcher as researcher-practitioner, along with benefits and threats to trustworthiness of the present study as a result, are discussed in more detail at this point.

The Researcher as Practitioner

The value of practitioner research in the field of education is not to be underestimated. It allows the investigation of complex, practice-based phenomena with confidence and clarity as the researcher has the advantage of being familiar with the context of the research in advance. This kind of research also tends to have a strong link with improving educational outcomes and direct impact on learning or teaching. It is not unreasonable to suggest that the study outlined in this thesis would be unlikely to be taken on outside a practitioner research sphere. The immersive approach and familiarity with the context was crucial in undertaking the project and producing such rich data. The time-consuming and naturalistic nature of the approach arguably means there are barriers to the completion of this sort of work by those researching a context other than their own.

The inherent familiarity a researching practitioner has with their context means that particular care must be taken in recording and communicating decisions and interpretations made, since factors affecting these might be influenced by the researcher’s knowledge of the context. In the present study, this was

mitigated by random sampling of focus students, who then acted as the threads that were followed through lessons. Field notes were recorded throughout the project to document decisions and interpretations made. These have influenced the discussion of the episodes in chapter five. Driven by the spirit of openness, chapter four is dedicated to outlining the rigorous analytical approaches undertaken. This clarity of approaches taken to analyse of the rich, complex data collected is particularly important in the case of the researcher as practitioner. This design has also incorporated stimulated-recall interviews in order to question, refute and corroborate the interpretations made by the researcher. The interview data in particular helped reduce the chance of interpretation being coloured by the perception of the researcher and their knowledge of the individuals involved in the project.

3.8 Ethical Considerations

Table 3.5 summaries the ethical considerations involved in the design of this study. The table is based on the work of Seedhouse (1988) and Flinders (1992), developed by Wilson and Stutchbury (2013). The study will be carried out within the ethical guidelines of the British Educational Research Association (BERA, 2011).

External Considerations		
Factor	Question(s)	Influence
Cultural sensitivity	How will I ensure that my research is compatible with the overall aims of the School?	Conversations took place with interested parties such as students and staff – including senior leadership – and the outcomes of these discussions were considered in the design of the project. This dialogue continued throughout the process, for example to negotiate the lesson to be recorded etc, though no changes were required.
Codes of practice & the law	Am I working within the BERA guidelines, and meeting legal requirements relating to working with children and data protection?	Confidentiality and anonymity was ensured throughout the project using pseudonyms consisting of initials, and restricting access to raw data, both of which were agreed with the participants themselves. The present study was discussed with the Principal and the Vice Principal with responsibility for sixth form, and was approved from a policy standpoint. Video recordings were kept confidential and will be destroyed once the study is complete and examined. This has been agreed with participants and parents, who continue to have the power to withdraw at any time.
Quality of evidence on which conclusions are based	How will I ensure that sufficient and reliable data is collected on which to draw valid conclusions?	A number of sources were used, details of these, and precautions used to ensure trustworthiness are considered in section 3.7.

Consequential Layer		
Benefits to individuals – informed consent	Does everyone involved know what I am doing and why? Are they aware that their participation is entirely voluntary?	Before any data was collected for the development of the coding scheme, all student participants and their parents were informed in writing of the procedure and aims of the project, and both parties were given the opportunity to opt out or find out more at any stage. Copies of the letters used can be found in appendix A. The Principal and Vice Principal mentioned above were kept informed throughout. This process was be maintained throughout the rest of the project, and consent was gathered from participating students, teachers and parents once they had been selected.
Benefits to the School	How could this research be of benefit to the School/department?	Findings and conclusions have been shared with members of the school where the present study took place. Details of this and the intended impacts for classroom practice are discussed further in section 3.9.
Duties & Motives		
Reciprocity	Have I made myself available when those involved might wish me to be? Are the participants clear about roles, including my own, as they relate to expectations?	During the development of the coding scheme and the data collection itself, it was made clear to students and parents that they could contact the researcher with questions, concerns or comments at any point during the project, and withdraw at any time. My role as a researching practitioner has been discussed in detail with these participants and my expectations, as well as what they can expect from me, was discussed at length. In short, expectations of them are no different than in normal lessons.
Keep promises	How will I ensure the confidentiality I have promised to participants?	No real names have been be used, and only relevant data has been mentioned. Raw data will be destroyed on completion and examination of the present study. Pseudonyms have been used throughout the coding example found in appendix C. The school where the research will take place has not been named, and any identifying information has been generalised to ensure the school cannot be identified.
Do the most positive good	Is there any other way I could carry out this research that would bring more benefits to those involved?	The project is designed to investigate and learn more about students' learning. As such, benefits have followed for the participants and other students. Since this project was a small-scale investigation, involvement of more students would not have necessarily brought more positive outcomes. Instead, the findings help bring more widespread positive outcomes based on evidence from this case. In order to ensure benefits rather than negative impacts, participation in stimulated-recall interviews was as succinct as possible, and at all times remained voluntary.

Individuals		
Collaboration & establishing trust	How will I manage relationships with colleagues and with students who are being asked to participate in my research?	The project was openly and frequently discussed with both internal and external colleagues and participants. This was providing the study was not compromised, for example students were not told specifically what recordings were looking for until data collection was complete, in order not to affect their behaviour and damage the trustworthiness of the research as a result.
Avoiding imposition	How will I ensure I am not making unreasonable demands on any individuals participating?	Recordings of teachers' lessons were agreed at a mutually convenient time and any information requested was be shared to ensure mutual benefit. Interviews were conducted at a convenient time for students, minimising impact on break times during school.
Confirmation of findings	Can I be sure that I have not misinterpreted participants' responses?	The use of stimulated-recall interviews provided another interpretation of data. They were used to confirm and/or discuss coding and other interpretations of data as seen in section 4.5, for example. Interpretations of responses to interview questions were, where possible, confirmed in situ by further probing.

Table 3.6: A summary of ethical considerations.

3.9 Impact

First and foremost, this project has been designed to be rigorous enough to genuinely contribute to the body of knowledge on regulation to inform future projects, practice-based or otherwise. As a classroom-based project completed by a researcher-practitioner, the present study fundamentally aims to improve classroom practice by building a deeper understanding of the learning that takes place there. Indirectly, it is reasonable to say that this project aims to improve educational outcomes for upper secondary students by improving teaching in the realm of promoting and supporting the development of learners as regulators. This will be particularly poignant for students who have been deskilled in regulatory terms by high-stakes testing and the spoon-feeding and results driven methods that result. It could be argued that students' time spent in upper secondary education, defined in this project as between the academic years of 11 and 13, is amongst the most important in defining future pathways and in opening doors. These years see the culmination of hard work by teachers and students in large numbers of national exams, including GCSEs and A-levels, and life-changing choices made by students. It is a belief in the profession's responsibility to improve all students' outcomes in these areas that underpins this work.

More specifically, the improvements in classroom practice proposed are related to the promotion and development of students' regulation of learning proficiency. Regulation links closely to the underpinning objective of improving outcomes through strong links with academic achievement, motivation, emotional resilience and lifelong learning, as discussed in section 2.6. If regulation of learning can be better

promoted despite the pressures of the national examination system and our data-driven school system, it is reasonable to hypothesise that outcomes will be improved however this loaded term is defined. If these skills are better developed late on; students will be more motivated and will perform better in high-stakes national exams, students will be better prepared for wherever their national exam results take them, and students will be better prepared for challenges faced later in their professional and personal lives.

There exists an underlying assumption in the position outlined so far that as it stands, the secondary education system is failing to adequately prepare students for later educational undertakings, as discussed in section 1.2. In fact, the problem, the cause of this inadequate preparation, may lie elsewhere, outside the classroom or even outside secondary education. If this does transpire, it is nonetheless essential information for the continuous improvement of our education system. More troubling is what could be described as the 'stopgap' nature of this project. It could be argued that the focus on upper secondary education seen here does not align with the desire to improve educational outcomes for all, or even the most effective way to impact the development of regulated learning skills. Why focus on upper secondary classrooms when the described lack of regulatory skills most likely stems from years in a flawed educational system? Is it not reasonable to assume that the problem is a systemic one and to focus on the development of a more appropriate system rather than a short-term fix and retrospective damage limitation in the later years of compulsory education?

These are undoubtedly reasonable and important questions. Ideally, if the sole objective is to promote skills, regulated learning skills or otherwise, the system in which these skills are proposed to be developed should be overhauled with this in mind. Sure enough, projects exist in which curricula have been developed to better develop regulated learning skills from day one (Dignath et al., 2008). The counterargument in support of the present study is a simple one. This is an investigation of the symptoms of a systemic problem. It provides essential information required for effective systemic change. In reply to the questions above, this project asks how regulatory skills manifest themselves in upper secondary classrooms. How can the system be changed effectively and successfully without a fuller understanding of the problem?

In a sense, the present study has been planned backwards from the desired impact. Ways in which the present study will work towards its desired impact are shown in a diagrammatic form in figure 3.4.

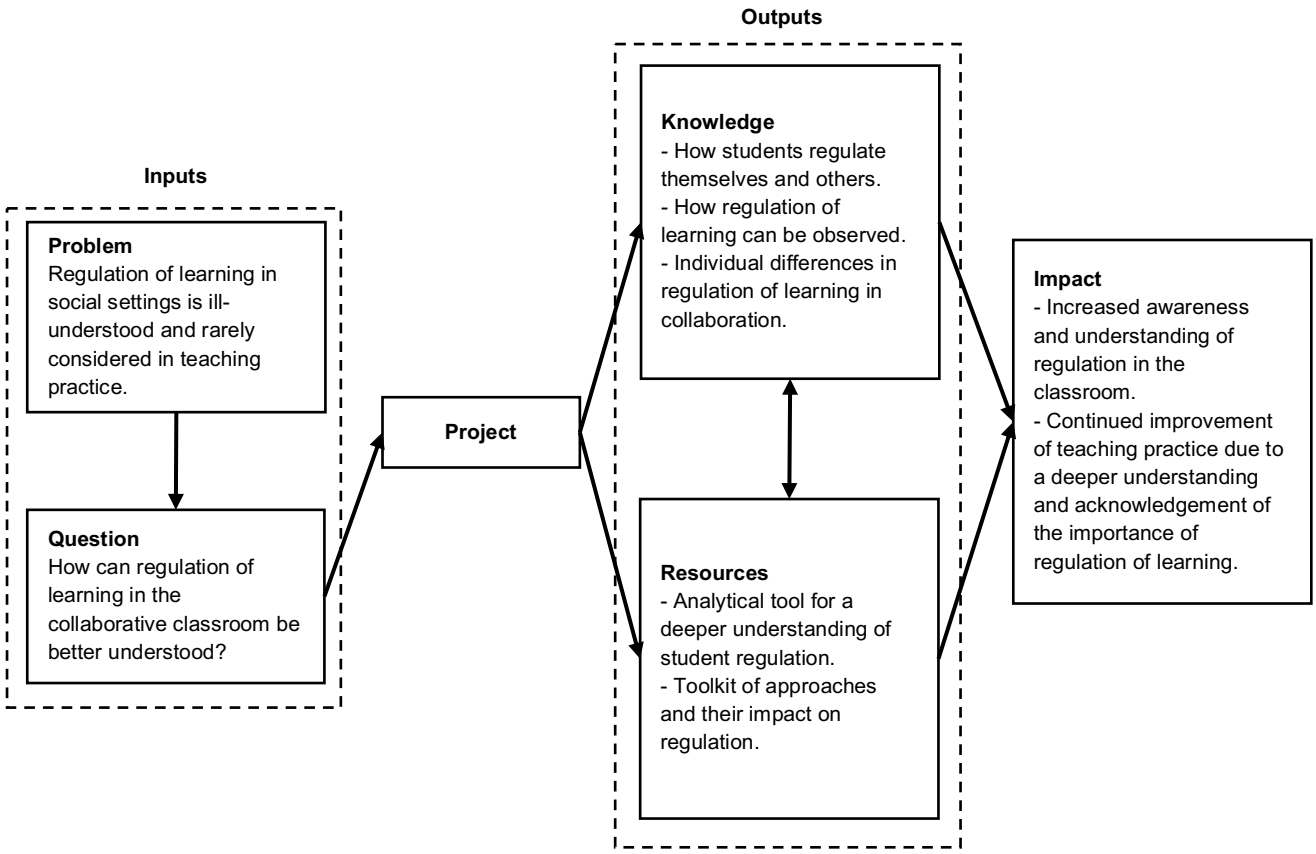


Figure 3.4: A diagrammatic summary of the impact-driven design of this project.

Whilst there is an overarching impact aim as discussed above, there are several distinct impacts that may result from this project. These are best discussed in terms of the proposed outputs of this project. Firstly, as with all research, this project aims to discover new knowledge of how the students in this sample regulate themselves and others in the classroom. This knowledge has the potential to have a broad impact both inside and outside classrooms. Inside classrooms, a greater knowledge of individual differences and how to recognise them will provide teachers with the knowledge and understanding they require to better promote regulation of learning in their own classrooms. In a less direct sense, simply a raised understanding and awareness of what regulation of learning is and is not will be a step in the right direction. On a wider scale, both of these impacts may lead to curricula and assessment which consider regulation of learning more thoroughly, training for practitioners, both beginning and experienced, on the importance and promotion of regulatory skills and a greater emphasis across schools, producing well-prepared and highly skilled students. These potential impacts are of course grand, but if practice is changed in just a few classrooms, a department, a school or a few schools, the number of students impacted directly and whose outcomes will be improved quickly becomes significant. Another way to increase this significance is to consider the impacts outside the classroom. This project, whilst inherently practice-based, is thorough and rigorous enough to contribute meaningfully to the existing body of knowledge in the field of regulation. In fact, this project's practical, classroom-based focus, in contrast to the more common formalised psychological tests and measures,

provides a fresh perspective. This perspective supports and questions existing work and may direct future work. In doing so the impact is multiplied across classrooms and awareness and understanding of regulation is raised as an area of importance in educational practice.

Alongside new knowledge, this project intended to produce tools and resources which will allow researchers and practitioners alike to better understand the regulation of learning in the classroom and to apply the learning and new knowledge from this project. What sets this apart from other similar work and from other doctorates is its practical focus. It was proposed therefore that a toolkit of analytical tools explicitly for practitioners is developed from the work in this project to allow teachers to better understand their own contexts and students and better cater for them as a direct result. A summary of the resources that stem from this research is shown, along with forecast target audiences and purpose in table 3.7.

Tool / Resource	Audience	Purpose
Coding scheme	Researchers	A tool generic enough for researchers to use in other contexts to add to knowledge of how students regulate themselves and others.
Teacher resource for recognising regulation of learning in collaboration (in development).	Practitioners	A tool developed especially for teachers, with workload and time in mind so they can quickly gain a better understanding of their own classrooms from a regulatory perspective.
Toolkit of teaching approaches to promote regulation of learning in collaboration in the upper secondary classroom (in development).	Practitioners & researchers	An index of teaching approaches found to promote regulation of learning in this project and existing literature. For use by practitioners in their classrooms, or researchers as a basis for further investigation.

Table 3.7: A summary of proposed outputs, audiences and purpose.

3.10 Chapter Summary

This chapter has outlined the research questions that underpin the work outlined in this thesis, alongside the methodology and methods employed to broach them. Consideration of trustworthiness has woven throughout the design of the present study in order to ensure a robust and rigorous approach. In short, this chapter has outlined all aspects of the case study approach including the interpretive perspective from which this work has examined the phenomenon of regulation in collaborative groups.

Alongside consideration of the methods of data collection, it is timely to consider the analysis of said data. This is a crucial consideration as the analysis of data is the mechanism for answering the research questions. The data itself is simply the raw material.

4 Analytical Methods

4.1 Introduction

Following on from the research design, this chapter outlines in detail the approach to data analysis in the present study. In order to analyse video recordings, a coding scheme was developed. The process undertaken, along with the scheme itself, is outlined. Directed graphs and graph theoretic statistics were used to visualise the coded data. This novel application is described in this chapter. Analytical approaches to the stimulated-recall interviews which followed the video recordings are outlined. As a mixed methods interpretive study, the process of integration of multiple data types and sources is as important as the data itself. The data integration process is considered and visualised at the end of the chapter.

4.2 Developing a Coding Scheme

In order to observe regulation of learning in situ, a complete coding scheme, or taxonomy, for regulatory behaviours in the classroom was developed. While other schemes for observing regulation of various kinds exist as outlined in section 2.10, it was deemed necessary to develop an original scheme in order to ensure it was applicable to the naturalistic setting of the present study, and to root the data strongly in the theoretical framework from which the intentions, perspective and questions of the present study come. The scheme itself is an important product of the present study and in itself is a tool for practitioners and researchers alike to recognise and observe the phenomenon of regulation of learning in collaborative settings.

Initially the original coding scheme was constructed deductively, using a variety of literature sources. The scheme was then further refined through application to audio-visual recordings and adaptations made where necessary. This chapter outlines these processes, the resulting coding scheme and example applications.

Considering Context

It is difficult to dispute that systems for analysis of classroom behaviours with ecological validity should take into account wider context. This closely ties with the perspective on social situations taken in the present study, and outlined in the context of the Ecological Systems Theory (Bronfenbrenner, 1981) outlined in section 2.7. As discussed in the development of their taxonomy, learning from the traditions of ethnography, this allows the established cultural context to inform the interpretation of contributions (Hennessy et al., 2016). This is how the present study and coding scheme differ from the task-based tests used to measure regulation in other studies discussed in section 2.10. After the Ethnography of Communication (Gumperz & Hymes, 1972; Hymes, 1964), a three-tiered hierarchy can be used order to structure this interpretation of meaning.

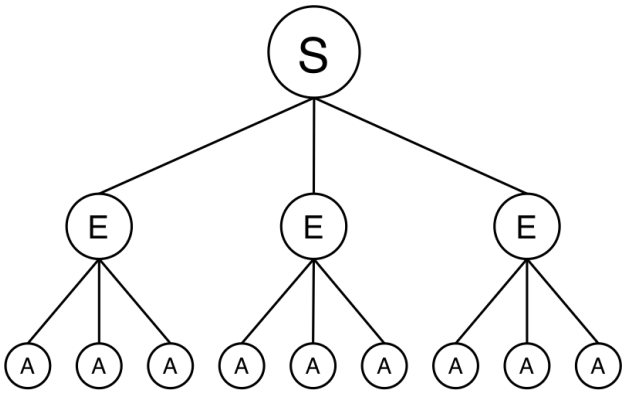


Figure 4.1: A model of the hierarchical and nested layers of analysis (S – situation, E – event, A – act).

Within this hierarchy, regulatory acts are nested within regulatory events, which are in turn nested within the overarching regulatory situation. Acts can be defined as interactions or expressions, verbal or non-verbal, which can be identified by their regulatory function. This function is derived from not only their discrete nature, but also their position in the regulatory event and wider situation in order to retain as much ecological information as possible and gain a richer picture of the situation.

This tiered consideration of the phenomenon is also present from another perspective. As discussed in section 2.10, the regulatory acts defined in this coding scheme can be viewed as indications of the nature of underlying, invisible regulatory processes, namely planning, monitoring and so on. These processes in conjunction form the overarching process of the regulation of learning and the associated functions, which are the core and culmination of the acts described here. The acts in this case form the most basic, outermost and therefore observable aspect of this model, as shown in figure 4.2.

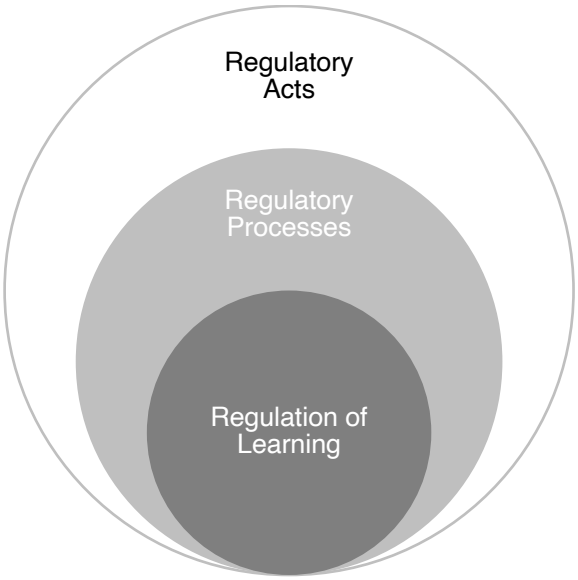


Figure 4.2: A visualisation of how regulatory acts are the outermost, observable aspect of the core process of regulation of learning.

Regulatory Acts as an Indicator of Regulation

It is theoretically important to outline fully how regulatory acts and regulatory processes are related. It goes without saying that regulatory processes themselves, being metacognitive in nature, are not directly observable. Instead, researchers rely on inference from behavioural observation. These behaviours are observable and can often be believed to be manifestations of the underlying metacognitive process. The fact that behaviours are impacted by metacognitive processes among other factors is not easy to dispute. The conceptual difficulty here is that it is significantly more difficult to confidently and logically move in the other direction and identify underlying processes from specific acts. This is akin to attempting to define the shape of an iceberg just by observing the visible tip. This is not a new issue, as the use of observational tools to research many cognitive and metacognitive concepts and phenomena is not new. Limitations in this area are discussed in depth by Mercer (2010), "the most serious are the problems of dealing with ambiguity of meanings, the temporal development of meanings, and the fact that utterances with the same surface form can have quite different function". After Hennessey et al. (2016) the coding scheme here considers intention rather than function, as this is significantly simpler to determine, however, the central point raised is crucial. These issues are fundamentally unavoidable, but ambiguity around many of these issues can be reduced through clear definitions in the coding scheme itself, consideration of context akin to the Ethnography of Communication (Gumperz & Hymes, 1972) and triangulation with other data sources, in this case, stimulated-recall interviews.

Classifying Regulatory Acts

Initially, key clusters of acts were defined from the recognised regulation of learning models discussed in section 2.2. These were directly based on the key processes in regulation of learning and form the basis of the general codes used in analysis. Planning, monitoring, controlling and evaluating were clear clusters of behaviours which would be central indicators of the regulation of learning. Acts in these clusters would be indicative of these metacognitive processes taking place. These four functions form the core of the overarching process of the regulation of learning and are terms found almost universally in regulation literature. The core four clusters of codes were therefore; planning, pertaining to goal-setting, role-setting and other preparations for volition, monitoring, referring to acts which indicated that learners were maintaining direction throughout learning, controlling, referring to acts which re-focus or change direction in order to address aims, and evaluating, referring to acts which betrayed an evaluation of outcomes or processes. Full definitions are noted in table 4.2. Clearly, some of these may be more observable or obvious than others, for example a planning act is likely to be more visible than a monitoring act, but it is important that these key processes are all represented to build a full picture of the regulation of learning taking place. Further discussion on the frequency of these codes is discussed in section 4.3 in relation to the investigation of inter-rater reliability for the eventual scheme.

Two further clusters were added to the core four. Emotional and motivational regulation was distinguished from monitoring or controlling and defined as a separate cluster of acts. This was to emphasise the importance of motivational factors in regulation of learning as discussed in chapter two. This is also seen in the large number of regulation-promoting interventions which emerge from a motivational theory standpoint (Dignath & Büttner, 2018). The cluster also ensures that the clear emotional implications of regulating learning in collaboration can

be considered. As discussed in section 4.3, when the first iterations of the scheme were trialled it was very clear that motivational acts played a central role in group dynamics. It may be more accurate therefore to describe two monitoring clusters as metacognitive monitoring, the core process of the regulation of learning, and emotional/motivational monitoring, a process distinctly different but no less important for the overall process. This is particularly poignant in social settings as students continue to encourage and support each other emotionally to reach their goal as well as monitoring their progress from a metacognitive perspective. These two monitoring clusters alongside planning, controlling and evaluation make five clusters of behaviours which indicate the presence of their namesake regulatory processes.

On reflection, these five codes were deemed theoretically sound in providing a good indication of when both the components and overall process of regulation of learning are taking place. However, it became clear that it is equally important to identify when learners are not engaged in regulation of learning, or regulation of learning has failed, as it is to identify when the process is taking place. Further than this, it became clear that it was insufficient to assume that a lack of regulatory acts meant a lack of regulation. Rather it was important to identify acts which would confirm a lack or failure of regulation as opposed to the process simply not being visible. A further cluster was added, originally called maladaptive. This was used to describe behaviours that indicated that the learner had disengaged from the regulation of learning entirely. This is an important distinction from neutral behaviours which do not directly betray regulatory processes but equally don't suggest they are not happening, merely that they are not being externalised. In contrast, maladaptive behaviours would suggest that either a regulatory process has failed, or a learner has disengaged from the shared regulation taking place. In a sense, rather than neutral, these behaviours are actively suggestive of the absence of effective regulation of learning. Behaviours attributed to the first five clusters actively suggest regulatory processes are taking place, whereas behaviours attributed to this final cluster actively suggest regulatory processes are not taking place or have not been successful. Where possible, this difference has been highlighted visually when considering data in chapter five.

As the coding scheme and the conceptualisation of how behaviours in the classroom can suggest regulatory processes developed, it became clear that the use of the term maladaptive was inappropriately negative. Learners who display disengaged behaviours are not maladapted as a result, and in fact, these disengaged behaviours may be a normal part of the process as students attempt to regulate their learning as well as social dynamics, emotions and motivation in the busy secondary school classroom. It was decided therefore to rename this cluster with the more descriptive, less negatively weighted title, disengaged.

Cluster	Description
Planning	Any act related to the selection and preparation of procedures and resources necessary for the performance of an individual or group task or activity.
Monitoring	Any act related to the ongoing on-task assessment of the quality of task performance and progress of an individual or group.
Controlling	Any act related to a change in behaviour with the intention of improving performance or progress towards goals.
Evaluating	Any act related to reviewing and evaluating the quality of performance or outcome by an individual or group.
Emotional/Motivational	Any act related to the regulation of an individual's emotional and motivational experiences during a task or activity.
Disengaged	Any act related to an absence of , or disengagement from, regulation and therefore an obstacle to progress or success in a task or activity.

Table 4.2: The six types of regulatory act defined in depth in the full coding scheme.

The six key types of regulatory acts are summarised and broadly defined in table 4.2. As discussed in section 4.3, the coding scheme seen in table 4.3 was developed deductively from precedent and further adapted inductively from observations and the experiences of the author as a classroom practitioner. Six superordinate codes were used and the definitions adjusted where necessary; (a) planning, a key aspect of regulation found in multiple previous observation schemes (Ucan & Webb, 2015; Whitebread et al., 2009), (b) controlling, named explicitly in the Winne and Hadwin model of self-regulation (1998) and well-defined by Ucan and Webb (2015) (c) monitoring, recognised as a keystone aspect of the regulation process, like planning, found in multiple previous schemes, (d) evaluation, defined well by Whitebread et al. (2009), (e) emotional/motivational monitoring, distinguished from metacognitive monitoring similar to Whitebread et al. (2009), (f) disengaged, initially taken from Cleary (2006) as maladaptive and also found in Bryce and Whitebread (2012), this cluster was renamed and redefined to acknowledge the importance of off-task behaviour for the overall regulation process.

These six superordinate clusters were further defined into individual acts. For example, goal-setting or role-setting, while different acts, would be defined as planning acts for the purposes of the present study. The final version of the coding scheme contained a comprehensive 28 individual acts comprising the six types of act. The scheme therefore has the potential to operate on two levels of granularity, either at the more general, process-focussed level of the six types of act, or with greater resolution when considering the 28 individual acts which make up the six clusters. In application to the present study, each act was coded as planning, monitoring, controlling, evaluating, emotional/motivational or disengaged using the definitions in table 4.2. The 28 separate codes were then drawn upon to identify patterns on a more granular label. For example, it could be recognised in a hypothetical case that all planning acts were specifically goal-setting and no role-setting acts were observed.

All codes within a cluster have a fundamental concept or intention in common, as can be seen in table 4.2 and when considering the full scheme in table 4.3. In defining both the individual acts and the overarching clusters, it was ensured that both internal homogeneity and external heterogeneity were considered (Patton, 2014). For example, if the planning cluster is considered, external heterogeneity means there is no overlap with each of the other clusters. This has been carefully assured by tying each cluster to a distinct aspect of regulation of learning. Considering the content of the cluster itself, internal homogeneity describes the idea that each aspect of the cluster is homogeneous or has a common theme or characteristic. In this case again this is true, as each of these acts has been defined to as to pertain to a process involved in planning only.

There are, of course, fundamental difficulties in attempting to determine the metacognitive process(es) which underpin an individual's behaviour in a complex social setting. More often than not researchers will attempt to mitigate this issue by observing behaviours in tightly controlled experimental conditions. This is extremely useful in terms of controlling variables, but not reflective of the task teachers have to undergo when attempting to determine whether students are on track or otherwise during a group task in a bustling classroom. If a student moves from their group to another to borrow a book, have they identified the need for a new source of information in order for their group to reach their goal, identified where they might find the new source of information and sought it out, or are they in fact looking for an excuse to leave the group they are in to go and speak to their friend with an appropriate excuse so as to avoid reprimand? This is a contrived, fictional example, but the point stands. In order to ensure these behaviours are appropriately coded, a thorough scheme with clear definitions and examples is needed. Clear definitions of the behaviours in this study which belong to each cluster provides clarity about what is meant, and as such the inferences that are and can be made about the regulatory processes underlying them. While each act is coded separately, as discussed in section 4.1, they must be understood within the context in which they occurred.

The coding scheme was piloted with two distinct objectives, firstly, to assess whether adjustments to the content of the scheme were necessary, and to trial the operational aspect of recording collaboration between groups. Two of the researcher's own lessons were recorded for this purpose. While the data was not analysed fully and is not discussed in chapter five, many of the examples seen in table 4.3 find their origin in these recordings. It was quickly realised that the task of recording a busy classroom with both accuracy and minimum disruption was a new and unique challenge. A single video camera was insufficient. While the camera could be positioned appropriately to observe all students and their interactions well, the audio was not of sufficient clarity. In the subsequent trial, the camera was paired with multiple audio recorders, which could be placed on tables and enhance the audio clarity with minimal disruption. The researcher would be visible turning the audio recorders on during the video recording, so the audio recordings could be matched up with the video recording before transcription.

4.3 The Full Coding Scheme

Codes

The scheme outlined in table 4.3 intends to be, as far as possible, a taxonomy of regulatory acts. This comprehensive scheme including a large number of distinct and exemplified acts intends to allow accurate identification and coding within the present study, but also potentially in other future studies based in other classroom contexts. The procedures followed to validate the coding scheme for use in the present study are outlined in this section, followed by practical notes on its usage.

Cluster	Act	Code	Description	Definition	Example(s)
Planning	Goal setting	P1	Statement/definition of objectives/goals to a peer or peers.	This is a simple statement or definition of objectives which may be individual or shared. It does not include repetition of objectives provided by others without explanation or modification.	"Finish this question then do that one." "OK, so we need to find the temperature of the solution after the solid is added."
	Role setting	P2	Statement/definition of role(s) to a peer or peers.	This is a simple statement or definition of roles which may be individual or shared. It does not include repetition of objectives provided by others without explanation or modification.	"You stir and I will read the thermometer." "I'll be the scribe."
	Preparing learning environment	P3	Preparing the physical learning environment.	This could be a behavioural code rather than one for discourse. It can include physically seeking resources and moving objects and resources relevant to learning. It does not include the movement of the learner themselves to a different environment but can include adjustment of position within the same environment.	"I need to get some graph paper." "Can I borrow your calculator?"
	Planning process	P4	Planning a task or activity before commencement.	This can be an individual or group planning activity before starting the set or agreed task. This can include setting individual goals, but not those of others, which would be coded as P2.	"Let's try this first then ask sir." "So this one uses the formula so I will try this first."

Planning	Clarifying direction	P5	Clarification of objectives/goals or the general process to a peer or peers.	This is a simple clarification of objectives which may be individual or shared and may or may not have been set by a third party. It does include simple repetition of goals or objectives without explanation.	"Remind me what is next?" "Is this the same type of calculation as before?"
Monitoring	Commentating	M1	Narrating or commentating on the acts of an individual or group.	This refers to narration or commentating on activity without recourse to evaluation. It is a simple verbalisation of activity.	"So for this one, I divide by four because the volume is $25cm^3$…"
	Reviewing progress	M2	Comparing progress to goals.	Reviewing progress can be any statement which compares current progress or outcomes to individual or shared goals. It can be used in conjunction with controlling codes when the review includes next steps and differs from evaluating codes in that the task must still be underway.	"OK so we have the value for this one." "We've done the first two steps."
	Correcting errors	M3	Identifying and correcting mistakes of peers or oneself.	This is a simple correction with or without explanation. It may or may not include explicit identification but identification without correction would be coded as M4.	"This should be a three not a four."
	Providing constructive feedback	M4	Provide informative or constructive feedback upon which others can build.	This refers to constructive, reflective feedback upon which others can act, rather than a simple correction or judgement.	"Next time it would be easier to do it this way."

Monitoring	Proposing action	M5	Propose a course of action or activity for an individual or group.	Propose a course of action or activity in order to reach a goal. This could include a proposal of questions to individually answer or collaboratively discuss. This differs from planning codes in that it must be part of a dialogic consideration of options. Whether the proposal is acted on or not does not affect the code.	“Shall we add this next?” “I think we should talk about this section now.”
Controlling	Changing strategy	C1	Alter an individual or group strategy within a task.	This could describe any alteration of strategy or approach to a goal or problem following review or evaluation. It could describe an individual or group change and may occur amongst many other codes if the new strategy is replanned etc.	“OK that isn’t right, I am going to try it a different way.”
	Assisting	C2	Assisting a peer or peers to reach a goal.	This describes any act which assists a peer or peers to make progress towards a shared or individual goal. It can follow a help seeking act, but this code is unaffected if the help was not sought by the target.	“You need to mention the language techniques next.”
	Seeking help	C3	Seeking support from a peer or peers, a teacher or a resource	Seeking help from a peer or peers, a teacher or a resource in a precise way, for example by asking for specific information, clarification or confirmation. It does not include simply expression of confusion but must be purposeful questions.	“How do I do this bit?”

Controlling	Imitating model	C4	Imitating or copying a model.	This refers to imitation or direct copying of any resource that can be considered a model. This might include another's work, a teacher-supplied model or an aspect of a resource. It must be an act that allows progress towards a goal rather than an avoidance of work.	
Evaluating	Evaluating outcomes	E1	Comparing/evaluating the outcome of an activity or process.	Evaluating or comparing an individual or group outcome from a process or activity. This could include comparison to a model answer or another individual's or group's outcome.	“I think ours is good, we got all of those points.”
	Evaluating process	E2	Comparing/evaluating a process undertaken.	Evaluating or comparing a process undertaken by an individual or group. This could include comparison to another individual's or group's process or a suggested alternative. It must be comparative.	“Got there eventually, next time we should start with that bit.”
	Reflecting on purpose/value	E3	Comment or talk about the usefulness or value of an activity or process.	This includes reflection and comment on the worth of an activity or episode. It includes reference to past/present/future trajectory and relevance.	“That was really useful.”
Emotional/ Motivational	Controlling attention/resisting distraction	EM1	Continuing work or the relevant task despite distraction.	Persisting despite distraction includes continuing with a learning activity despite distraction from peers or anything/anyone else. This must be an explicit display such as ignoring an off-task question or comment from a peer, or a clear refocus after brief distraction.	

Emotional/ Motivational	Persisting despite difficulty	EM2	Continuing work or the relevant task despite difficulty.	Persisting despite difficulty includes continuing with a learning activity despite any difficulty or cognitive set-back. This must be an explicit display such as continuation following a display of frustration with the task, or persistence through various improving iterations or multiple failures.	
	Encouraging	EM3	Encouraging or motivating oneself or others.	Any act intended to motivate or encourage oneself or another. This could include praise or non-task-related motivational statements as well as behavioural acts.	“Yes you can do it!”
	Emotional monitoring	EM4	Monitoring emotional state.	Any act related to the assessment of one's own or another's current emotional and motivational experiences regarding a task.	“I’m sad I got this one wrong.”
	Managing behaviour	EM5	Managing the learning behaviour of peers.	This can be ascribed to discourse or physical behaviour. Managing the learning behaviour of peers includes explicit behavioural directions.	“Stop it, we need to finish this.” “Shh!”
Disengaged	Losing concentration/interest	D1	Losing concentration or interest in the learning activity.	This is an individual act and primarily behavioural. It is used to describe the loss of interest in a task so can include off-task activity but must not include other individuals, in which case it has a different code.	

Disengaged	Distracting others	D2	Distracting peers instead of completing the relevant activity.	Distracting surrounding peers. This could be acute or prolonged, and could involve discourse or non-verbal behaviour. It includes anything that is not relevant to the activity at hand. It only applies to the individual identifiable as the source of the distraction, otherwise a separate D code applies.	"What lesson do we have next?"
	Being distracted by others	D3	Being distracted by peers instead of completing the relevant activity.	Being distracted by surrounding peers. This could be acute or prolonged, and could involve discourse or non-verbal behaviour. It includes anything that is not relevant to the activity at hand. It applies to individuals who are distracted because of the action or actions of another, otherwise a separate A code applies.	
	Procrastination	D4	Procrastinating rather than completing the relevant task or activity.	Procrastination should be used when a learner completes constructive activities in order to avoid the activity they have been tasked with. This differs to losing concentration/interest in that the off-task activity is somehow constructive.	
	Statement of confusion or misunderstanding	D5	Statement of confusion or misunderstanding to a peer, peers or a teacher.	Simple statement of confusion or misunderstanding without any constructive question or help-seeking behaviour, which would be coded as C3.	"What is going on? I don't get it." "I'm baffled."

Disengaged	Giving up	D6	Giving up on the activity in hand.	Giving up on the activity in hand, but without distracting others or being distracted by others. This differs from losing concentration in that it follows a period of difficulty but may be hard to distinguish.	“I can’t do this.” “I give up, this is stupid.”

Table 4.3: The full coding scheme.

Validation

The present study has not addressed sufficient sample sizes to complete a full factor analysis on the coding scheme. Although the scheme been used only by the researcher in the present study, if it is to be useful for future research, it was clear that inter-rater reliability needed to be explored. This addressed the reliability of the scheme and its descriptions and examples. The validity of the scheme in measuring what it was designed to, which was addressed through reflexive adjustment when the scheme was first used. This section discusses these processes in more detail, beginning with a discussion of the inter-rater reliability of the scheme.

Hennessey et al. (2020) outline the complexity of issues around coding scheme construction for classroom dialogue, including the importance of scope and granularity in designing a scheme.

> *"In practice, levels of success vary with classroom dialogue and achieving high reliability levels is notoriously difficult and time consuming, typically taking up to 6 months or even more for a complex scheme. The finer grained and more complex a coding scheme, the less reliable it is likely to be simply because there is more room for discrepancy and error. Levels of inference and potential over-interpretation need to be monitored carefully, and a detailed coding manual should be developed – ideally with illustrative examples covering inclusion of ambiguous cases – and regularly consulted and updated."* (Hennessy et al., 2020, p. 8)

It is reasonable, in response to Hennessey et al., to suggest that there is no such thing as a perfect coding scheme, but there certainly are things that can be done to minimise the negative impact of any problems. Mercer (2010) highlights that "the most serious are the problems of dealing with ambiguity of meanings, the temporal development of meanings, and the fact that utterances with the same surface form can have quite different function" (p. 4). While stimulated-recall interviews have been used in part to mitigate these concerns and to get student input into the meaning of observed acts, it is important that the coding scheme used mitigates ambiguity by design as far as possible. This was done by ensuring thorough and clear definitions of codes. To check the reliability of these, three raters; the author/researcher and two other experienced researcher-practitioners, independently coded a randomly selected section of transcript of a video recording after brief training by the author. The training involved a verbal discussion of the coding scheme and each code, followed by the three raters watching a video episode and the author/researcher explanation of coding decisions made as a result. The transcript was randomly selected to avoid bias through researcher selection but was from a real classroom recording so raters could use the context of the acts nested within the whole episode in order to interpret intentions. The episode selected consisted of 139 acts which could be coded. Fleiss' Kappa was used to assess inter-rater agreement. There was a moderately high agreement overall (κ=0.666,

p=0.00; 73% agreement). The highest agreement was found for planning (90%), whereas the lowest was for monitoring (66%). 100% agreement was found for disengaged acts, but there was only one act coded this way by all three raters. Percentage agreement and individual kappa values (κ_1) for all clusters are shown in table 4.4, including values for unassigned acts, or those not coded as regulatory in nature, and the overall Fleiss' Kappa and agreement values for all rater responses.

Code Type	P	M	C	E	EM	D	None	All
Agreement	90%	66%	73%	71%	85%	100%	89%	73%
Kappa (κ_1/κ)	0.726	0.763	0.803	0.779	0.906	0.890	0.778	0.666

Table 4.4: Fleiss' Kappa and percentage agreement values for the codes used, including unassigned and overall values

The percentages shown in table 4.4 were judged as reasonable for this sort of interpretive coding scheme. Whilst a higher agreement could be achieved when coding for less ambiguous behaviours, for example certain words or specific actions, this coding scheme was designed to be applied to unpredictable and dynamic classroom situations, so room for interpretation provides an element of flexibility required for the context being studied. While the random section of transcript selected only included one act coded as disengaged, the raters agreed that this type of act in particular was the most obvious so the artificially high percentage agreement was not cause for concern with respect to the reliability of the definitions provided in the coding scheme. The lower percentage agreement in the case of monitoring in particular is not necessarily a surprise. This is, as discussed in section 2.3, a central metacognitive process and by definition more difficult therefore to identify reliably. The most common discrepancy regarding monitoring was over-identification, in other words the coding of non-regulatory acts as monitoring acts. This was particularly prevalent in the case of narration. This finding led to clarifications of the requirements for an act to be coded as monitoring to reduce over-identification in this way.

Notes on Usage

In this scheme, each code represents an individual act. It aims to be comprehensive enough to differentiate between acts with different regulatory function, but succinct enough to avoid redundant distinctions and repeated definitions. Each act is linked to an actor and a target. The actor is defined as the individual who carried out the act, and the target is the individual to whom it was directed, whether or not they respond or acknowledge the act. Very few acts are untargeted, but these have a blank target column. Every act transcribed from video should usually be coded if it shows a clear regulatory purpose. If it is unclear whether or not the act fulfils a regulatory purpose, or it is considered completely neutral from a regulatory perspective it remains uncoded. Appendix C contains an excerpt coded using the scheme by way of an exemplar and includes explanations of coding decisions made.

4.4 Identifying Patterns and Trends in Coded Data

In the present study, a coding scheme is used to allow the processing of large amounts of video data. The large amounts of coded data produced is also difficult to handle, particularly because the richness of the data is something that should be conserved as far as possible in the present study. A somewhat unusual method has been used in this study as a way to highlight patterns and trends which otherwise may stay hidden, and to visualise the group interactions in the recorded episodes. Directed graphs allow statistical identification and visualisation of patterns and trends in sequence-based data, such as the sequence of regulatory acts which is elucidated by the coding process. Since the application of this tool is relatively new in educational research, and novel in its application in the present study as an analytical tool for classroom interaction during collaborative learning, it deserves further explanation.

This section initially outlines the theory and specific use of directed graphs within the context of the present study, followed by an outline of the graph theoretic statistics which are referred to in chapter five as part of the findings. The latter section details the further layer of analysis which was applied to directed graphs once they were constructed. Visual examples are provided wherever possible as this is a key strength of the approach.

Directed Graphs

The significant challenge faced by researchers attempting to better understand any learning process, is compounded by attempting to understand said phenomenon in collaboration and the inevitable increase in complexity of data that results. In these cases, a key challenge is visualisation of the complex data that comes from observation of the dynamic, sporadically visible, individualised processes taking place. A full picture cannot be sufficiently elucidated with frequencies alone, nor can the experiences of those involved be described by interviews alone. A large aspect of the present study was the search for an appropriate means to analyse and visualise the interactions taking place within collaborative groups using numerical data from the coding process. The challenge was to present large amounts of data from coding in a digestible way, while retaining the fidelity of the temporal data so that patterns could be identified. Ultimately, if regulation of learning is considered as a process, as highlighted in section 2.4, the temporal dimension of all the data collected is crucial in order to further understand the process as a time-bound entity. This is necessary, while also retaining the information for the different individuals involved in collaboration, which in essence multiplies the data types and data sets by the number of individuals involved, while adding a further data type required in who was interacting with whom. Not an insignificant task, but one which could yield further tools not just for future research but potentially practice too.

Initially, the intention was to visualise the interactions in groups using a modification of the radar diagrams which are seen in chapter five. In order to include directional data, i.e. who was interacting with whom, nodes could be used for individuals and the width of the arrow between nodes would

represent the frequency of regulatory acts that occurred between each individual or node. The symmetry of the observed acts, i.e. the proportion of acts in each direction between individuals could be represented by the relative length of the arrows. An example of this is shown in figure 4.3. However, while directional data is clear, temporal analysis using this sort of visualisation would not be possible, and the diagram quickly becomes prohibitively complex when the type of regulatory act is considered as opposed to considering all types in one arrow.

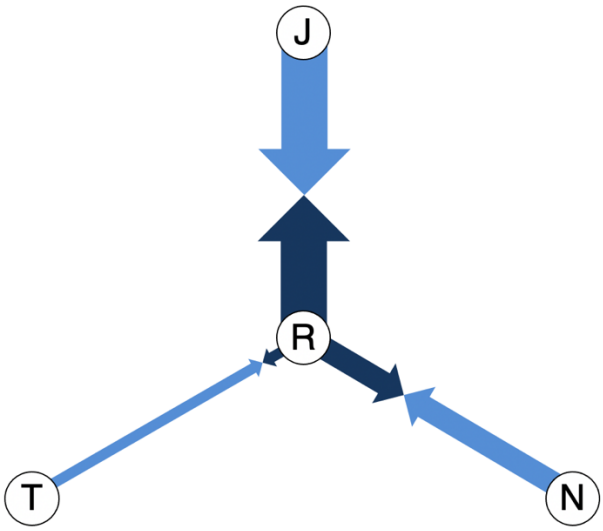


Figure 4.3: An early-stage proposed visualisation of the regulatory acts within a collaborative group.

Following a chance conversation with Phil Winne at the European Association for Research into Learning and Instruction Conference in 2019, where some initial patterns from the present study were presented, directed graphs were identified as a way forward in representing the relationships between types of act over time and therefore the process of the regulation of learning taking place. Treatment of the regulation of learning as a sequence of acts opens the door to a number of approaches in terms of identifying likely processes undertaken by individuals or groups of individuals. This new direction was based on work by Winne, Gupta and Nesbit (1994), who used directed graphs to visualise data in a similar way. These have since been applied to self-regulated learning through the use of trace data (Hadwin et al., 2007).

The use of numerical data and graph theory to investigate regulation of learning is not entirely new, but is certainly an emerging field. Notably, Bannert, Reimann and Sonnenberg (2014) have used process mining, a data mining technique used to illicit process models, to analyse self-regulated learning of individuals. The idea of process data has also been applied to collaborative settings but overwhelmingly within a computer-supported collaborative learning context (Kapur, 2011; Lajoie & Lu, 2012; Schoor & Bannert, 2012). The recent, exciting development of the use of computers to collect data on the temporal regulatory process (Bannert et al., 2014; Hadwin et al., 2007; Järvelä et al., 2016; Winne et al., 1994), are not to be ignored, however they are not in keeping with a naturalistic approach and tend

to require much larger datasets than are realistic for the present study. This approach does, however, share the same intention of processing data on the actions of individuals to describe likely processes or tendencies in the order of their actions.

In contrast to a process mining approach, directed graphs can be developed from coded data without the requirement for computer-based data collection. Directed graphs can also be constructed from any amount of data, from very large to very small samples. This section outlines precisely how this has been done in the present study.

The synthesis of directed graphs relies on the concept of adjacencies, or which act follows which. This temporal relationship is called followed-by (Winne et al., 1994). By way of an example, if an action, A, is followed by another action, B, these acts are adjacent. Directed graphs allow the identification of the frequency of different types of adjacency. The first step in the construction of a directed graph is the construction of an adjacency matrix. For the same hypothetical example of A → B, this would appear as in figure 4.4.

	A	**B**
A	0	1
B	0	0

Figure 4.4: An adjacency matrix representing the transition A → B.

In figure 4.4, an *N* x *N* matrix, where *N* is the total number of types of act, has been constructed. In this example, there are two acts, A and B, so this forms a 2x2 matrix. Each cell *(i, j)* represents a possible adjacency, so in the case of figure 4.4, the non-zero cell represents the coordinates (A, B) and represents the transition from A to B. This is a very simple example and one from which the graph would be contrived. If the more complex, arbitrary ten-step sequence A, A, B, A, B, C, C, C, B, D is considered, the adjacency matrix can be constructed as before and appears in figure 4.5.

	A	**B**	**C**	**D**
A	1	1	0	0
B	0	0	1	1
C	0	1	1	0
D	0	0	0	0

Figure 4.5: An adjacency matrix for an arbitrary ten-step sequence, A, A, A, A, B, C, C, C, B, D.

In a directed graph constructed from figure 4.5, each of the four possible acts; A, B, C, D is represented as a node. Where a cell is non-zero, this adjacency has occurred and is represented by an arrow, *i* → *j*. Figure 4.6 displays a directed graph for the matrix shown in figure 4.5.

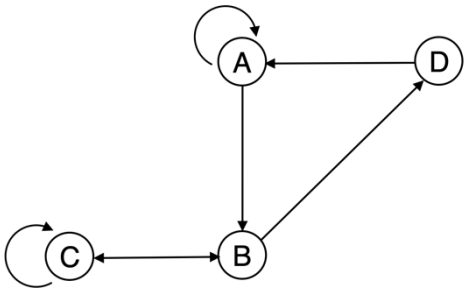


Figure 4.6: A directed graph constructed from the matrix in figure 4.5.

There are some important features of figure 4.6 to pick out at this juncture. Firstly, the fact A is followed by A is shown as a self-loop in the directed graph in figure 4.6. It is also worth noting that the arrow between the nodes representing B and C is bi-directional, meaning that B has been followed by C, but also that C has been followed by B. As is clear, this graph can visualise significant amounts of data with respect to sequences of acts. In order to recognise tendencies and patterns, however, frequencies of adjacencies must be considered. This is done using a weighted adjacency matrix and a corresponding weighted graph. The weighted matrix for the same sequence is shown in figure 4.7.

	A	**B**	**C**	**D**
A	3	1	0	0
B	0	0	1	1
C	0	1	2	0
D	0	0	0	0

Figure 4.7: A weighted adjacency matrix for an arbitrary ten-step sequence, A, A, A, A, B, C, C, C, B, D.

In figure 4.7, rather than binary values, the frequency of each *i*, *j* adjacency is contained in each *(i, j)* cell. For example, B followed by C has occurred once, whereas A followed by A has occurred three times. This allows further consideration of how frequently patterns occurred and can be represented graphically simply by including the frequency data on each edge, such as in figure 4.8.

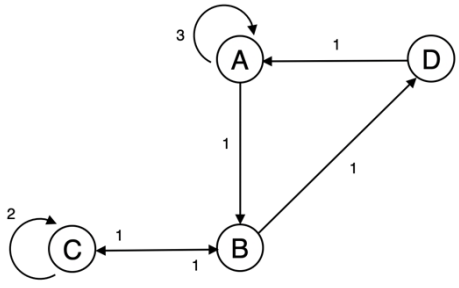


Figure 4.8: A weighted directed graph constructed from the matrix in figure 4.7, displaying frequencies against each edge.

The graph in figure 4.8 shows that the most common adjacency is A→A, followed by C→C. There is also a clear cyclical process A→B→D which occurs in one direction. Identifying these characteristics is arguably simpler because the sequence is visualised. Depending on the nature of the process being studied, these graphs illuminate the nature of the process itself, beyond simple frequencies, which effectively consider types of event in isolation.

Weighted graphs such as the one shown in figure 4.8 retain frequency data, so this is the type of graph used to represent coded data in the present study. By their very nature, the graphs constructed as part of the analysis of the coded video data in the present study are more complex than those in this section. There are six possible types of regulatory act considered; planning, monitoring, controlling, evaluating, emotional/motivational and disengaged. These six acts can also be displayed by any number of different individuals, so in an episode featuring just three individuals, the total number of distinct acts, *N*, is the six types of regulatory act multiplied by the three actors, so $N = 18$. Despite their complexity, the construction of directed graphs from video coded data in the present study has provided a framework for trustworthy, process-based analysis of the emergent patterns. Rather than considering types of act in isolation, these graphs have allowed for the analysis of patterns and tendencies within the behaviours of the recorded graphs, highlighting relationships between the six types of act. They have also allowed for identification of characteristics of the overall process of regulation during students' collaborative learning.

As well as being clear visualisations of complex data, directed graphs can be subjected to statistical measures. These can describe, in numerical terms, characteristics of the graph in hand, allowing statistical comparison of graphs alongside visual inspection. These graph theoretic statistics are described in the following section.

The approach employed in the present study to visualise significant quantities of complex data provides a handle for more focussed and informed analysis. However, it is far from being without flaws or limitations. Firstly, with the depth of data collected from each recording, some data reduction was required. Following Hadwin et al. (2007), transitions that occurred only once were excluded from the graph construction. Whilst this decision was necessary to ensure clarity and to focus the graph on the more prevalent transitions, it is reasonable to suggest that there may well be important acts that have been missed through this reduction. This serves to highlight the purpose of the graphs as visualisations of the key processes taking place in a group, rather than a complete documentation of all of the individual acts. Once patterns and themes were identified from the graphs, the data reduction was mitigated by returning to the data itself and further analysis with themes in mind.

Secondly, as discussed by Winne et al. (1994), considerations around construction of directed graphs are limited to ensuring where possible that there are no overlapping edges, so the same graph constructed from identical data can have a different appearance depending on how it is configured in

space. This is problematic in that the repositioning of nodes can alter the impression given to the reader (Winne et al., 1994). This is also true for more traditional graphs, wherein scale choice, colouration, type of graph exemplify decisions which can influence the message received by the reader. This highlights the importance of both transparency around the process undertaken to construct directed graphs, and consideration of alternative configurations in analysis.

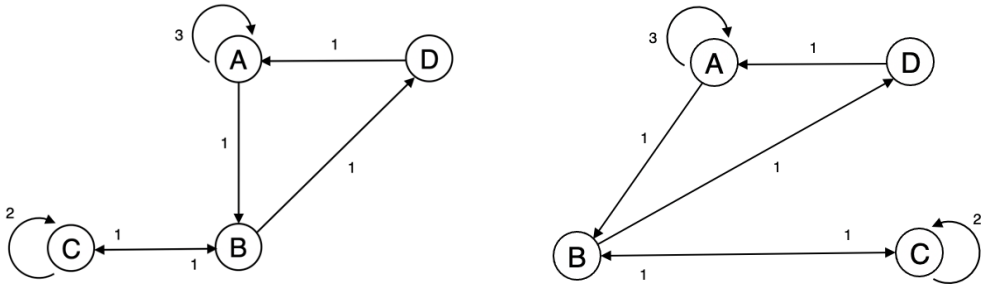


Figure 4.9: An alternative graph constructed from the same data as that for figure 4.8 exemplifies how different configurations can influence the impression given to the reader.

Figure 4.9 shows two graphs, the graph on the left is identical to that shown in figure 4.8, whereas the graph on the right is configured differently. It is crucial to recognise that these two graphs, whilst ostensibly different, are produced from identical datasets. Both graphs therefore contain identical information but, depending on the focus of the graph and the nature of the data, the impression on the reader might differ between the two simply because of the arrangement of nodes and connections in space. In the present study, graphs have been constructed in such a way as to contain the minimum number of crossing edges as possible. This imposes restrictions on the configuration of the graphs, but variation is still possible.

To mitigate the potential impact on the reader of the configuration of the graphs contained in the present study alone, graph theoretic statistics have been called upon to describe the directed graphs in a statistical manner, removing an aspect of subjectivity when analysing graphs. These statistics use formulae to describe characteristics of directed graphs with numerical values. Whilst arbitrary in nature, these values allow discussion in general terms of the characteristics of the graphs produced from video data to question and support non-numerical interpretation and provide basis for tentative comparison of graphs where the data allows. The nature of the graph theoretic statistics used in the present study are outlined in the next section, alongside their statistical functions and implications on the process of the regulation of learning.

Graph Theoretic Statistics

As well as the raw visualisation of complex data afforded by directed graphs, there are a number of statistical measures which can be applied to gain further indications of aspects of their character. Graph theoretic statistics have been used previously to describe properties of graphs with numerical values

(Winne et al., 1994). The relevant statistics for the present study are presented in this section; density, cohesion and degree, along with a brief discussion of what they may indicate when applied to the data seen in the present study.

Firstly, density is a graph theoretic statistic which ranges between zero and one in value. Density compares the number of links present in a graph to the number of possible links if all nodes were mutually linked. The number of possible links is represented by N^2 where N is the total number of nodes in the graph.

$$density = \frac{\#\ links\ in\ graph}{N^2}$$

This value gives an indication of the regularity and repetition in a process. A lower value would indicate fewer types of act and dominant transitions occurring repeatedly, whereas a higher density value would suggest less repetition and a greater variety of transitions occurring (Hadwin et al., 2007). It could be suggested that a lower value suggests a more rigid process amongst a group. This could occur for a variety of reasons, including control of the process by one individual, highly specialised approaches to a familiar task or limited amounts of shared regulatory processes. By way of example, two graphs and their density values are shown in figure 4.10.

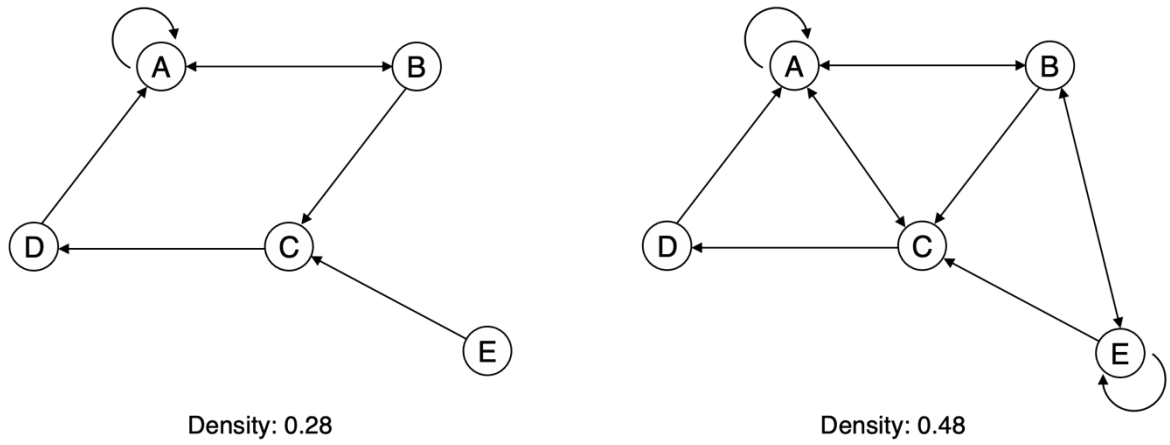


Figure 4.10: The more connections present, the higher the density value.

It is worth noting that the graph on the right, whilst appearing to have significantly more edges or connections than that on the left, the density value is only slightly higher, and still below 0.5. This illustrates a valuable point, as in order to approach a density value equal to one, the majority of connections, must not only be present, but must be present in both directions. If a graph with $N = 5$ like those in figure 4.10 were to have a density value of one, it would appear as shown in figure 4.11.

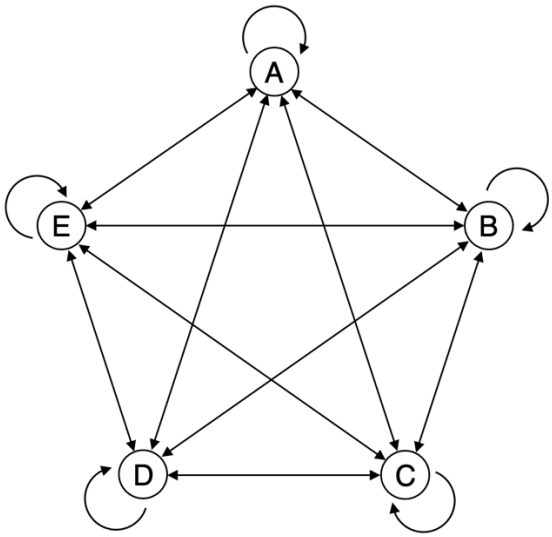


Figure 4.11: A hypothetical graph with *N* = 5 and density equal to one.

The likelihood of a graph such as this within a social scenario is unlikely, particularly within a time-bound episode, but this illustrates the extreme end of the density statistic. When considering the graphs in figure 4.10, the implications for the dynamics of group behaviour are clear. A higher density suggests a greater range of approaches. From a regulation of learning perspective, a higher density may represent a more resilient group, or a less practiced group, with less of a set process. It is notable that in isolation, the graph cannot shed light on the reasons for this, but visualises and highlights these characteristics very effectively. This has allowed patterns to be recognised and investigated in chapter five.

Cohesion, a value between zero and one, measures the proportion of links in a graph, excluding self-loops, which are two way. That is to say where A is followed by B, B is also followed by A within the sequence. Cohesion can be used to represent the reciprocity of a process appearing in a sequence.

$$cohesion = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} x_{ij} \cdot x_{ji}}{\frac{N^2 - N}{2}}, i \neq j$$

Where x_{ij} is the entry in the i^{th} row and j^{th} column of an adjacency matrix. $\frac{N^2-N}{2}$ is the number of possible pairs of nodes. The more cohesive a graph, the less constraint a learner imposes on selections from the set of actions. By way of illustration, two graphs and their cohesion values are shown in figure 4.12.

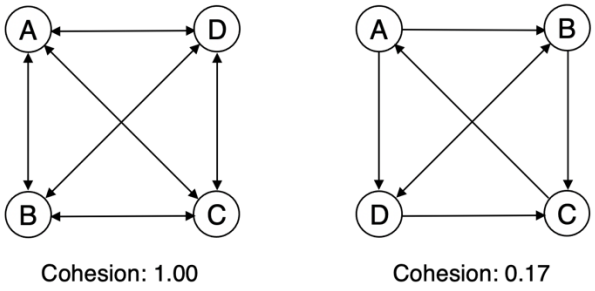


Figure 4.12: These ostensibly similar graphs show significant differences in cohesion values.

The graphs in figure 4.12 deliberately both have four nodes ($N = 4$) and all nodes are connected, however, cohesion deals with the proportion of connections which are reciprocal, and therefore appear in the graph in both directions. All six connections in the graph on the left are reciprocal, which is the maximum number, hence the maximum cohesion value of one. The value for the graph on the right is far lower, as only one of the connections in the graph is reciprocal, between B and D and vice versa.

From a regulation of learning point of view, and with respect to the elicitation of a process, cohesion gives a strong indication of the clarity around the process that is occurring in a group. When considering the graphs in figure 4.12, the graph with a cohesion value of 1.00 indicates the absence of a set process. All acts, A to E, are occurring, and in any order, as they are all reciprocally connected. The graph with the lower cohesion value of 0.17 gives far more information as there appears to be more constraint on the process occurring, for example, A always follows C, not the other way around. This information can give an insight into the preferred behaviours of a group, or regular patterns or tendencies in their activity.

Degree deals simply with the frequency and direction of edges to and from a node in a graph. In degree is the frequency of transitions to a given node, out degree is the frequency of transitions from a given node, and degree or overall degree is the sum of the transitions both to and from a node, or the sum of in degree and out degree. The higher the degree of a node, the more central it is to the process visualised by the directed graph. A higher degree indicates a regulatory act which has been revisited multiple times from multiple other types of act and/or has led to a number of different kinds of act. In this sense, a high degree node is akin to a crossroads or junction which is visited multiple times from different directions. From a regulation of learning perspective, this statistic provides interesting insight into how learners use types of act throughout collaborative learning. For example, it could be hypothesised that degree values for monitoring acts will be high, as metacognitive monitoring takes place throughout the regulation of learning according to the models discussed in detail in section 2.2. In a similar way, it could be hypothesised that the degree values for both planning and evaluating acts might be lower, as they will tend to be towards the beginning and end of a learning episode respectively.

4.5 Analysing Interviews

Stimulated recall interviews were analysed according to the process shown in figure 4.13. This figure is adapted from Cresswell (2014, p. 247) to make it specifically relevant to the present study.

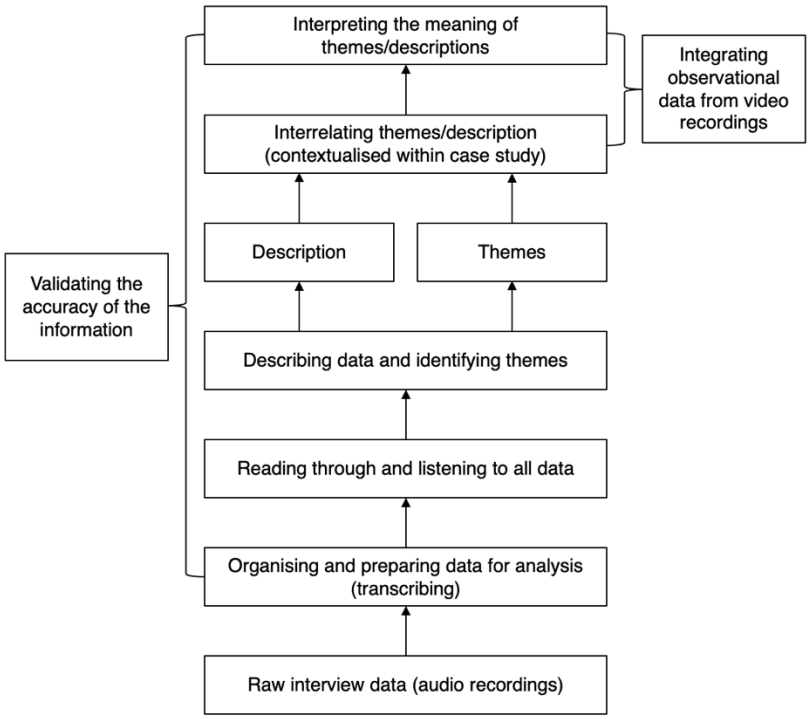


Figure 4.13: A representation of the process for analysis of stimulated recall interviews adapted from Creswell (2014, p. 247).

Firstly, the raw recordings were transcribed and organised for analysis. Next was arguably the most important stage of the analysis, which was to familiarise the data. This involved listening to and reading transcripts of the recording repeatedly before moving on to the next stage, which was describing the data and identifying themes. These themes and descriptions were then brought forward to the interpretation phase, at which point the data from interviews was integrated with that from the coded video data. This important aspect of data analysis addresses how mixed methods will work together to answer the research question and the approach taken in the present study is outlined in the following section.

4.6 Data Integration

In the introduction to a special issue on mixed methods research in educational psychology, Plano Clark (2019) highlights the critical nature of not just the data collection and analysis, but how contrasting data are integrated. It is of course important that appropriate methods are selected and implemented, but in mixed methods research it is also crucial that the resulting data is appropriately integrated to answer the research questions.

The integration stage is indicated in figure 4.14, and since the present study most closely resembles an explanatory sequential mixed methods design, integration between the interview data and observational data was through connection of the two data sets. The latter stimulated-recall interviews were used to explain and challenge the observational data. Joint displays and other visual representations (Plano Clark & Sanders, 2015) are used throughout the present study to illustrate how and when integration of data has taken place. For example, when the strands of the types of data used in the present study are separated, the integration and connections become clear. This is shown in figure 4.14, adapted from Plano Clark and Sanders (2015, p. 188).

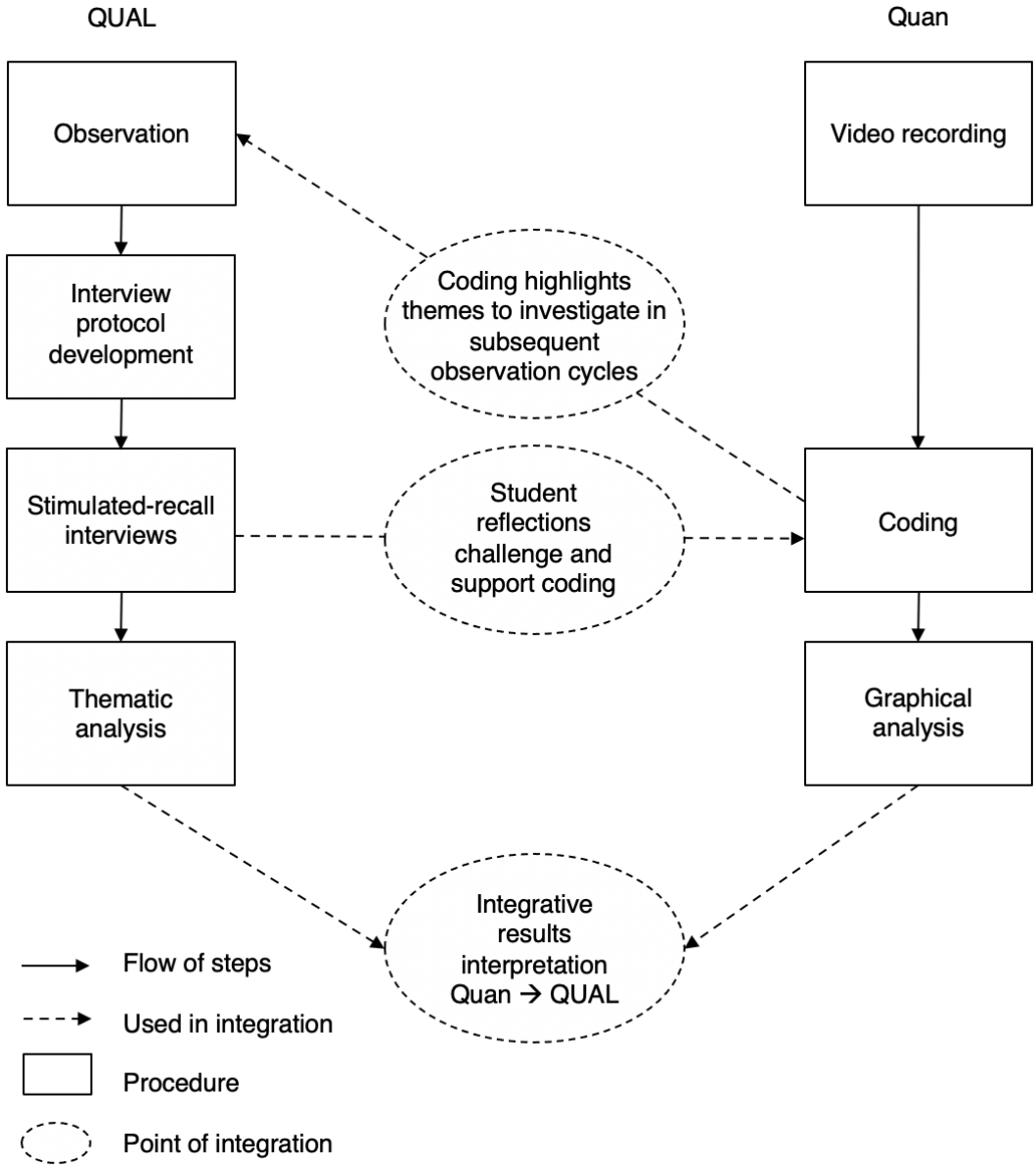


Figure 4.14: A visual representation of the integration procedures between qualitative and quantitative strands adapted from Plano Clark and Sanders (2015, p. 188).

As shown in figure 4.14, there are several links between the data sets in the present study where integration took place. Firstly, coding to produce numerical data highlighted themes to investigate in subsequent observation cycles which in turn helped the design of the interview protocols for each episode. The stimulated recall interviews played a role in challenging and supporting the coding data produced from video recordings. Finally, the results interpretation drew on both strands using graphical data to identify patterns and trends and drawing heavily on qualitative interview data and raw transcripts to explain and contextualise these numerical data.

4.7 Chapter Summary

The richness of data collected as part of the present study has called for a real depth of analysis. This chapter has described the range of analytical approaches which have been employed in the present study in order to answer the research questions outlined in section 3.4. The analytical techniques used here are of note in and of themselves. The unusual approach to investigating a broadly cognitive phenomenon, namely a mixed method, interpretive approach, has called for original use of analysis to make sense of the data. Novel application of directed graphs to coded classroom data and thoughtful data integration has been necessary to make sense of the large amounts of rich data that have come from the present study. A balance has been struck in order for patterns and trends to be identified from the data, while retaining sufficient granularity that individual differences can be discussed, and minute-by-minute dynamics identified. Such original application of these analyses promises to provide unique insight into the landscape of regulation of learning in the classroom, and perhaps opens the door to more interpretive approaches to psychological phenomena to provide individualistic perspectives and provide researchers and practitioners alike with a richer understanding of such highly contextualised events.

5 Results and Analysis

5.1 Introduction

The following chapter showcases the recorded episodes. These all took place before school closure and changes in classroom practice due to COVID-19. Firstly, an overview of the four episodes is presented in brief, with key characteristics highlighted. Following this, episodes are outlined individually, detailing the patterns and behaviours emergent from the data. Each of the four episodes are presented separately, firstly by considering the contextualised observational data and then by connecting to the stimulated recall interview findings. This mirrors the integration process discussed in section 4.6 and shown in figure 4.14. This has allowed appropriate illustration of macroscopic patterns and themes followed by individual experiences of the focus students in each case. The chapter is concluded with a joint display (Plano Clark, 2019) to summarise the themes evident from the data and highlight once more the integration of the data sources before introducing the discussion.

The term episode, used to refer to the separate recordings made as part of the data collection, is used deliberately. In this case episode is used to refer to a segment of time that has been recorded, in other words, it must be acknowledged that the episode sits as a small segment of a significant timeline or timelines and is not a self-contained entity. Using language from chapter four, each episode can be seen as an event, nested within a situation, which consists of a range of regulatory acts. Events before the recorded episode will have affected the episode itself, for example. The term *scenario*, which was originally used as this project was ongoing, was thought inappropriate as it has connotations of a self-contained period in time, selected and potentially artificial contextual factors. This seemed to conflict with the ecological validity and contextualised nature of this methodology. The term *episode* is therefore used to refer to the recorded segments of lessons which are described in detail in the following sections.

5.2 Overview

Four episodes were recorded and coded in total. Whilst this is fewer than originally intended, the depth of data has provided valuable, rich insights into the functioning of the groups in question. A summary of the basic characteristics of the episodes is shown in table 5.1.

Episode	1	2	3	4
Subject	English	Biology	Chemistry	
Individuals present	*Student G* Student H Student S Student Y	*Student A* *Student R* Teacher	*Student G* *Student R* Student L	*Student A* Student M Student N Student Y Teacher
Task	Group discussion	Review of exam paper	Practical experiment	
Recorded episode length (min)	80			
Coded episode length (min)	28	26	21	23
Total number of regulatory acts	21	81	180	181

Table 5.1: A summary of key characteristics of the four recorded and coded episodes. Focus students are indicated in italics.

As can be seen in table 5.1, the recorded episodes vary in nature significantly. While a larger number of recordings, as intended before school closures, would have reduced the impact of some confounding factors such as task type, the episodes nevertheless contain rich, in-depth information on how students regulated their learning in these varying contexts. While the differences in episodes make direct comparisons problematic, a number of patterns, themes and tendencies can be recognised and are described and justified throughout this chapter.

The episodes are simply presented in the order they were recorded. Each episode is presented firstly by considering basic frequencies and descriptive statistics before considering the manifestation of regulatory acts over time, and more complex graph theoretic statistics, introduced in section 4.4. Finally, stimulated-recall interviews are discussed to reflect on the interpretations of the coded data. This is in line with the explanatory mixed methods structure (Cresswell, 2017) discussed in section 3.2.

5.3 Episode One

Episode one occurred in a small, ten-student English classroom. The recording centred around a small group of students as the teacher introduced and discussed a new piece of literature, Shakespeare's Othello. This was followed by discussion with varying levels of participation by students.

Observations

Despite continued efforts and encouragement by the teacher, the discussion did not become collaborative during this lesson. There were no sections of the recorded lesson which could be chosen to be fully coded and analysed according to the criteria set out in section 4.3. That said, the decision

was made to transcribe and analyse the 28-minute portion of the lesson which involved interaction. Only vocal utterances were transcribed, but out of 139 utterances, only 21 could be coded as regulatory in nature. The primary contributor was the teacher, with 98 out of 139 utterances (71%) attributed to her. Four students also contributed, as shown in table 5.2.

Contributor	Teacher	Student G	Student S	Student Y	Student H
Utterances	98	16	10	8	6
% of Total	71	12	7	6	4

Table 5.2: The teacher in episode one was the primary contributor to discussion by a large margin.

Much of the discussion took a question-answer format, with primarily closed questions from the teacher.

> *"So think about, who, which male, which man, do we view Emilia through?"*
>
> *"Iago."*

These questioning phases sat alongside encouragement to share ideas and discuss the work.

> *"Yeah? Talk to the people around you, share ideas."*

There were only 21 utterances coded as regulatory in nature, all of which were asymmetrical, or directive or co-regulatory in nature. That is as opposed to symmetrical regulation where responsibility for regulation is shared. Table 5.3 contains the totals of each type of regulatory act coded in the episode.

P	M	C	E	EM	D	Total
5	5	2	8	1	0	21

Table 5.3: A small number of utterances were coded as regulatory in nature in episode one.

Five utterances were coded as planning, all of which were from the teacher setting goals for the students.

> *"What you are going to do for the last 10, 15 minutes of this lesson is you're going to go back to the brainstorm now, but you want to change pen and just differentiate between the scene that we were looking at the beginning..."*

Monitoring acts were also observed on five occasions. One ostensibly important act was when student G interrupted the teacher to seek clarification.

"What does shrewd mean?"

In this instance, this interruption to the instructions from the teacher by student G was coded as controlling as student G clearly recognised that she could not access the instructions without the definition of shrewd. This lack of knowledge was identified and addressed through a halp-seeking act coded as controlling.

The teacher also displayed evaluation acts on eight occasions in response to student suggestions. This was the most common code, identified on eight occasions throughout the episode and making up 38% of all regulatory acts observed.

"Lovely, so you have just made a really nice contextual link there, the idea she's commenting on the context of the times, so she's a voice, she's criticising the times, written history, so she's a contemporary critic."

Perhaps most interestingly, the teacher appears to display monitoring and control as the contributions from students do not live up to expectations and a different tactic is employed. This is an interesting insight into the contrasting goals of the teacher versus the students. It appears that the teacher in this case has the goal of eliciting interaction from the students. The first utterance coded as monitoring seems to make this obvious, as well as identifying the shortcoming to this goal. This is then followed by a controlling act, in which an alternative approach is taken and the teacher aims to model expectations for students.

"Yeah? Again, are we going to have to talk about this because it's quite difficult because they move between the two. Yeah? Alright."

"Do you want me to do an example with you? Yeah?"

This recorded episode arguably does not help to answer the questions about the nature of the regulation of learning during collaboration in this particular context for two reasons; the lack of collaboration and the lack of observable regulation of learning. Two interesting themes are still clear, however. The regulation of learning by the teacher in this instance is particularly interesting. While only observed clearly enough to be coded on one occasion, the monitoring and controlling function suggests that the teacher takes control of the regulation of learning in this case in order to support students to reach their goals, which are also set by the teacher. The lack of regulatory acts displayed by the students in this setting is also interesting in itself. This provided an opportunity to investigate why this might have been and what might have prevented the collaboration and student input so clearly intended by the teacher.

One thing is clear, which is that effective regulation of learning during collaboration appears to require effective collaboration in the first instance.

Stimulated-recall Interview

Following this episode, student G took part in a stimulated recall interview on the same afternoon, within the intended 24 hours after the recording was made. The concurrent observation of the recorded lesson had identified the lack of collaboration and regulatory acts, although student G had clearly broken convention by interrupting the teacher to gather information required to reach the goals set by the teacher. This theme was explored within the interview, with particular interest in student G's perspective on the lack of student contribution observed.

> *"There's a point here where [the teacher] starts speaking and you interrupt her to ask a question…"*

> *"I think I needed to ask it so I can, like, to make it more clear for me, the, what we were talking about."*

The initial reflection by student G appears to tally with the analysis of the interruption as controlling in nature. It also suggests that student G has monitored progress against the goals set by the teacher. Student G reflected that the recording made was representative of English lessons in general. When asked for reflections on why students didn't contribute, student G mentioned the efforts of the teacher to encourage contributions.

> *"Yeah she always tells us to speak up and they said that they are going to make us be the teachers basically, like make us like lead the lessons so we can talk up."*

> *"Ok, how would you feel doing that?"*

> *"I don't like it I don't want to do that."*

Student G did not need prompting to explain why she thought the class was not interacting as much as the teacher wanted.

> *"I think we don't really talk because no one really knows each other, and I think it's just a bit awkward for everyone."*

> *"I think everyone is, like, embarrassed to say what they think as well."*

This is an interesting reflection as it emphasises the importance of the social pressures faced by upper secondary students. Perhaps more pertinently, it highlights the impact this can have on effective collaboration and therefore effective regulation of learning in collaboration. It is not possible to say that regulation of learning was not taking place, in this case in the form of internalised self-regulation, but the reliance of the students on the teacher is clear.

When student G was asked whether the observed episode was representative of other lessons, the answer reinforced the social factors influencing behaviour, and provided a potential reason for some of the reluctance to contribute in English lessons.

> *"The other classes are bigger and I have like, there's more people that are my friends so we talk more."*

> *"…because English is like, you have to talk about your own ideas and other lessons it's just like facts really. So, for me it's easier to like, memorise facts let's say so I just put my hand up more to say answers and stuff like that."*

Interestingly, there seems to be a difference in approach for student G when dealing with types of knowledge in different subjects. While not affecting regulation of learning directly, it appears to affect student G's self-efficacy and confidence in contributing, therefore affecting the quality of collaboration and by proxy the opportunity to regulate learning.

In this episode the teacher appears to take control of the regulation of learning on a macroscopic level, setting goals and evaluating responses from students. This does in part seem to be because of the lack of contribution in this sense from students, to the point that the teacher's monitoring and controlling processes are visible in trying to engage them. When student G was asked about the teacher, she reflected that she needed teacher input in English because of what she saw as the difference between knowledge in English and 'facts' in chemistry, for example. This was investigated further, and student G was asked how she would approach learning independently, when the teacher isn't there. This led to an interesting reflection on when student G needs teacher input.

> *"So I think, I need for the teacher to be there to learn it, but once like I know it, I don't need the teacher to be there anymore. I can't like, this is why I can't, it's hard for me to, when thy tell us to like go away and research that at home or something like that. It's really hard for me to do that, because I need someone to explain it to me in a simple way, and then when I know it I just know it so in an exam I just know what to write."*

This apparent reliance on the teacher might also go some way to explain the lack of collaboration in the observed episode. If there are a number of students who feel a similar way within the group observed

in episode one, it may be that they are not contributing in the way that the teacher intends because they see the input of the teacher as crucial to their learning and as what they need to be successful. This attitude, paired with potential social anxieties and a lack of surety due to the nature of knowledge in English in comparison with other, perhaps more positivist subject areas, seems to have led to a very directive episode characterised by the teacher trying, unsuccessfully, to engage students in collaborative discussion.

Episode Summary

Episode one is characterised by a lack of observed regulation of learning. It is not reasonable to suggest that this mean it wasn't happening, but the sort of shared, social regulation of learning as part of collaboration that the present study was intending to investigate was not present. The episode was still included in this chapter, however, because the small number of regulatory acts observed exemplified the role of the teacher in the classroom, as the teacher's regulation against their own goals became visible. The stimulated-recall interview conducted with student G also highlighted a number of interesting themes providing potential reasons for the lack of collaboration and therefore regulation of learning observed, namely existing social relationships, reliance on the teacher as an authority of knowledge and even the nature of knowledge within English in comparison with other disciplines.

5.4 Episode Two

Episode two centres around two students as they collaborate on exam feedback. The students, student R and student A, also appear in episodes three and four respectively. The teacher also features heavily in the collaborative episode. The full 80-minute lesson was recorded, but after data reduction a collaborative portion of 26 minutes was coded in full. In this 26-minute section of the lesson, 81 acts were coded as having a regulatory function. First, the frequencies of each type of act displayed, and by whom, are considered.

Frequencies

Table 5.4 shows the raw frequencies of regulatory acts in episode two. This is a significantly different profile to the other episodes, as seen in tables 5.4, 5.7 and 5.10. The majority of acts were coded as planning and as emotional/motivational regulation. This is at odds to the pattern seen in episodes three and four wherein monitoring is the most frequent code and the four core codes are significantly more common than either emotional/motivational regulation or disengaged behaviours.

P	M	C	E	EM	D	Total
15	16	5	13	19	9	81

Table 5.4: Planning and emotional/motivational regulation are the most common codes assigned to acts in episode two.

The acts are relatively evenly spread across both students and the teacher, showing the influence the teacher has in this particular episode. This is not true for planning or monitoring, for which the teacher and student R take responsibility respectively according to the frequencies by individual shown in table 5.5.

	Student A	Student R	Teacher
P	3	1	11
M	3	11	2
C	1	3	1
E	9	7	1
EM	5	6	8
D	4	5	0

Table 5.5: There is a significant contribution to planning, evaluation and emotional/motivational regulation by the teacher in episode two.

The teacher contributes to aspects of the regulation of learning significantly in episode two. In particular, the teacher in this instance is responsible for 73% of acts coded as planning. This suggests a significant amount of authority over this process. It may also indicate intentions to set out goals and plan the learning episode thoroughly before allowing students to work with agency. On further inspection, the planning acts occur throughout the coded recording, with between zero and two instances per minute. This is at odds with the idea that the teacher is setting out goals at the beginning of the episode, instead suggesting that they retain authority over planning throughout the collaborative session.

With regard to monitoring, student R appears to have the greatest contribution, with 69% of acts coded as monitoring attributed to student R. Controlling acts were not seen in abundance. When considering this in theoretical context, this suggests one of two things. It could be the case that monitoring acts were not effective, so the monitoring against goals was not sufficient to cause change to better reach those goals. Alternatively, the fact that controlling acts were not observed could simply mean that this aspect of regulation of learning was internalised and not that it did not occur. It is also certainly true that the teacher set out abundantly clear and specific goals at the start of the collaborative activity, suggesting perhaps that the amount of controlling acts required was minimal.

It is interesting that after such a significant contribution to planning in this episode, the teacher contribution to evaluation, perhaps to be expected at the other end of the activity, is minimal. When placed in context, a possible reason for this becomes clear. The episode and the data presented here represents the collaborative section of the lesson, when student A, student R and the teacher work collaboratively to reflect on an exam paper completed by the students in a previous lesson. The exam paper had therefore been marked, which could be seen as a form of evaluation, meaning far less evaluative input was required in situ. It is also worth noting that before the episode defined as

collaborative according to the criteria set out in section 4.4, there was a phase of IRE questioning (Larson, 2000).

Initiation: The biurette test is a test for…?
Response: Proteins.
Evaluation: Good.
I: A positive test shows a colour change from what to what?
R: Colourless to lilac.
E: Good, to lilac. Colourless to lilac.
I: A Benedicts test is for…?
R: Sugars.
E: Well done. Well done if you said recuding sugars.
I: A positive test shows a…
R: Red.
E: Good, or brick red, ok.
I: Then to change a non-reducing sugar to a reducing sugar you heat the solution with…?
R: HCl.
E: Yes! Well done, nicely remembered.
I: And the test for lipids is the what?
R: Emulsion.
E: Good.
I: And the positive result is a…?
R: White.
E: White what?
R: Precipitate.
E: Precipitate, good. Or you can say milky white.

This type of directive interaction is discussed further in section 2.8, but if the evaluation phase of these questions is taken as an evaluating act through the lens of the coding scheme in the present study, there were 22 consecutive evaluating acts from the teacher in this phase of questioning, with no regulative acts observed from students. While not directly part of the episode discussed here, this is an indication of not only the context within which this episode is nested, but also of the regulatory authority of the teacher in such settings.

Apart from the core four processes, the teacher contributes significantly to the emotional/motivational regulation of the group, with two thirds of non-planning acts by the teacher coded as such. This responsibility taken for motivating students ties in with the authority over planning as the teacher encourages students to complete the desired activity in a time-pressured context.

Student R appears to take responsibility for monitoring progress, with 69% of monitoring acts attributed to them, whereas evaluating acts are relatively evenly split between student A and student R will little teacher input.

Figure 5.1 displays the proportion of each type of act attributed to each individual in this group. The large area of the polygon representing student R reflects their contributions to monitoring in particular. This appears to be true for controlling acts too, though this is skewed somewhat by the small numbers of this type of act identified.

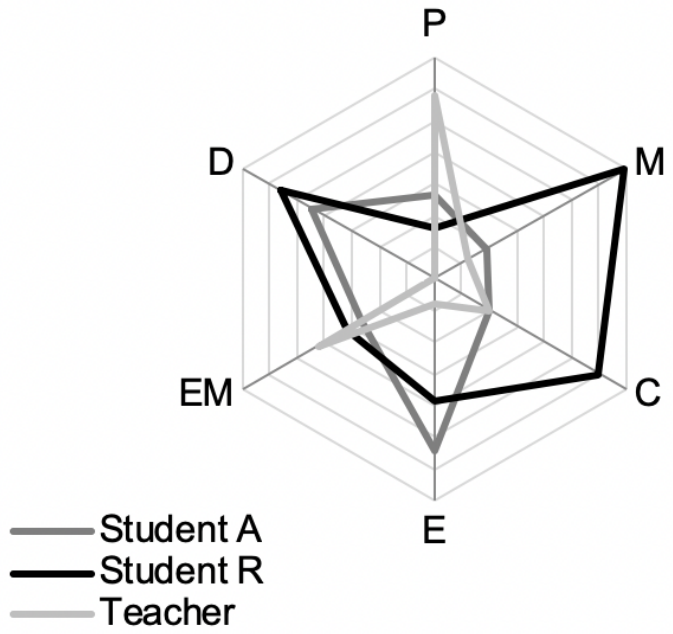


Figure 5.1: A radar diagram representing the contributions of each individual to each type of act observed.

The proportions of each type of act displayed by each individual are represented in the form of a radar diagram in figure 5.1. Each of the six axes represents one of the six codes introduced in chapter four. The plot points for each individual represent the proportion of the total number of instances of the act in question that were displayed by that individual. As an illustrative example, on the D axis, representing disengaged acts, student A displayed four out of a total of nine of these acts, equating to 44%, so student A's polygon is slightly closer to the origin than the polygon representing student R, who displayed 56% of the disengaged acts in this episode. It is important to note, therefore, that this representation does not give information on the frequency of each type of act, but rather the proportion of each individual's contribution to the total of each act. This visualisation highlights the idea of contribution to the aspects of regulation represented by each code. It follows, therefore, that the greater the area of a polygon, the greater the contribution of the individual it represents.

Figure 5.1 emphasises the significant contribution of student R to the monitoring and controlling of group activity, as discussed in relation to the frequencies in table 5.5. The contribution to planning from the

teacher is also stark, along with the apparent sharing of responsibility for emotional/ motivational regulation between all three parties.

As with other episodes, frequencies of particular types of act give limited information, especially when considering regulation as a dynamic process. For this consideration to be reflected in analysis, temporal dimensions of the data must be considered. One way to do this with simple frequency data is to consider the frequencies in specified time periods. An illustration of the impact of granularity when considering this perspective can be found in section 5.6.

In order to consider the regulation of learning over time, a timeline has been constructed by simply plotting the types of regulatory act in a cumulative area graph, shown in figure 5.2. This type of graph, used as a timeline in this case, provides an overview of the total number of regulatory acts at minute intervals. It also provides information about the number of acts from each category at minute intervals.

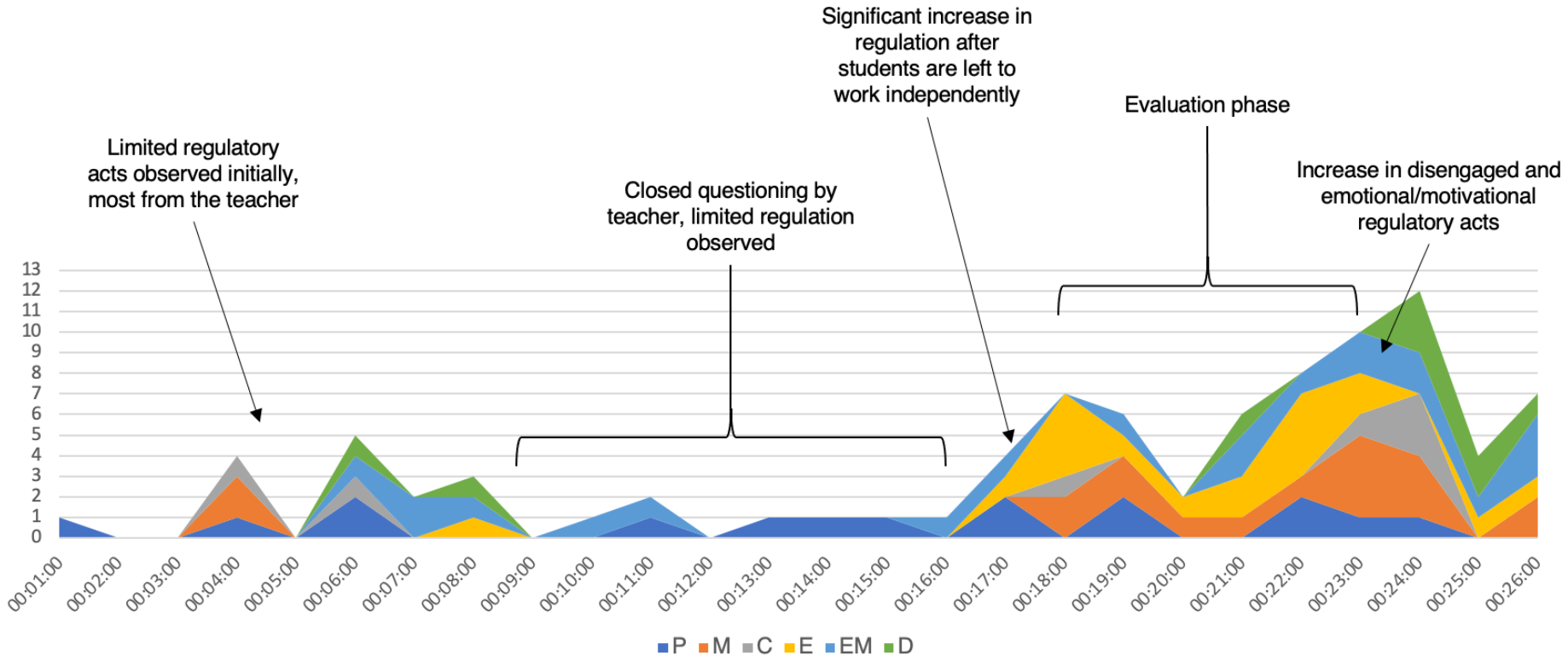


Figure 5.2: The frequency of regulatory acts fluctuates significantly throughout episode two.

This type of representation is effective in providing temporal information about the frequencies of regulatory acts. For example, it can be quickly identified that the number of evaluating acts is particularly high between 17 and 24 minutes, and that there is a peak in the number of disengaged acts in the final two minutes, when six acts are coded as disengaged. Emotional/motivational regulation and planning acts appear to be fairly consistently displayed throughout the episode.

The frequency of acts coded as regulatory in nature increases significantly after 16 minutes, with almost three times as many regulatory acts occurring in the final ten minutes of the episode. So why would the frequency of overtly regulatory behaviour increase threefold like this? What happened in the 16th minute? On closer inspection, the likely reason for this change becomes clear. For the first 16 minutes of the recording, the teacher is engaged in asking closed questions to student A and student R, punctuated by written work by the students as they correct exam answers. This does not appear to provide the opportunity for the students to regulate their learning. In fact, the students have very little agency at this point and whilst there must be regulation of learning occurring, and whilst it is not visible in a collaborative sense, it is reasonable to posit that the teacher holds the authority over this episode of learning. This is compounded by the fact that the teacher moves from the two students in the 16th minute. At this point, students A and R begin to compare answers and there are a significant number of acts which evidence the regulatory processes taking place. In this episode it is almost as if the barrier to regulation has been removed when the teacher leaves. It might be that the authority over such metacognitive processes the teacher holds is the barrier, or perhaps more indirectly, the prohibitive effect of the presence of the teacher stems from an aspect of the self-efficacy of the students. It is more likely, considering the responses of both students during stimulated-recall interviews, that rather than an inability to regulate, or initiate required regulatory processes, students instead rely on the regulation by the teacher. The lack of visible regulation of learning by the students in this case is more due to the inactivity of the students than it is the activity of the teacher.

Rather than the teacher necessarily being a barrier or obstruction to appropriate student-led regulation of learning, it is an easy option for students to allow the teacher to take on these processes. This is certainly a less difficult, perhaps safer course of action and even perhaps an indication of adaptive regulatory behaviours as learners recognise that this reliance on and deferral to the teacher is an efficient means to reach their goals. It could also be argued that there was no requirement for students to regulate due to the low level of cognitive challenge if these processes were taken on by the teacher. There are of course difficulties in the creation of such a narrative with the limited data available from the observations made, but the same theme of reliance also emerged from the interviews conducted with the same students so it may not be too great a leap. The stimulated-recall interviews are discussed in section towards the end of this section.

Sequencing

In figure 5.2, the effect of a physical change in the group is seen as the teacher leaves. The regulatory acts undertaken by the students appear to increase as a result. Alongside this, it is interesting to consider whether behaviours of the individuals can also trigger changes in the function of the group. In other words, it is important to identify any patterns that emerge in regulatory acts over time, and to consider factors which may influence or cause these patterns and their emergence. This can be done by considering adjacencies, or how frequently a given type of act is followed by each type of act. These adjacencies are shown in matrix form in figure 5.3. Further details on adjacency matrices can be found in section 4.4.

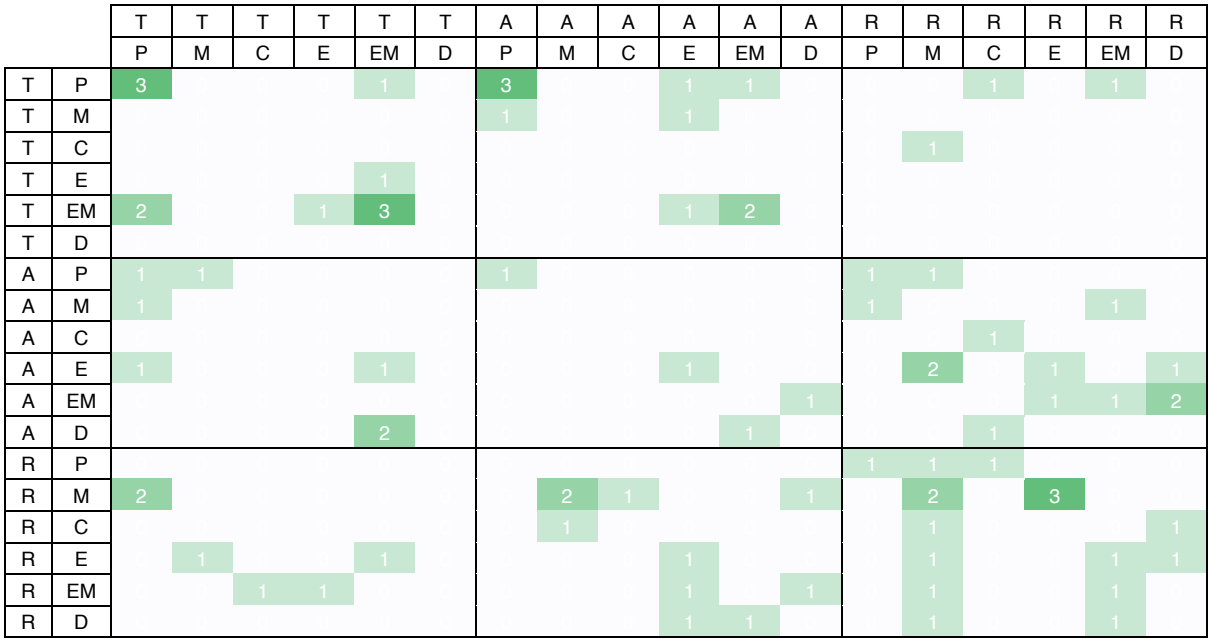


Figure 5.3: There are few repeated adjacencies observed in episode two.

The matrix in figure 5.3 is coloured with the tone used to indicate relative frequency. The darker the shading of a cell, the more frequent the adjacency it represents. This shading allows visual representation of the frequencies to be better visualised and the matrix to be treated as a heatmap. In this particular instance, the range of frequencies is very low, so each adjacency occurred between zero and three times only. Adjacencies are relatively spread throughout the matrix, though two of the four adjacencies with the highest frequency appear in the top left section of the matrix, denoting a reciprocal teacher to teacher act. In other words, a regulatory act by the teacher has been followed by another regulatory act by the teacher. This is also common in the case of student R. Another of the most frequent adjacencies is a monitoring act by student R followed by an evaluation act by student R. Reciprocal acts by student R occur most frequently overall, with seventeen instances, higher than any other type of participant-to-participant adjacency, regardless of regulatory act type.

What these observations from the matrix can elicit about the nature of the regulatory interactions of the group is limited somewhat by the number of regulatory acts observed, which is relatively low as seen in table 5.4. Having said this, the fact that few clusters appear on the heatmap in figure 5.3 might tend to suggest an adaptable, fluid regulatory process. In contrast, the highest frequency of teacher planning to teacher planning and teacher emotional/motivational regulation to teacher emotional/motivational regulation could indicate that the teacher is retaining authority over these aspects of the regulation of learning taking place.

In the case of emotional/motivational regulation it seems reasonable to suggest that this might be higher from the teacher as they attempt to keep students motivated despite setbacks in the exam being reviewed.

> *"So you did the difference? That's absolutely fine. This is a really tricky question because the percentage difference or the percentage increase is actually huge, so the answer is 6607. Ok. Have a look at it and think if you can get to that answer."*

> *"So there's only one person in the whole year group who got 2 marks on that question. Really well done if you got one."*

It also seems reasonable, with respect to planning acts, that agency in this aspect of regulation is not being afforded to the students. This is perhaps not uncommon with this type of task with pre-set goals, closed instructions and clear time restraints for achieving the said goal of reviewing exam answers. Alternatively, the planning undertaken by the teacher is so effective that student regulation is unnecessary. This is certainly the suggestion when the stimulated-recall interview by student A is considered later in this section.

The matrix shown in figure 5.3 can be represented as a directed graph, whereby each non-zero act type is represented by a node and each adjacency by an edge, or an arrow between two nodes. The graph shown in figure 5.4 is weighted, meaning the frequencies of each adjacency are noted beside each respective arrow. In this instance the frequencies are low, but in order to focus on the more frequent adjacencies, only those which occurred more than once feature on the graph. This is consistent throughout this chapter for each episode and is consistent with data reduction practices seen in previous studies (e.g. Hadwin et al., 2007). Further information about directed graphs can be found in section 4.4.

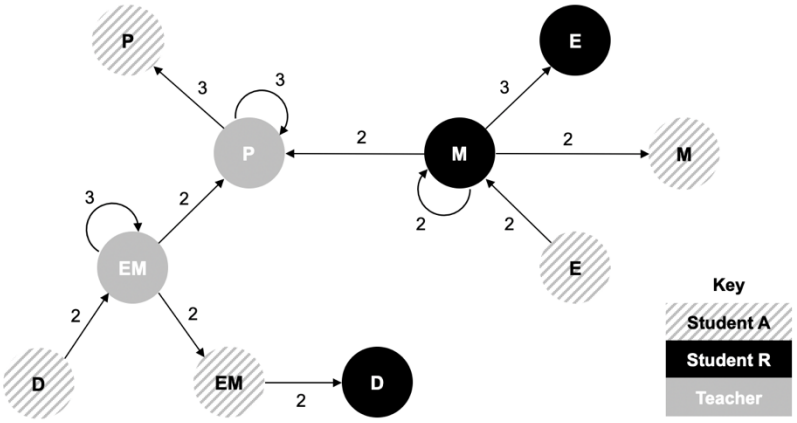


Figure 5.4: A directed graph representing the adjacency data for episode two highlights the importance of teacher input to regulation of learning.

Figure 5.4 displays the graphical representation of the matrix shown in figure 5.3. In this instance, the adjacencies that occurred more than once are relatively small in number, so the graph has few nodes. Despite this, clear patterns and tendencies can be seen in this representation. Before considering graph theoretic statistics such as degree and density in any way, it is important to first consider the surface-level appearance of the graph itself. It is somewhat striking, particularly when viewed alongside graphs from other recorded episodes seen in figures 5.8 and 5.17, that this has a clear 'tree' structure, in other words there are no cycles present in the graph, and six out of ten types of node are only connected to one other type. This relates directly to the adjacencies of types of regulatory act, so these six types of act by the noted individuals only repeatedly lead to or follow one other type of act. This type of clear pathway perhaps suggests a well-trodden process, or a lack of experimentation with types of regulatory acts. These inferences are difficult to draw with certainty considering the limited numbers of regulatory acts that were identified during this episode. This said, the fact that the number of regulatory acts identified was limited also provides information about the nature of the collaboration. This may be because externalisation of regulation through observable acts was not necessary, in other words the process remained internalised within the individuals involved in the episode, or that the few acts identified were sufficient to regulate the learning taking place within the task. Alternatively, it may be that the limited number of regulatory acts is a result of a tentativeness or lack of confidence from the individuals involved in the episode. For example considering planning, the vast majority of these acts were displayed by the teacher, perhaps because the authority and clarity provided by these meant little planning had to be carried out by students A and R, or perhaps because students A and R were not confident enough to display these acts themselves. The nature of the task set suggests the former is more likely, as the teacher set clear, time-bound instructions with little agency afforded to students over goal-setting and other key planning acts.

"OK. I'll give you five minutes, just with the people next to you, I want you to compare your marks and have a look through the questions which you haven't got, so use each other for each other's marks schemes. Alright, any questions? No, I'm here to help as well, off you go – start comparing."

One other thing to note is that the acts by student A are often echoes of the previous act type. For example, on three occasions a planning act by the teacher is followed by a planning act by student A. Student A also echoes monitoring by student R and emotional/motivational regulation by the teacher. This might be an indication of effective sharing of these regulatory processes, however, it is important to note that these adjacencies are always in one direction, student A always follows the previous individual and these relationships between nodes are not reciprocal. In other words, student A echoed the teacher with a planning act on three occasions, but the teacher did not echo student A at any point.

Qualitative considerations of the nature of the graph are supported by graph theoretic statistics. In this case, it is pertinent to consider two key values, that of density and that of cohesion. Firstly, the density of the graph shown in figure 5.4 is 0.20. Density compares the number of transitions in a graph with the total number of possible transitions. This is expressed as a value between zero and one. This value gives an indication of the regularity and repetition in a process. A lower value would indicate fewer types of act and dominant transitions occurring repeatedly, whereas a higher density value would suggest less repetition and a greater variety of transitions occurring (Hadwin et al., 2007). It could be suggested that a lower value suggests a more set process amongst a group. This could occur for a variety of reasons, including control of the process by one individual, highly specialised approaches to a familiar task or limited amounts of shared regulatory processes. In the case of this recorded episode, it could be suggested that the low density value is indicative of the effect of the control of the teacher over the regulatory processes taking place.

Secondly, cohesion, a value between zero and one, measures the proportion of links in a graph, excluding self-loops, which are two way. This measure can be used to represent the reciprocity of the regulatory behaviours in a process. A higher cohesion value could be suggestive of a more dynamic, adaptive process. When the fact that each node could represent an act by a different individual, a high cohesion value could also suggest reciprocity in the interactions taking place, and parity of authority over the regulation of learning. The cohesion value for the graph shown in figure 5.4 is particularly low at 0.14. Avoiding problematic comparisons, it is clear that this value is significantly closer to zero than it is one. Alongside evaluation of the graph shown in figure 5.4, this suggests that the regulation of learning process displayed in the episode in question was not particularly reciprocal, further suggesting that the teacher had authority over the regulation of learning taking place.

Whilst cohesion and density provide an overall insight into the statistical nature of a directed graph, they are limited in scope in the present study beyond arbitrary indications of the magnitude of the

characteristic in question. Beyond being used alongside qualitative analysis of a graph in a confirmatory fashion, these values cannot be used with great confidence in a directly comparative sense as the factors affecting these values are numerous and are not controlled between cases. This being said, comparisons can give a better sense of the magnitude of these values which would otherwise stand in isolation. This issue does not exist for all graph theoretic statistics. For example, degree, which considers individual nodes, representing regulatory acts in the present study, can be compared within the same graph. This does give crucial comparative information on the behaviour of the individuals present in the case represented graphically.

As discussed in section 4.4, the graph theoretic statistic *degree* can give an indication of the number of times a certain act is revisited and therefore how central it is to the overall process taking place. It might be expected that monitoring acts have a high degree as they may be expected throughout an effective period of regulation of learning. A low degree might also indicate a repetitive process. It might also be expected that planning and evaluation might have a lower degree as they are enacted less frequently and at particular points in the learning process. However, without thorough analysis of these statistics, these remain suppositions, so it is important to consider what these values actually are in this case.

For each type of act and for each individual in the episode, table 5.6 summarises four values; the number of times the act was observed and coded, the total degree and the separate values for in degree and out degree. Types of act which did not occur do not appear in table 5.6, instead the table cell is left blank. It should be noted that degrees are not cumulative, in other words, if planning by student A leads to monitoring by student R six times, this will only equate to an out degree of one, as the transition is of the same kind.

		A	R	T
P	Frequency	5		12
	Degree	1		5
	In, Out	1, 0		3, 2
M	Frequency	3	11	
	Degree	1	6	
	In, Out	1, 0	2, 4	
C	Frequency			
	Degree			
	In, Out			
E	Frequency	7	6	
	Degree	1	1	
	In, Out	0, 1	1, 0	
EM	Frequency	5		9
	Degree	2		5
	In, Out	1, 1		2, 3
D	Frequency	4	5	
	Degree	1	1	
	In, Out	0, 1	1, 0	

Table 5.6: A summary of degree values for the acts displayed in episode two.

The acts of most interest in table 5.6 are arguably those with the highest degree. As discussed, these acts are those which are most central to the process that has emerged from this data as they are revisited regardless of the preceding act, and lead to a range of subsequent acts. In this case those of note are planning and emotional/motivational regulation by the teacher and monitoring by student R. These are also, as noted when considering the timeline in figure 5.2, the acts which consistently occurred throughout the episode, and could therefore be argued to be central to the overall process.

Once again, both acts which feature in the graph in figure 5.4 by the teacher are of a particularly high degree, indicating their repetitive nature and their importance in the structure of the process seen in this episode. This observation is not a surprise as it echoes qualitative observations, reflections during stimulated-recall interviews and other analyses of the graph. This result is perhaps more surprising because it potentially refutes the idea of regulation taking a cyclical format. Instead of planning taking place at the beginning of this activity, it has occurred consistently throughout and has both followed and preceded a wide range of other regulatory acts. This is as opposed to being bound within a structured cycle or process. The centrality of the acts by the teacher also provides further justification for viewing the teacher as the key authority of the regulation of learning in this episode. The inherent power held by the teacher in the classroom appears to be exercised to carry out regulation of learning in this episode, particularly with respect to planning and emotional/motivational regulation.

Also notable is the magnitude of the degree for monitoring acts by student R. In fact, the value for the degree of this type of act is the highest of all those observed. The fact that the highest degree pertains to a monitoring act is not necessarily a surprise. This aspect of regulation underpins other regulatory processes according to a large number of models of regulation of learning discussed in section 2.2. The fact that this recurring type of act comes from student R might suggest something about the student's regulatory proficiency. Consistent monitoring can be an indication of successful regulation of learning and the fact it is happening here despite the apparent control of the teacher may be an indication of a refined ability to regulate learning by student R. In fact, when the data is more closely analysed it appears that whilst the teacher takes responsibility for goal setting, they do not monitor the students' progress against these goals, so the responsibility for this has, in this case, fallen to student R. The fact that student R is displaying these acts far more frequently and with a higher degree than student A does suggest an element of reliance of the latter on the former for this element of regulation of learning.

It appears, from the numerical data derived from coding the video recordings that several key roles are being played by the individuals in this group. Firstly, the teacher is planning and motivating the two students. It appears that this input in the first part of the episode means that little regulation is displayed by the students themselves. When the teacher leaves, student R appears to do the majority of monitoring the students' progress against the goals clearly set by the teacher. While student A displays a range of types of regulatory act, they appear to rely on the regulation of both the teacher and student R, with acts by student A having a far smaller degree, contributions to each type being smaller than the others and acts frequently being echoes of the act previously, for example planning by the teacher followed by planning by student A. This picture is built up from the frequency and directionality of thoroughly coded data, but it is important to consider whether this correlates with the experience of the students themselves. The following section considers the themes of the stimulated-recall interviews, analysed according to the process outlined in section 4.5.

Stimulated-Recall Interviews

As discussed in section 3.6, stimulated-recall interviews were conducted within 24 hours of each recording, based on field notes from the observation of the recorded episode itself. In this episode, because both student A and student R were part of the sample as described in section 3.5, they were both interviewed individually after this lesson.

Student A was interviewed first of the two students. There were three clips selected for discussion, the first being a clip of student A asking student R a question about the exam paper they were reviewing, the second included the teacher sitting with both students and the final clip showed the two students working together towards the end of the episode. These were shown in chronological order so as to aid

recall of the progress of the lesson. The interview was started using a very open question, using the video clip as stimulus and avoiding any leading suggestions.

> *"This little bit of video here, can you talk me through what is happening?"*

> *"I think we were looking through exam questions and I didn't know the answer and [student R] was kind of helping me"*

The theme of help-seeking is evident in the initial response to the stimulus by student A. This theme recurs throughout, with student A reporting that they rely on others "a lot". After the final stimulus video, when talking about the fact that student A had sought help from student R, student A gave an interesting insight into the decision-making process around help-seeking. When deciding which peers to ask for help from:

> "*Usually it's on if I know them, or if not. So if I know them, I approach them and ask them."*

This factor in the regulatory behaviour of student A is particularly interesting. Help-seeking, when required, is an appropriate aspect of the control aspect of regulation of learning. This suggests that it is dictated by the nature of existing social relationships, not by how likely an individual might be to have the appropriate information for student A to move forward. On recognising this theme, the data was revisited and the number of help-seeking acts within controlling acts was totalled. In fact, the number of help-seeking acts was only two, both displayed by student R. This is somewhat surprising as this type of behaviour is such a clear theme in the interview. However, when considered more carefully, it becomes clear that while help-seeking, as defined in the coding scheme, is infrequent in this episode, monitoring acts appear to be the reason for this, the high frequency and consistency of monitoring acts appears to mean that more obvious help-seeking and other controlling acts are not required by the students. Their monitoring processes are sufficient to continue working towards their goals. Perhaps the reason for the emergence of help-seeking as a theme in the interview stems from the high support provided by the teacher in this episode, so student A feels helped. Perhaps paired with an apparent lack of confidence this highlights this aspect of regulation in the reflections, despite the lack of overt help-seeking acts observed.

A second emerging theme was related to the role of the teacher in this episode. The second clip shown to student A included the teacher sitting with both students. As this happened, the focus of both students in the video recording visibly became the teacher. This was also evident in the coded data as the planning and emotional/motivational acts by the teacher became central to the regulation of learning taking place. When describing the clip shown, student A described the activity shown:

"It was in that part I think [student R] didn't understand the question, and [the teacher] was explaining to her. I got it right, but I was kind of listening as well. Just in case."

When asked whether the observed lesson was representative of other biology lessons, student A reiterates the role of the teacher.

"Usually when we do activities from new content. Sir always sits in front of me and when I'm always struggling with things he's always like, "are you ok do you need help?" and I'm like, "yes I'm struggling with this one" or with this question and he kind of like goes through it with me. And if it's new content he doesn't give me the answer, but he gives me more hints and sort of clues for the activity."

It appears from the reports by student A that the teacher in this case often plays a supportive role in these lessons. A crucial consideration is whether this support, and habitually sitting in front of student A, allows student A to regulate their learning effectively. Alternatively, this could cause reliance on teacher input. Student A reports that the teacher input is often of the same kind, with the teacher asking probing questions to draw the answer or progress out of student A, rather than simply providing the answer.

The suspected reliance on others by student A is possibly evident in her responses during the interview when they talk about working independently. Student A describes not having people to ask questions as "hard" and describes looking through books and other resources. This echoes student A's previous report that they rely on others "a lot". Interestingly, when student A was asked whether this was similar in all of her subjects, they identified health and social care and Spanish lessons specifically as being different.

"In health and social care [lessons], the person I have next to me is the person that's always asking me questions."

This is an interesting switch of roles, which student A also reports in Spanish lessons, which are not included in the present study as they are primarily conducted in Spanish. This supports the idea that the role played by any individual depends not just on the characteristics of the individual, but also the characteristics of the other members of the group. It could be suggested that due to their lack of self-efficacy, or perhaps because of teacher intervention, that student A has little authority over the regulatory processes occurring in collaborative work, whereas in health and social care and Spanish lessons, student A plays a different role and becomes the student who takes more responsibility for the regulation of the learning of both herself and those around her.

Student R was interviewed on the same day, after student A. This is important to note as the interviewer will inevitably have identified themes, discussed in this section, from the first interview. There is a risk of these affecting the second interview with student R as the stimulated recall interview is semi-structured. An awareness of this possible impact was important, and as per the discussion in section 3.6, a narrative of the rationale for lines of questioning and themes explored was recorded during and directly after the interview itself. This rationale is clarified in this section to ensure complete transparency and to maximise trustworthiness.

The same three clips were used in the stimulated recall interview with student R. This was an opportunity to further triangulate the researcher's interpretation of events in the recording and any discrepancies between the students' experience of the clips was a source of interest. In the first clip, there was a point where student R asked another student, other than student A, a question, which meant turning around, away from student A. This was an interesting episode as there was clear effort required to ask a student other than student A, who was sat adjacent to student R. As student R talked through her account of the clip, the reason for this became clear. It would be easy to assume that this was a reflection of student A's lack of confidence or student R's perception of student A's lack of ability in the subject, causing student R to seek help from someone they view as more reliable, in fact it was dictated by the exam paper the two students were reflecting on and the identification of the fact that student A did not have the correct answer.

> *"Yeah, me and Ashley made the same mistake so, yeah."*

When considering these actions through a regulation of learning lens, both the researcher's misinterpretation that this was related to the characteristics of the students themselves and the student's reflection indicate a significant level of regulation of learning taking place, in both cases identifying and following the course of action most likely to assist in student R reaching the group's goals. This is in contrast to student A's report of asking individuals with whom a relationship already exists rather than the likelihood of them being able to help. This being said, the individual that student R chose to ask in lieu of help from student A may well have been someone with whom they had an existing relationship.

In the second clip, when the teacher is seen sitting with student R and student A to help, student R's account of the clip tallied with that of student A.

> *"At one point here, there was a question on the paper that I didn't understand. I didn't understand why it was wrong, because to me, the question didn't really make sense, so I asked [the teacher] and that's why he sat with me and [student A] because I was asking him about the question and why it was wrong because I couldn't understand."*

Based on some of the answers and the theme of help-seeking arising from the previous interview with student A, the interviewer wanted to explore this aspect a little further. It was clear from the clips that student R in particular would try things first then turn to someone for help once stuck. When asked whether this was the case in all lessons, student R explained a nuanced difference in approaches across subjects.

> *"For a subject like history I don't really turn to the people around me, just because there will be a problem with my essay that I will need to ask the teacher about instead because there's not a set answer."*
>
> *"So your first port of call would be the teacher?"*
>
> *"Yeah. So, I would look at it and read my answer and see if I could change anything or if there is noticeably something I've done wrong and if not then I would ask the teacher about my essay."*

The interviewer in this case wanted to clarify whether there were any stages before asking the teacher. Next, the interviewer sought to explore how the student would respond to a situation where the teacher, and the source of support they appear to rely on for evaluation in this case, is not present:

> *"So how do you know once you've gone through that evaluation process, if there is no teacher there, how do you know you've done it right?"*
>
> *"I don't"*
>
> *"Okay"*
>
> *"Yeah, so I would try and correct it from what I think is wrong then I would check with the teacher. I would always try and check with the teacher."*

This is a clear indication of a significant reliance on the teacher, as an entity in this case rather than a particular individual, for the evaluation aspect of regulation of learning. The seeking of this support could indicate a refined ability to recognise which aspects of regulation of learning student R cannot complete herself. However, the externalisation of the process of evaluation suggests that this student relies heavily on others for this and therefore that her own evaluative processes are perhaps under-developed. This is reflected in the relative frequencies of evaluating acts by each individual in this episode, with seven instances displayed by student R and nine by student A. On three occasions, student R evaluating followed student R monitoring, as shown in the graph in figure 5.4. This might be the transition expected considering the models of regulation of learning discussed in section 2.2, but

this only occurs one third of the time, which might suggest an ill-defined process for evaluation by student R in in this case, taking into account her apparent outsourcing of this process.

When reflecting on biology lessons in general, student R identified a similar pattern to that seen in the coded data, specifically the major contribution to planning and specifically goal-setting acts from the teacher.

> *"So, sir will always talk us through it first, make sure we're all okay, we all understand it. Then he'll set us off on the task and then he's always there if we need him."*

In the final clip, when working with student A, it became obvious that student R was very frustrated with the fact that they had got one of the answers wrong in the exam. This appeared to be correctly interpreted by the observer as student R reflected in response to the clip:

> *"I was very frustrated because I made stupid mistakes in that test, and I knew it, so going through the test and just looking back at myself I could see the mistakes I had made."*

In fact, this frustration led to a number of disengaged acts in the final few minutes of the video recording, specifically six acts coded as giving up, four of which were from student R. This also resulted in an increase in emotional/motivational acts, three of six being displayed by student R. These emotional/motivational regulation acts were all narrating emotional state:

> *"That's so annoying!"*

Except one motivational input from student A:

> *"Oh, you had it!"*

The presence of emotional/motivational monitoring at a time when both students are struggling with their confidence is a clear display of regulation. The focus moves away from the regulation of learning per se, towards emotional/motivational regulation which might suggest a difficulty in regulating learning without the teacher present. A significant amount of collusion takes place rather than the students moving forward in their evaluation of the exam paper.

> *"I'm so sad."*

> *"It's the same with me with genetics. I just have all the words in my head, but I just can't."*

However, it could be said that the purpose of this collusion is also important, strengthening the bond between the students and allowing them to continue working in a non-judgemental, supportive partnership. This could be an important aspect of the emphasis placed on existing social structures when considering collaboration, as shown by student A selecting the individuals they seek help from based on the relationship that already exists, rather than the likelihood the selected individual will be able to assist them reach their goal(s).

Episode Summary

Episode two focusses on two students who work together in evaluating their responses to an exam paper completed in a previous lesson. Initially, students work together and seek help from another student before the teacher present sits with them to help student R through a question. When the teacher leaves, a significant increase in regulatory acts from the students is observed, before student R gets frustrated and both students display a number of acts which suggest disengagement.

The major themes that emerge from this episode pertaining to regulation of learning are the nature of help-seeking behaviours, and the influence of the teacher on the nature of regulation of learning between the students. Help-seeking was identified as important by both students, but was rarely seen. Monitoring and planning acts were observed throughout, however, the latter primarily from the teacher, which may have supported the students sufficiently that help-seeking was not necessary.

Both students report a reliance on help-seeking, which, as seen in section 4.3 is coded as a controlling act through a regulation of learning lens. More broadly, students report reliance on the teacher for what can be interpreted as a range of components of regulation. Student R reports not being able to evaluate their own outcomes at all without a teacher, and student A reports seeking help from individuals based on the existing social relationship rather than any consideration of their ability to help. While both students display and discuss help-seeking, there appear to be key differences in this. Student A reports help-seeking in biology and chemistry in particular and displays a great deal in this episode, whereas student R displays far less and appears to have far more contribution to the provision of help in this episode. The help-seeking behaviour appears to play a prominent role in the nature of the regulation of learning in this case, but the individual differences in approaches and recognition of this aspect of regulation are clear.

When considering the influence of the teacher, the concept of power is central. Students report, and the observation confirms, that the teacher in this case does not simply provide the answer, but asks questions to attempt to draw reasoning from the students. That said, the teacher's very presence changes the actions of the students. The teacher sets the goals for the students, coded as planning from the video recordings, and the students rely heavily on this input. This is reflected in figure 5.4, wherein planning by the teacher is central to the process displayed with a high degree in both directions.

Again, student R reports not being able to evaluate their own outcomes at all without a teacher. This is not a surprise perhaps when the role of the teacher in the classroom is considered from a power-dynamic perspective. The teacher has the answer that the students are working towards, so there will be little doubt in the students' minds when deciding to follow the teacher or not. It is far less effort for students to allow their learning to be regulated by the authority figure of the teacher as opposed to carrying out this process, with all of its rabbit holes and iterations, themselves. This can almost be observed in the complexity of the graph describing the regulation of learning in this episode. The regulatory acts by the teacher are the most central, and there are very few paths displayed by the group, suggesting a well-trodden, repeated pattern, most likely in this case guided by the authority of the teacher.

5.5 Episode Three

Episode three and episode four were recorded simultaneously in the same classroom as students completed a practical experiment. The full 80-minute lesson was recorded. Episode three focusses on a group of three students, student G, student L and student R. After data reduction, a 21-minute section of collaboration between these students was coded in full. Student G also features in episode one and student R features in episode two.

Frequencies

The frequencies of the acts coded as regulatory in nature are summarised in table 5.7. As with the other episodes, monitoring acts are the most frequent. Normally, comparisons would be avoided as there are numerous factors not controlled that differentiate between episodes. That said, this episode and episode were recorded in the same lesson and during the same task, so tentative comparisons are possible. A very similar number of coded acts can be seen here as in episode four, perhaps due to the nature of the task, which was the same in both cases.

P	M	C	E	EM	D	Total
46	66	32	20	5	11	180

Table 5.7: The four core regulatory processes are far more common than emotional/motivational regulation and disengaged behaviours.

As might be expected when observing an engaged group of learners, the frequency of the core regulatory acts, namely planning, monitoring, controlling and evaluating were observed more frequently than emotional/motivational monitoring and disengaged behaviours. This could suggest an engaged and confident group of learners, although there were a significant number of disengaged acts recorded. Evaluation appears less frequently than the other core types of regulatory act. When considering the contributions of each individual to each of the dimensions of regulation represented by the codes, a clear imbalance emerges.

	Student G	Student R	Student L
P	2	27	16
M	6	28	32
C	3	9	20
E	3	8	9
EM	0	2	3
D	7	2	2

Table 5.8: Monitoring acts by both student R and student L clearly play a key role in the dynamic of this group.

Note in table 5.7 one planning act was observed by the teacher, so does not appear in the breakdown of contributions by individual in table 5.8. In this episode, there is a nucleus of acts around monitoring by student R and student L, with a significant number of acts coded as controlling by student L and planning by student R and student L. Although these overall frequencies elicit little information about the dynamics of the group, it is certainly notable that the controlling acts are particularly one-sided, and that student G appears to have had far less input into the regulation of learning in this instance. Controlling acts are generally changes in direction and theoretically follow the identification of the need to change through monitoring processes in traditional models of regulation. It is perhaps unsurprising that the core of the controlling is carried out by student L, who also appears to take responsibility for a large proportion of the monitoring and evaluation functions in this episode. The majority of these coded controlling acts by student L were help-seeking. These three aspects of regulation could be seen as related in their requirement for reflective and reflexive thinking.

A radar diagram such as that seen in figure 5.5 can be used to visualise the contributions of each individual to each dimension of the regulation of learning that took place in this episode.

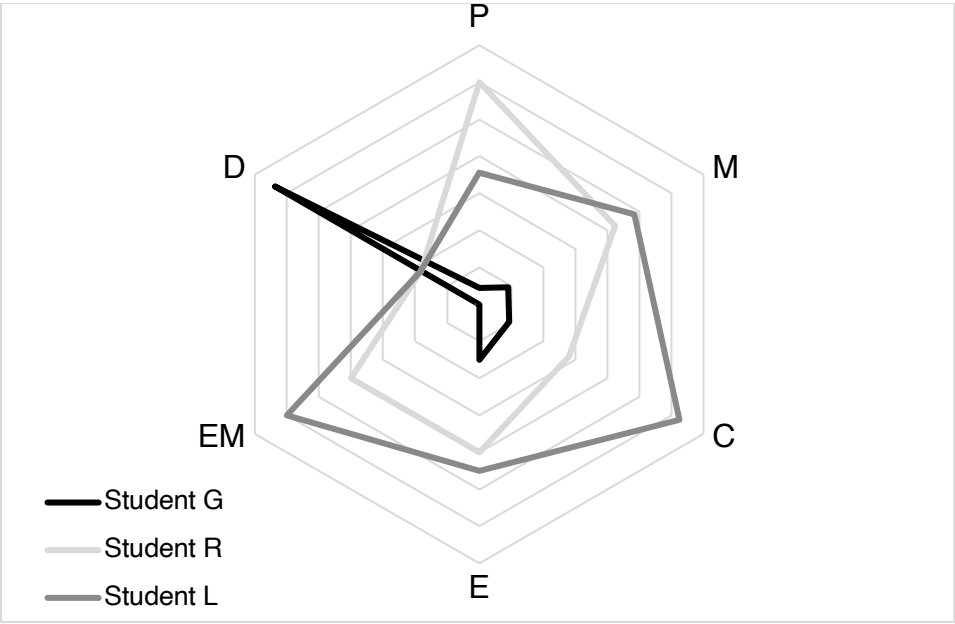


Figure 5.5: A radar diagram of contributions makes it clear that student L contributes the most across all regulatory acts bar disengaged and planning.

The frequencies of different act types shown as a radar diagram in figure 5.5 emphasise the control that student L appears to have over the regulatory processes taking place here. The area of the polygon representing the contribution to regulation by student L is large, indicating a significant contribution comparative to the other members of the group. On closer inspection of the monitoring acts by student L, many are simply narration rather than more active types of monitoring act.

"I'm going to take a little bit off."

"OK it's getting colder, OK it's getting warmer - it warms."

"OK, stir, stir, stir!" [student L stirs the reaction mixture]

Controlling acts by student L are unsurprisingly more active, as she tries to ensure the success of the group as she encounters something she is not sure of. In fact, the majority of acts coded as controlling displayed by student L were help-seeking in nature. This is interesting because help-seeking, while a controlling act because it stems from the recognition of a limitation or obstacle recognised that requires external support, it relies on the input of others, rather than the change in direction or strategy coming from student L themselves.

"How are we going to make sure that all of this goes in there?"

In contrast, while controlling acts displayed by student R are much less frequent, far more of them fall under the category of assisting or changing strategy as described in the coding scheme in chapter four.

This is interesting as the frequency of controlling acts in this case does not reflect the role played by the acts themselves. The controlling displayed by student L appears to seek engagement from other members of the group, so is outward looking from student L. In contrast, while less frequent, the controlling acts displayed by student R are far more directive, either providing assistance to another group member or changing strategy and therefore bringing the group towards their common goals. The starkly different functions of the controlling acts displayed by the two students in this episode emphasise the importance of the concept of authority and symmetry alongside the type of act in itself. Student L is seeking input, whereas student R is acting herself to move the group forward. Both have the same theme, a recognition and correction of a shortcoming. Student R takes responsibility and acts on this immediately, whereas student L shares this with the group and seeks input. This responsibility that appears to be shouldered by student R is echoed later in the episode when she leaves the group to work on a graph that she later shares with the other individuals she is working with. This is raised in the stimulated-recall interview discussed later in this section.

Student R also makes significant contributions to the planning dimension of the regulation of learning taking place here. Interestingly the majority of these acts displayed by student R were directive in nature as illustrated by the following examples.

> *"If you read the method, it doesn't say when to add the solid. It says to add the water to the cup and then record it's temperature and then I take it you add the solid and measure it every minute."*

> *"Where's the… right I'm going to get some tissue and then I'll deal with this. You just measure 24cm^3 and put it in here, OK?"*

When the frequencies are considered on a minute-by-minute basis, a timeline emerges and allows the consideration of temporal variation in behaviours. This can also identify key events in the progress of the group. A line graph serving this purpose can be seen in figure 5.6.

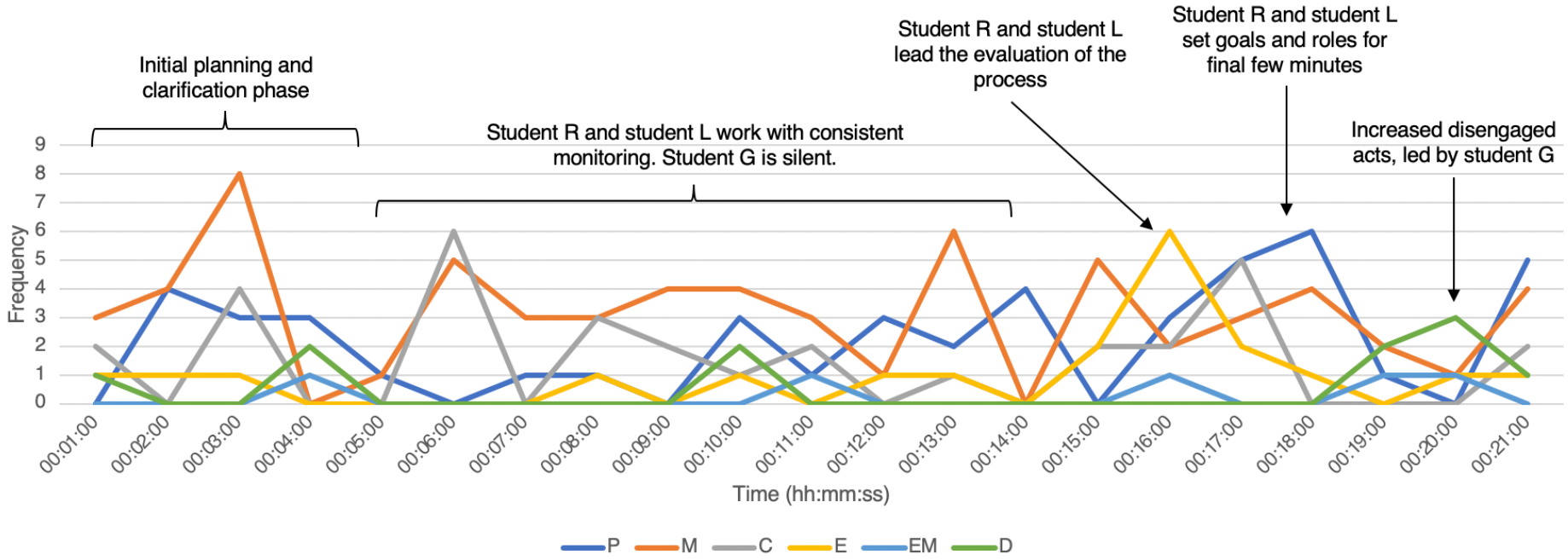
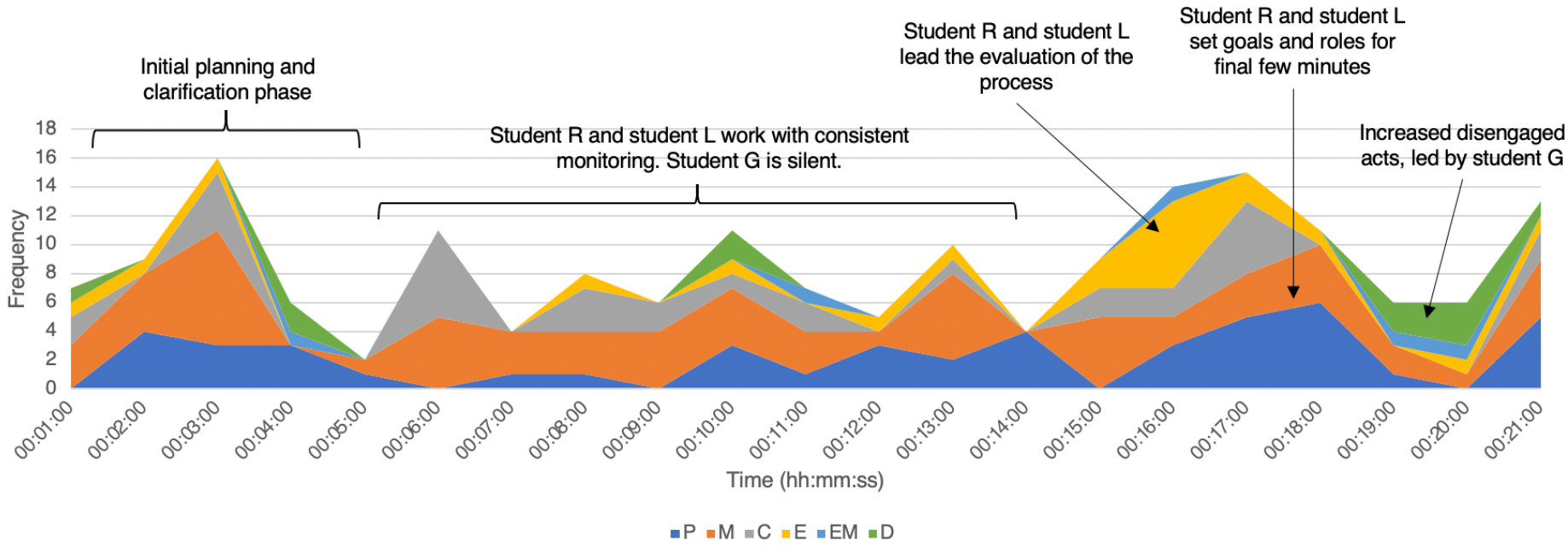


Figure 5.6: Noting frequency of different act types per minute forms a timeline of regulation of learning. Key observed moments are annotated.


Initial planning and clarification phase
Student R and student L work with consistent monitoring. Student G is silent.
Student R and student L lead the evaluation of the process
Student R and student L set goals and roles for final few minutes
Increased disengaged acts, led by student G
Frequency
18
16
14
12
10
8
6
4
2
0
00:01:00
00:02:00
00:03:00
00:04:00
00:05:00
00:06:00
00:07:00
00:08:00
00:09:00
00:10:00
00:11:00
00:12:00
00:13:00
00:14:00
00:15:00
00:16:00
00:17:00
00:18:00
00:19:00
00:20:00
00:21:00
Time (hh:mm:ss)
P M C E EM D

As can be seen in figure 5.6, several key phases and events can be identified from frequency data shown in this timeline format. Initially, there was a clear planning and goal setting phase, during which planning acts were more frequent, along with monitoring acts, which were primarily commentating. This phase is particularly clear during the first six minutes of coded episode.

"Which one is the weighing bottle, is it this one or this one?"

"Where are you looking?"

"This bit says weigh out... Oh OK, a solid glass container - I think it's this one…"

During the following eight minutes, between the fifth and fourteenth minutes, students R and L focus on the practical task at hand, whereas student G is silent. This is the data collection phase of the practical activity and many of the monitoring acts are commentating as described in the coding scheme in chapter four.

"OK, so we've got the initial temperature so then we do…"

"Are you making sure there's no parallax error?"

"Stirring the liquid continuously…"

"Oh, so you have to keep on stirring it."

In the final phase of the recording, from the fifteenth minute, the regulation of learning is less clear and focussed. There is an initial spate of evaluative acts from student R and student L.

"That didn't work – it's fine. It's fine, that's the point of an experiment."

This is followed by goal-setting and role-setting for the final few minutes of the lesson, but then all three students, led by student G, lose focus and display a number of disengaged acts.

"Do we have to?"

"This is the most boring thing!"

Sequencing

The timeline in figure 5.6 allows for temporal consideration of the frequencies of types of regulatory act. While the transcripts can be re-visited to identify key individuals involved, generally information about the actors and others involved as well as which acts followed which on a more granular level, are lost. In order to better consider this information, adjacency matrices and directed graphs were constructed from the data. Adjacencies, as discussed in section 4.4, represent which acts follow which, so can provide information succinctly about sequences of regulatory acts. Adjacencies were defined for this episode using the same procedure as in section 4.4. The adjacency matrix for this episode can be seen in figure 5.7.

		G	G	G	G	G	G	L	L	L	L	L	L	R	R	R	R	R	R
		P	M	C	E	EM	D	P	M	C	E	EM	D	P	M	C	E	EM	D
G	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
G	M	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00
G	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
G	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G	EM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G	D	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
L	P	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.04	0.01	0.00	0.00	0.00
L	M	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.03	0.02	0.01	0.00	0.00	0.03	0.05	0.01	0.00	0.01	0.00
L	C	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00
L	E	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.00	0.00
L	EM	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
L	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
R	P	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.03	0.02	0.01	0.01	0.00	0.04	0.01	0.00	0.01	0.00	0.00
R	M	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.05	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.00
R	C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
R	EM	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
R	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Figure 5.7: The adjacency matrix for episode three shows hotspots in both directions between student R and student L.

The adjacency matrix for episode three shows clear hotspots of interaction between student R and student L. This appears to be reciprocal, with hotspots appearing both from student R to student L, and from student L to student R. These hotspots are perhaps unsurprising considering the frequencies shown in table 5.8. More specifically, the most frequent adjacencies were from student R monitoring to student L monitoring and from student L monitoring to student R monitoring. This shows the centrality of the monitoring process to the regulation of learning in this group and appears to suggest that student L and student R are sharing responsibility for this process. It would appear that student G is not part of this sharing of responsibility, as her contributions to regulation of learning are less frequent. The next most common adjacencies were student L planning followed by student R monitoring, and student R planning followed by student R planning, a self-loop with regard to the directed graph.

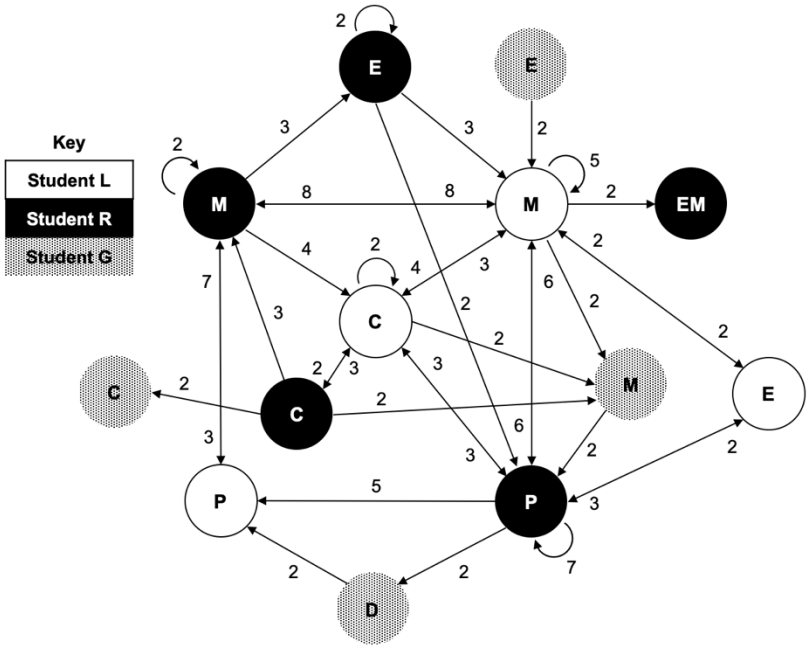


Figure 5.8: The directed graph for episode three.

The complex directed graph shown in figure 5.8 represents the adjacencies between regulatory acts displayed by student G, student R and student L during this collaborative episode. The complexity, or the number of nodes and connections, could indicate the range of approaches employed by the group to undertake the task at hand. Just from visual inspection of the graph, certain acts clearly play a key role in the regulation of learning within this episode, namely monitoring by student L, which is preceded by seven other acts, and leads to six. Planning by student R appears to also play a central role, whereas it is notable that while there are four types of act displayed by student G present in the graph, none of these have connection weights greater than two, meaning the adjacencies shown did not occur more than twice. This implies that the acts displayed by student G played a minor role in the process of regulation, along with the fact that two of the acts, evaluation and planning, by student G are leaves, which in graphical terms means there is only one connection to or from these nodes.

Considering graph theoretic statistics for the graph shown in figure 5.8, the values for density and cohesion are 0.27 and 0.20 respectively. As discussed in section 4.4, density values provide an indication of the repetitive nature of a process, a higher value suggesting a greater range of approaches, and a lower value suggesting a more refined process. Cohesion provides an indication of the reciprocity or directionality of a process, a higher value indicating less restriction on the direction of adjacencies and a lower value suggesting a more sequenced process. In this case, the low cohesion value suggests there is a reasonable amount of directionality in the process undertaken by students in this case. While direct comparisons are difficult, episode three and four consisted of two different groups completing the same task. Interestingly, both the graph in figure 5.8, and the graph shown in figure 5.17 visualising episode four have the same density value, but that representing episode four has a higher cohesion value at 0.35. This could be due to the group consisting of three individuals in episode three, compared

to two in episode four, meaning reciprocity is more likely. Alternatively it could suggest that the group in episode three were more certain of their tactics or approach to the task, in comparison to a more exploratory approach by the group in episode four.

In contrast to episode two, when very few planning acts were recorded for student R, the same student in this episode appears to take on a significant amount of responsibility for planning the activity of the group. The majority of planning acts in this case were of the goal- and role-setting types. This significant change in the nature of this student's contribution between episodes suggests that the nature of regulation by individuals within a group is fluid and relative. It is reasonable to suggest that this changes dependent on need. This study is not designed to investigate the key factors causing these kinds of differences in behaviour. However, it could be suggested that in episode two, student R was not required to employ planning acts as part of the group's regulation because this role was taken on by the teacher. In contrast, in episode three, planning is required since the authority of the teacher in this domain is absent. So, in this scenario, student R employs planning, and specifically goal- and role-setting, in order to regulate the learning of the group.

"[Student G] do you want to take one for the team and do a table of results?"

Why student R took on this planning role over the other students is unclear. It is clear that student G was unlikely to take on this responsibility in the context described, as the contributions from this individual were minimal across all types of regulatory act. Student R may take on more of a planning role than student L because this is an area of competence, or conversely an area of lack of competence for student L. What can be said for sure is that the behaviours of student R in these contrasting contexts differs significantly. It should also be noted that contributions by student L and student R complement each other. That is to say there is a significant degree of reciprocity to their interactions.

Collaboration between student L and student R seems to be strong as seen in the matrix displayed in figure 5.7, with a large number of connections between monitoring by both students in both directions, as well as between student L monitoring and student R planning. These central processes appear to underpin the rest of the graph. To explore this further, a simple assumption that the most frequent acts were the most important was made to create two further graphs. While this is arguably an over-simplification, it enables the reduction of some of the noise on a graph as complex as figure 5.8. The data used to produce figure 5.8 has already been reduced as the graph does not include adjacencies which occurred only once. Applying the same logic, the graphs in figure 5.9 display only the adjacencies that occurred on three or more occasions and four or more occasions respectively.

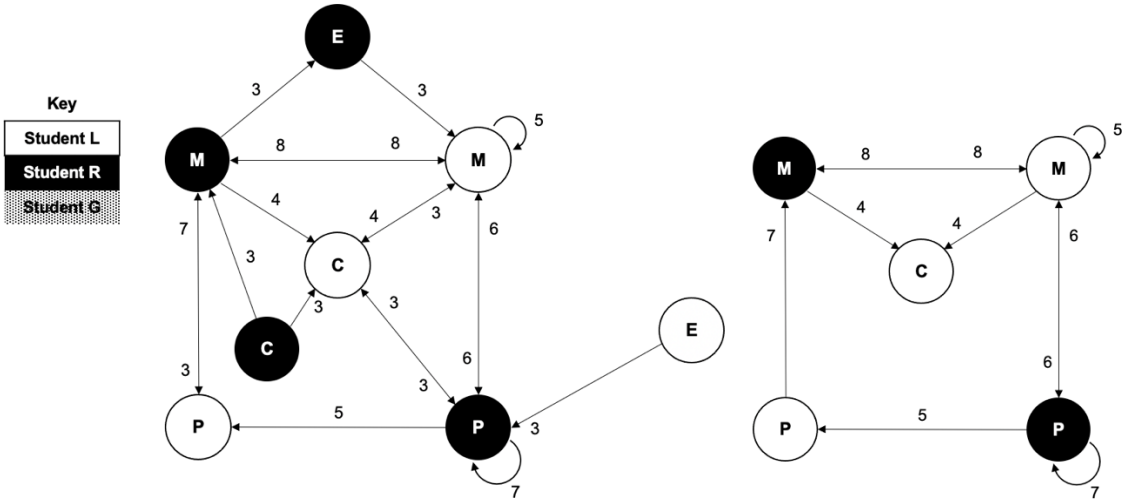


Figure 5.9: Further data reduction can reveal the dominant process within the directed graph.

This method of reduction does not take into account the impact of regulatory acts, which invariably will not be the same for every act and some will be more important than others in this respect. That being said, the frequency indicates importance on another level as these are the sequences of acts which individuals in this group are revisiting. When considering the research questions of the present study, this approach is appropriate to elicit patterns from this data.

Particularly when considering the graph of the most frequent sequences, a pattern emerges with some clarity. The five acts featured in this vastly reduced graph are monitoring by both student L and student R, planning by student L and student R, and controlling by student L. The controlling acts were most often preceded by monitoring acts, which is unsurprising considering the definition of these two types of act as changing approach or adapting behaviour and monitoring progress against goals respectively.

“So shall we do four?”

“That's like bang in between it's four.”

“Let's try to put four - shall I zero it?”

“Yeah might be better.”

In this example, the monitoring/controlling relationship is clear on an utterance by utterance scale. Students L and R are weighing out a solid in preparation for an experiment. Initially, student L clarifies direction, coded as monitoring, and student R compares the actual value achieved with the target mass, again coded as monitoring. At this point, student L suggests a clear change of tactic and the students reach a consensus about their new approach, controlling their activity in order to reach their goals. Although a very small-scale example, these monitoring/controlling processes are seen scattered

throughout the episode and appear to play an important role therefore in the overall regulation of learning in the group.

There is also another interesting one-way pattern emergent from the most reduced graph; planning by student R, followed by planning by student L followed by monitoring by student R. This path appears to be well-trodden. There is an alternative path to student R monitoring which is not one-way and therefore appears to be more adaptable via monitoring by student L. The reduced graph emphasises the shared nature of planning and monitoring processes in particular. It also highlights the symmetry in the responsibility taken on by student L and student R over the regulation of the learning of the group. It should again be noted the absence of student G and the asymmetry between the contributions of student G and the rest of the group.

The heavily reduced graphs in figure 5.9 are interesting as they provide further insight into the relationships between types of act, beyond the contributions shown in figure 5.5. Considering the clearly important function of monitoring acts, the reduced graphs provide an insight into the differences in functionality between monitoring by student R and monitoring by student L. Whereas the radar diagram in figure 5.5 simply suggests that both students contribute to this aspect of regulation approximately equally. In fact, there are far fewer limits to where monitoring by student L is inserted into the process, or in other words, student L employs monitoring acts more freely during the regulation of learning. On the other hand, student R employs monitoring in a much more predictable and restricted fashion, as suggested by the lower in degree, i.e. the fewer connections from other nodes to the node representing monitoring by student R.

The implications of the reduced graph are important. It may suggest that the displayed acts form the core process, and the other peripheral acts seen in figure 5.8 are employed when required. This core process includes three of the four core regulatory act types, namely planning, monitoring and controlling and appears to show clear pathways. In particular, the fact that controlling acts follow monitoring acts is striking, which fits with the cyclical model of regulation of learning outlined in section 2.2.

The functions, or importance of the types of act shown in figure 5.8 and figure 5.9 can be discussed when considering degree values as well as following visual inspection of the directed graphs. Table 5.9 contains degree values for all of the acts present in figure 5.8 alongside frequency values. Degree as a graph theoretic statistic is discussed in more detail in section 4.4, but by way of a reminder, in degree indicates the number of pathways to a given act type or node, out degree indicates the number of pathways from a given node, and the overall degree value is the sum of both in degree and out degree. It should be noted that degree values are not weighted, so if the same type of act follows planning by student R on eight occasions, because this refers to the same act, this is eight occurrences of the same transition, so forms a single pathway and would contribute to the out degree value of planning by student R by only one.

		G	L	R
P	Frequency		21	19
	Degree		6	11
	In, Out		4, 2	6, 5
M	Frequency	6	32	28
	Degree	4	13	12
	In, Out	3, 1	7, 6	5, 7
C	Frequency	3	20	9
	Degree	1	12	5
	In, Out	1, 0	5, 7	1, 4
E	Frequency	3	9	7
	Degree	1	5	4
	In, Out	0, 1	2, 3	2, 2
EM	Frequency			2
	Degree			1
	In, Out			1, 0
D	Frequency	3		
	Degree	2		
	In, Out	1, 1		

Table 5.9: A summary of graph theoretic statistics for the graph shown in figure 5.8.

The degree and frequency values in table 5.9 can be used to determine and discuss centrality of types of act for the graph representing regulation of learning for episode three. In terms of implication for regulation of learning, it allows identification of some of the most important types of act by considering how often other types of act lead to the act in question, and how often the act in question leads to other types of act. The more types of act a given act leads to, the higher the degree and potentially the more important it is for the process, as this high centrality indicates that it is regularly re-visited as part of the approach to the collaborative task. This also allows comparison with the graphs in figure 5.8 and figure 5.9, which visualise the same data, allowing triangulation with the interpretation of the directional graphs.

Unsurprisingly given the theme emerging from this data, the degree values for monitoring acts by both student L and student R are very high, alongside student L controlling. These types of regulatory act are clearly central to the regulation of learning in this episode. In contrast, the degree value for controlling acts by student R is much lower, despite some of these having a greater impact or being more directive compared to the help seeking often displayed by student L.

It may seem significant that the primary contributions to the group by student G are disengaged in nature. However, despite these acts forming a high proportion of the acts displayed by student G, the low degree suggests that they have little impact on the dynamic of the group. These acts are followed by planning by student L on two occasions, and preceded by planning by student R on two occasions. This low centrality, or the fact that these disengaged acts are connected to a limited number of other types of acts is indicative in this case of the limited impact on the progress or regulation of learning of the group. The significant proportion of the acts displayed by student G being disengaged instead is indicative of the nature of this individual, who appears to be relatively disengaged within this group. The reason for which may be the same social anxiety reported in the stimulated recall interview following episode 1.

> *"Even when you watch the time it goes slower I don't know why."*

The group recorded in episode three contained two focus students, student R and student G. This meant the potential for two stimulated-recall interviews following this recording which would shed light on the student perspective on the themes identified here. The following section discusses these interviews and highlights the themes that were revealed as a result.

Stimulated-Recall Interviews

Episode three involved two students seen in previous episodes, namely student G from episode one, and student R from episode two. These two students, as focus students according to the sampling process outlined in section 3.5, were subject to stimulated-recall interviews following the video recording. Unfortunately, student G was not available on the same day of the recording and the following day was the beginning of an extended period of absence, meaning that the stimulated-recall interview with student G could not be completed. The interview with student R was carried out on the same day as the lesson recording and observation, so again within the target of 24 hours.

As before, clips of the lesson were identified during the live observation to be put to student R for description and reflection. In this case, two clips were used, one of the group of three students working together at the beginning of the episode, and the next at a point in the episode when student R leaves the rest of the group to draw a graph of results. As student R had already completed a stimulated-recall interview following episode two, only a limited introduction to the format was required and answers seemed more forth-coming. It could be that the reflections of student R were affected by the fact this process had been carried out once before. On noticing that the lesson was being recorded, student R may have been conscious that a stimulated-recall interview would again follow the lesson. This may have caused reflection to be more active as the lesson went on, or perhaps decisions made were impacted as student R considered decisions with the observation and interview in mind. While this is a possible threat to the trustworthiness of this process, it should be noted that none of the students were

aware of what was being observed or looked for in the interviews. Student R also didn't display any unusual behaviours with respect to their conduct in the previous observed lesson, or the researcher's knowledge of the student as a teacher.

Perhaps inevitably, when shown the first clip, which simply displayed the three students, student R, student G and student L working together reading the method of the practical, student R began drawing comparisons with the previous context. While this was not the intention, the interviewer deemed at the time that it gave sufficient insight into the episode in hand, and even enhanced the contextual understanding of both episodes two and three.

> *"I'm a lot more confident with [student A] in the lessons. So, like, with [student A] we doubt ourselves a lot but with [student G] and [student L], if you ask me something they seem to be quite secure."*

This assertion seems to back up the data suggesting student R's contribution to the group's regulation of learning is greater during episode 2 compared to this episode. That said, it is particularly interesting that student R reports being more confident in a context in which both students are unsure of themselves. This could indicate that comparative confidence has more of an impact on these behaviours, in other words, the fact both students doubt themselves means that student R is more confident working with student A, whereas with other more confident and in this case higher achieving students, student R feels less confident. This is an interesting oxymoron, but perhaps is clarified when considering learning. While student R feels more confident with student A, they are unlikely to be challenged as much, hence comfort, reported as confidence. However, when working with student L and student G, student R feels less confidence. This is likely due to increased challenge which would likely indicate increased learning. As noted in section 2.6, self-confidence and self-efficacy are key reciprocal factors relating to regulation of learning. It is important to note that the behaviour of student R is not noticeably affected in any way which would indicate lack of self-confidence in episode three. However, this relative confidence in relation to other group members, and more broadly the comparison of oneself against other group members, seems to be important to student R here.

Alongside self-efficacy and confidence, the theme of help seeking surfaced again, with student R describing the difference in tactics depending on the makeup of the group they are in.

> *"With [student A], because we both doubt ourselves it means we turn to the teacher a lot to answer my questions, but when I am working with [student L] and [student G], it is very much I ask them and they have the answer. That's really the only difference."*

Once again, student R identifies the same process with regards to help-seeking, asking peers before the teacher. In particular, student A is identified as someone who is unsure and is therefore not a regular

target for help-seeking. This supports the idea that help-seeking acts, while indicators of the controlling regulatory process as defined in section 4.4, can be seen as a deferral of regulatory responsibility to stronger regulators in some cases. As seen in this instance, student R is likely to seek help from students that are perceived to be strong regulators. However, in the case of student A, who is not perceived as a strong regulator, student R instead defers to the teacher. The teacher, almost by default, being the regulatory authority in the room.

The second clip was identified for use in the stimulated-recall interview because it appeared to show student R exercising a significant amount of agency and regulating her own learning as well as that of the others in her group to a significant extent. When asked to describe the reason for this decision during the collaborative episode, student R clearly reports regulating her behaviours to a significant extent, monitoring not just herself but the whole group against their goals and making a decision to move away to complete an independent task as a result.

> *"Well [student L] and [student G] already were, they were carrying out the practical and the graph had to be drawn so I just took it upon myself. There was not space where we was working so I said I'm gonna move away to draw the graph because I was doing nothing. So, yeah."*

This behaviour by student R appears to show a sophisticated level of regulation of learning. This is despite displaying fewer regulatory acts than student L. This particular act is noticeably internalised, in other words it is not discussed or decided by the group. Instead it is effectively a self-regulating act by student R, but one whose intention is to contribute to the learning and progress of the entire group. This is evidence that the nature of the acts, rather than necessarily the number, is important to consider when making judgements around group dynamics. This can be difficult considering the data collected in the present study, but is the reason for the use of quotes and focus on intention rather than other characteristics of the acts discussed in this section.

Episode Summary

Episode three focussed on two students who have already been encountered in the data collection process; student G from episode one and student R from episode two. The three students worked on a practical experiment together. Student R and student L apparently shared a significant amount of responsibility for the regulation of the group's learning. Student G worked with the group but displayed a very limited number and range of regulatory acts in comparison to the other two students. Student R, while displaying monitoring and controlling acts less frequently than student L, particularly with respect to controlling acts, held a large stake in the authority over these processes. Student R showed highly developed regulatory processes when choosing to move away from the group to work on a task required

by all three individuals. Student L, while very frequently displaying planning, monitoring and controlling acts, often deferred to others and needed clarification over the direction of the task.

Major themes are evident in both the observational and interview data. One is help-seeking and the implications for authority and responsibility for regulation of learning that emerge from the apparent deferral as part of this kind of act, displayed very frequently by student L. Another, emerging from reflections during the video-stimulated interview of student R, is confidence and the interesting and complex relationship between this perception by students and the regulation of learning in groups. This latter theme ties strongly with the social constructs already encountered in other episodes. Finally, the reciprocity between student R and student L in this case, despite the disengagement of student G, is quite striking. In particular when considering the directed graphs, the contributions and process that is shown by these two students is highly symmetrical. Students appear to share the responsibility for the regulation of learning to a large extent, carrying student G with them.

5.6 Episode Four

Episode four focusses on a pairing between students A and M, and features the teacher and two other students, students N and Y, who frequently contributed despite not formally being part of this group. Student A was also recorded in episode two. The recording was of the full lesson, totalling 80 minutes, and the segment coded lasted just over 23 minutes during a collaborative practical chemistry experiment. 181 utterances were coded as regulatory in nature.

Frequencies

Firstly, considering simply the frequency of regulatory behaviours by both contributor and type can give a broad overview of the function of the group. It is clear when considering the number of each type of regulatory act that there is a significant number of each of the core behaviours, namely planning, monitoring, controlling and evaluating, with far fewer coded as emotional/motivational monitoring and disengaged. The most frequent type of regulatory behaviour is monitoring, which has more than double the frequency of the next most common act.

P	M	C	E	EM	D	Total
26	78	37	23	7	10	181

Table 5.10: Monitoring acts are the most frequent type of regulatory behaviour in episode four.

As shown in table 5.11, students A and M are the key contributors of regulatory acts. This is not a surprise as they are working with the same equipment as a pair to complete the collaborative experiment. Notably, the teacher also appears to contribute significantly to the regulation of learning in this group.

Student A	Student M	Student N	Student Y	Teacher
62	78	10	2	29

Table 5.11: Students A and M displayed the most regulatory behaviours with a significant contribution by the teacher.

As was the case in previous episodes, the core four types of regulatory act were the most frequently observed. Emotional/motivational regulation and disengaged acts were much less common. Table 5.12 combines two aspects of these frequencies and displays the frequency of types of act by each individual in order to better display the contributions made by each individual. It should be noted that student A and student M are the key members of the observed group. As can be seen in table 5.12, the teacher also contributes a number of acts but moved around the classroom helping other groups as this episode took place so was not always present as part of the group in question. Student N and student Y also feature in the recording and interacted with student A and student M so are included in table 5.12. They were both members of a neighbouring group completing an identical task during episode four.

	Student A	Student M	Student N	Student Y	Teacher
P	8	12	3	0	3
M	26	27	5	2	18
C	12	24	1	0	0
E	8	6	1	0	8
EM	3	4	0	0	0
D	5	5	0	0	0

Table 5.12: A summary of the types of act displayed by each contributor shows the significant input to monitoring and evaluating from the teacher.

Table 5.12 shows that again, monitoring is a key feature of this episode. Monitoring is the most common type of regulatory act observed and both student A and student M displayed it on a similar number of occasions. Of the other three of the four core act types, planning and evaluation frequencies seem parable between the students, whereas controlling acts are far more commonly displayed by student M. While further analysis is required, this might suggest that while both students are monitoring their progress, student M appears to be driving the direction taken, and acting where necessary to keep them on track to reach their goals. This role is not exclusively undertaken by student M, but twice as frequently as by student A.

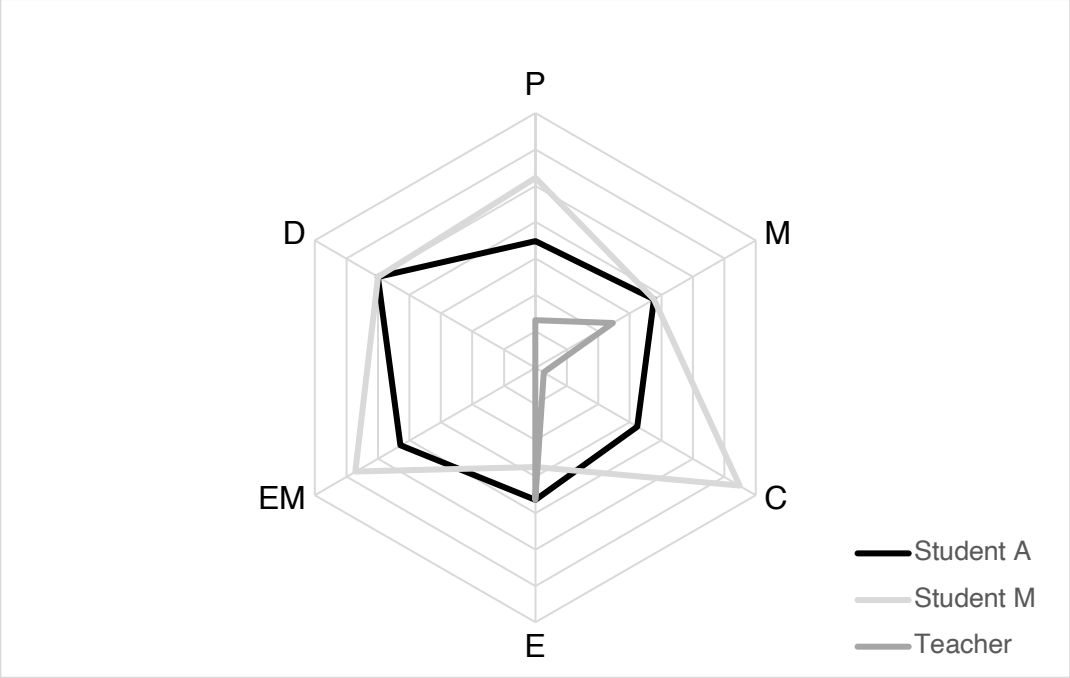


Figure 5.10: When frequencies of types of act are displayed in a radar diagram, it becomes in clear the magnitude of the contribution of student M compared to student A and the teacher.

In figure 5.10, a radar diagram visualising the frequency data of different individuals in episode four is shown. Despite appearing in the transcript and table 5.12, students N and Y are not included in the diagram for clarity. Each axis represents a type of regulatory act, and polygons are plotted on these axis representing the proportion of each type of act by the individual in question. Polygons for student Y and student N would therefore be so small as to serve no purpose, so for clarity have been omitted.

As can be seen in figure 5.10, the teacher plays a distinctive role in the episode, with a significant contribution to evaluating acts and some contribution to both planning and monitoring, although notably less than the two students present. This is not a surprise as the teacher is present only for a limited amount of time during the recorded episode, approximately six minutes in total..

When considering student M and student A, it appears that there is a relatively symmetrical shared dynamic when it comes to regulation of learning. Both students displayed a reasonable and comparable amount of each type of regulatory act. Notably, the proportion of evaluating acts is the only type for which student A displays much more than student M. The proportion of controlling acts by student M is much higher than those displayed by student A, despite monitoring acts being comparable. This might suggest that while both students were monitoring their progress, many of these coded acts were narration, and student M took control of the controlling acts following monitoring. In other words while both students were narrating their progress, student M took on authority of suggesting new directions and next steps. Most controlling acts were suggesting a change in strategy.

“OK, let's work out this bit.”

“Let's do anhydrous first.”

“Let's put a bit more in.”

In these particular examples, it is worth noting the use of ‘let’s’. In contrast to perhaps more directive alternatives such as ‘we need to’, this appears to be a suggestion rather than a direction. The use of ‘us’ as opposed to ‘I’ or ‘you’ also provides an insight into the consideration of the group and the symmetry of the regulation taking place. This aspect of the language at least suggests a sharing of regulation as opposed to asymmetrical regulation of others, which might be more likely to be directive and individualistic.

While the polygons for each student are similar in size, and therefore simplistically might suggest that both students took on similar responsibility for regulation, the difference in the controlling acts might actually bely a significant imbalance in authority over the regulation of learning in this context. It could be argued that student M was forward looking, with more planning and controlling acts looking at next steps, whereas student A took on the role of evaluation.

The next section begins to look at the temporal development of the types of act in this episode to further describe the dynamic between student A and student M. This analysis helps clarify the progress of the group and provide further insights into the roles played by the two students and perhaps even into the balance of responsibility in terms of regulation of learning too.

The broad picture of the dynamics of this group appears to be that students A and M shared responsibility for regulating learning between themselves with minor contributions from students Y and N and major contribution from the teacher. This is still not a detailed picture, however, and isolated consideration of frequencies of types of act gives limited information on the dynamics of a group. It is crucial that group behaviours are seen as dynamic and as such, temporal changes in behaviour are considered in analysis. Frequencies do not consider temporal changes. Considering frequencies at intervals retains some temporal information, but granularity must be discussed. Figure 5.11 shows a graphical representation of the changes in act type over time. Frequencies have been totalled at four-minute intervals, creating six equal-length segments. These totals of each type od act were then plotted against time.

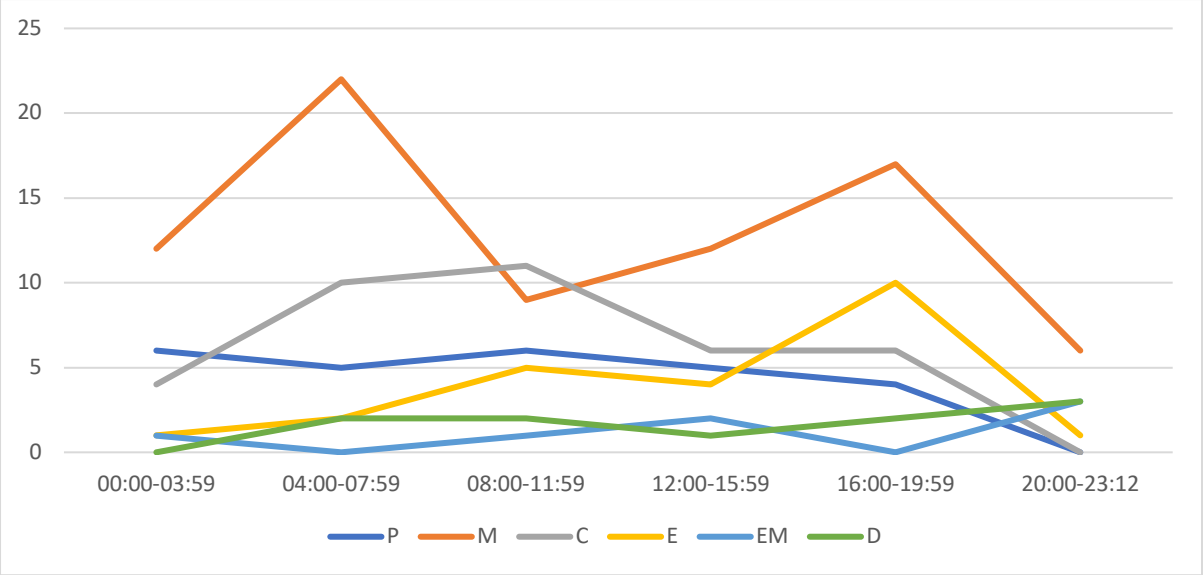


Figure 5.11: Monitoring is consistently the most frequent type of regulatory behaviour, whereas evaluation increases in frequency in the final eight minutes.

To explore the effect of granularity, the same graph can be plotted but with frequencies in two-minute segments of the learning episode. In this instance, the overall pattern changes very little, in fact the expression of evaluating and planning acts becomes more erratic. The increased resolution does appear to reveal the increase of controlling behaviours following the first monitoring peak at around eight minutes in. This is not an unexpected pattern considering the function of these two types of act. Firstly, monitoring acts will compare progress with goals and ensure learning is on track. Controlling acts tend to manifest as changing tack, suggesting approaches or adapting behaviour, which unsurprisingly is often in response to monitoring. It is also not a surprise that monitoring is the most frequently coded type of regulatory behaviour, as it is known to underpin the overall process of regulation and its consistent presence in the behaviours of this group reflects positively on the quality of the regulation of learning taking place.

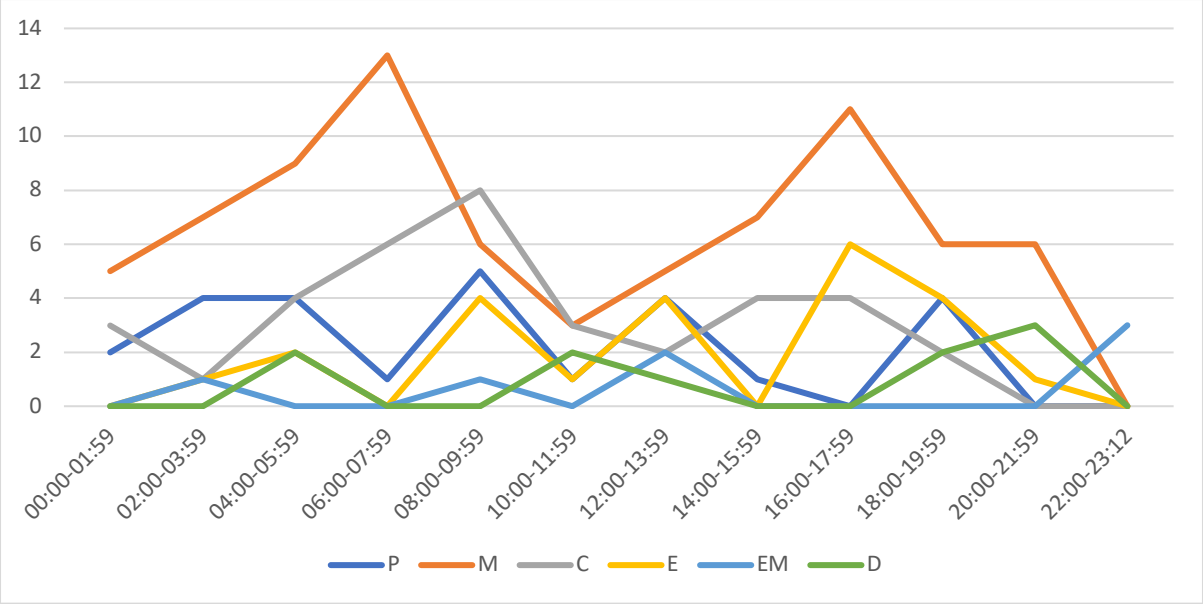


Figure 5.12: The increase in controlling acts following the first peak in monitoring becomes clear with finer granularity.

The graphs shown in figures 5.11 and 5.12 support the argument that it is unhelpful to necessarily consider regulation of learning in the traditional cyclical form. Instead, the process represented here appears fluid and iterative in nature. It is entirely possible that complete regulation cycles from planning to evaluation exist within this learning episode, but they overlap, form part of larger cycles and are formed by smaller cycles. This is so much the case that the cycles and small-scale processes are difficult to distinguish in the overall function of the group. This ostensibly chaotic, fractal context is what teachers and educators must understand on a deeper level to effectively influence it positively.

In this case, the finer granularity in figure 5.12 does little to clarify the process undergone in this learning episode. If resolution is increased further and frequencies are graphed minute-by-minute, the graph begins to form a timeline. Figure 5.13 shows such a timeline for this episode, including annotations of key regulatory events.

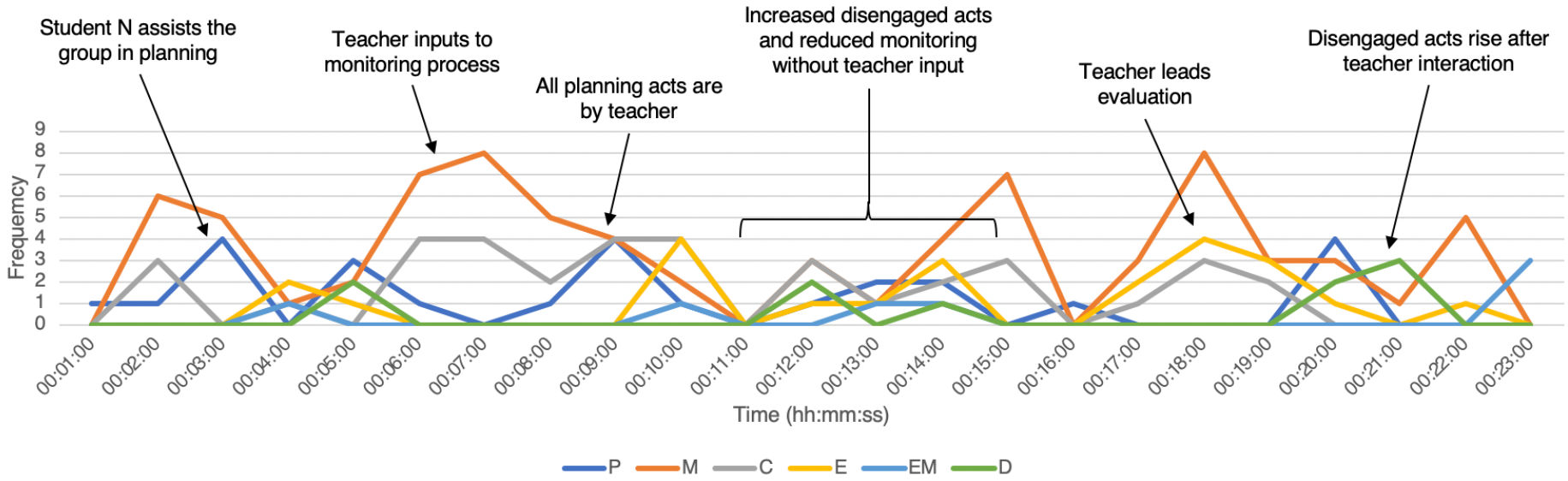


Figure 5.13: A graph of frequencies of act builds a timeline of group behaviour.

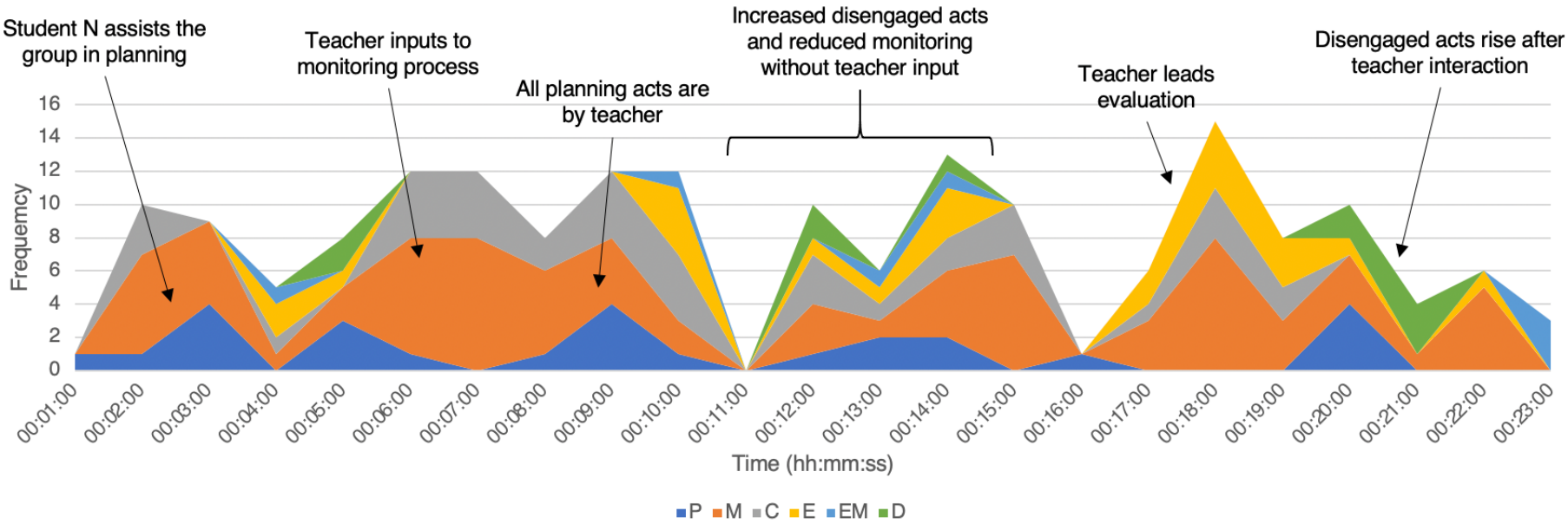


Figure 5.14: A stacked line graph emphasises the cumulative frequency of regulatory acts.

From the timeline in figure 5.13, an initial planning phase is clear.

> *"Using enthalpy change, we are going to work out the enthalpy of dissolving one, then the other and we can work out the enthalpy of thingy, because it will be anhydrous, hydrous, then the enthalpy for both to become aqueous..."*
>
> *"And then we have to subtract them?"*
>
> *"And then we use that to work out the enthalpy change."*

At around nine minutes, the majority of planning acts were by the teacher, who seemed to take responsibility for this aspect of regulation.

> *"It's kind of hard to do both. I would recommend putting the temperature probe all the way through so it's submerged."*
>
> *"Yeah."*
>
> *"And just have the stirrer to the side"*
>
> *"Can we just stir it like this?"*
>
> *"I wouldn't."*
>
> *"Why not?"*
>
> *"It could potentially affect the temperature reading, and you avoid going through the cup."*

In this vignette, the teacher gave the group instruction with regard to the practical activity. Coded as planning, there are some interesting themes that emerge from this extract. Firstly, the teacher's use of the singular first person makes it clear that they are not part of the group. This distance accentuates the authority held over regulatory processes. That said, student G did question the recommendation, but the response of the teacher remained directive and closed. The role of the teacher being external to the group is also indicated by the use of 'we' when discussing stirring the solution in the experiment. It goes without saying that there will only be one person stirring at a time, but the use of the plural here further suggests the perception of the teacher as an external influence on the group. If this social structure is consistent with the perception of those involved, this causes barriers to symmetry of regulation between teacher and student. While these two parties don't share goals necessarily, so true shared regulation is unlikely, symmetry in terms of responsibility for regulation of learning would allow

students to develop these processes with the guidance of the teacher. In this case, the interaction is particularly asymmetrical, and the external, authoritative teacher took responsibility.

When the teacher left the group between the 11th and 15th minutes, the number of disengaged acts, specifically giving up, increased and the number of monitoring acts decreased. This perhaps is not a surprise as effective monitoring might suggest a lower probability of disengagement. The teacher returned in the 17th minute and led a phase of evaluation.

> *"What would happen if you touch the cup?"*
>
> *"It's hot."*
>
> *"Your body, your fingers are hotter than that right so it could increase the temperature and create an error."*

After the teacher-led evaluation, further planning took place in minute 20, followed by a significant increase in disengaged acts when the teacher moved on once more.

> *"I don't want to do it!"*

Whilst temporal data is conserved when considering frequencies in this way, regulation of learning is not properly considered as a process and the different types of act are still considered in isolation. The frequencies of a given type of act are more valuable if information about what type of act they precede or succeed is retained.

Sequencing

Whilst frequencies of types of act provide an overview of the contributions of a group, the nature of this type of surface-level analysis means information about a number of important aspects of collaboration is lost. Firstly, by definition, interactions are directional in nature, in other words they are vectors and exist with a from and to value. Specifically, in this case, a regulatory behaviour displayed by student A would rarely exist in isolation but will usually be directed towards another member of the group. Secondly, temporal information is lost in consideration of frequencies alone, so information on which behaviours follow which and when they occur is not retained.

The directional nature of interactions observed in this episode can be represented in matrix form. The x-axis of the matrix displays the contributor, the y-axis displays the individual the act was directed towards.

	Student A	Student M	Student N	Student Y	Teacher
Student A		56	0	0	6
Student M	59		4	0	15
Student N	0	6		4	0
Student Y	1	1	0		0
Teacher	5	24	0	0	

Table 5.13: The direction of regulatory interactions between students A and M are well balanced, but interactions with the teacher more often involved student M.

The regulatory acts coded from student M directed at student A are approximately equal to those in the other direction, as can be seen in table 5.13. This symmetry may suggest a good degree of sharing of regulation. As the two individuals with the highest number of regulatory acts this is not necessarily unexpected and does reflect the fact that these two students were completing the set task as a pair. At this point, the nature of the acts here is not considered, however, it is also clear that student M appears to have a significant number of interactions of a regulatory nature with individuals other than student A. In contrast, student A has few interactions with individuals other than student M. The reason for this is unclear without looking further at the nature of the interactions and regulatory acts in question in more detail.

Further clarity on the types of act which tend to sequence together or are often otherwise related will provide greater insight into the patterns and preferred behaviours within a group. For example, a group may have a repeated pattern of acts that is exhibited throughout the learning episode, but simple consideration of frequencies or even frequencies within segments will not elucidate this information. Adjacency information can be represented in a matrix, with one axis for the first act and another axis for the following act. While this does not present information on long sequences of acts, it provides information on repeated adjacencies which can then be further investigated for patterns and anomalies.

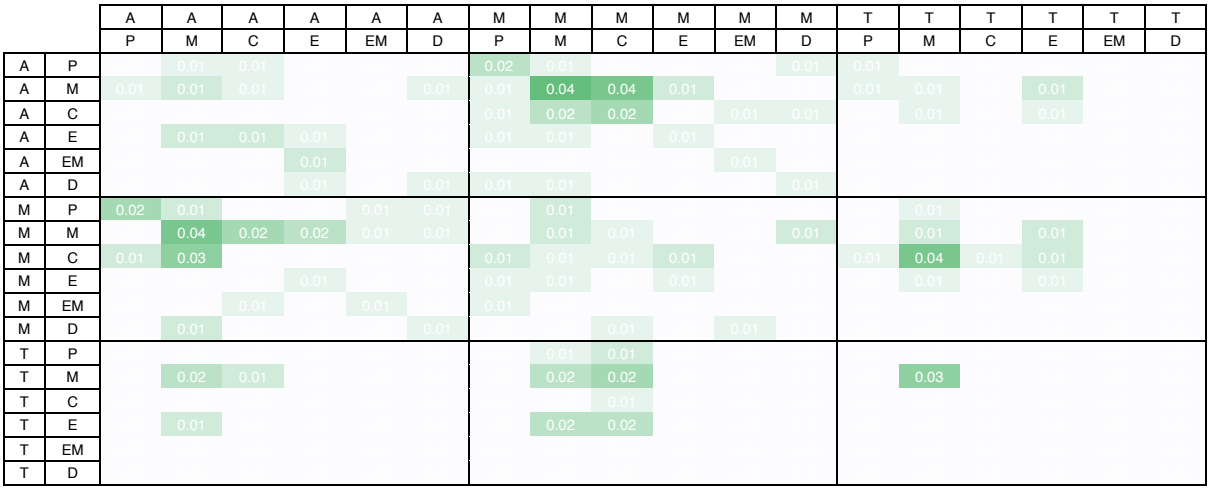


Figure 5.15: A matrix of the proportion of each adjacency shows clusters between student M and student A monitoring and controlling in both directions.

Figure 5.15 shows a matrix of adjacencies. A colour gradient has been used to emphasise common interactions and create a heatmap. This heatmap suggests an even distribution of a significant number of different types of act from a number of individuals. The implications of this are discussed further alongside the directed graph in figure 5.17. In figure 5.16, the same heat map is rearranged by cluster rather than individual.

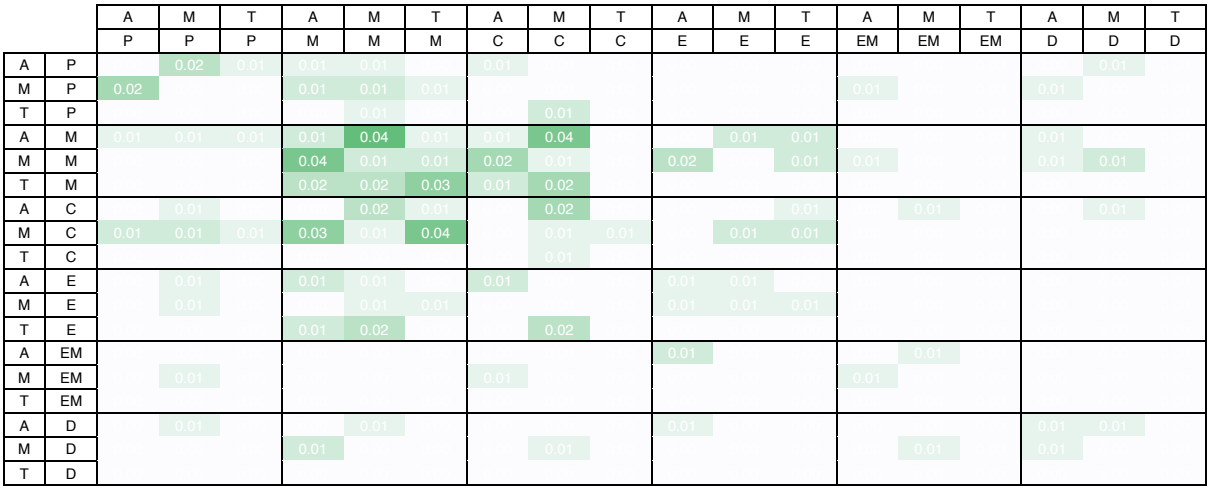


Figure 5.16: When the matrix is organised by cluster rather than individual, the importance of the monitoring and controlling acts in this episode is emphasised.

The two matrices in figures 5.15 and 5.16 begin to provide further insight into the regulatory process that occurred in this learning episode. Monitoring was clearly a central aspect of the process, which may suggest that the individuals involved were proficient regulators of learning. It is no surprise that these are the most common types of act from all three individuals as monitoring and, to a lesser degree, controlling should occur throughout the learning episode regardless of progress, whereas it may be more likely to observe planning acts towards the beginning of the episode and evaluation as the group

approached their goals. To an extent this is true in episode four, as can be seen in figure 5.13, although all of these regulatory acts were observed throughout the episode. There are few disengaged acts, suggesting a relatively focussed group. There were also few acts coded as emotional/motivational monitoring, though it could be postulated that these are more likely not to be observable, and the frequency and nature of these will depend heavily on the nature of the existing social relationships in a group.

In order to better visualise these repeated adjacencies, a directed graph can be produced. The directed graph for this episode can be seen in figure 5.17.

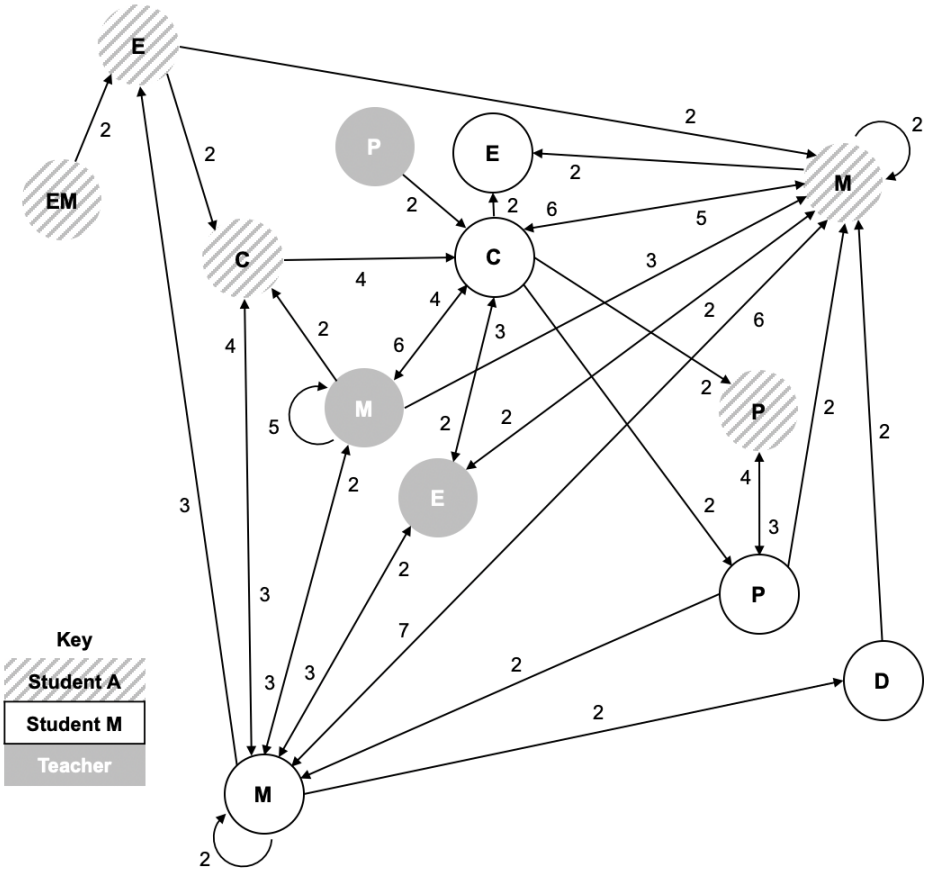


Figure 5.17: The acts coded in episode four produce a complex directed graph with 13 nodes in total.

As with other directed graphs in episodes two and three, each node represents a type of act, denoted by the letter, by a specific individual, denoted by the colouration. A key is included for the latter. All six types of act are featured; planning (P), monitoring (M), controlling (C), evaluating (E), emotional/motivational (EM), and disengaged (D). Adjacencies are represented by the arrows in the graph, which indicate the direction of transition from regulatory act to next regulatory act. The number of adjacencies of each kind is shown beside each arrow, with numbers on bidirectional arrows pertaining

to the direction of the arrowhead they are closest to on the length of the arrow. Any adjacencies which occurred only once have been excluded to improve clarity.

Firstly, it is worth noting the complexity of this graph compared to those in figures 5.4 and 5.8. There are significantly more nodes than in figure 5.4 at a total of thirteen, the same number as in figure 5.8. Cohesion is a value which measures the proportion of links, excluding self-loops, which are two-way. The cohesion value for the graph shown in figure 5.17 is 0.35. Higher cohesion values suggest less restriction on which acts follow which. Density, another graph statistic is an indication of the proportion of all of the possible transitions which take place. The density value, which is any value between one and zero, is 0.27. A higher density value could indicate the employment of an increased number of strategies while learning, and perhaps therefore more proficient deployment of monitoring behaviours.

To emphasise the most important adjacencies, using frequency as an indicator of importance, the same process can be followed as seen in episode three to further reduce the graph to show only the most frequent transitions between regulatory acts. While the most frequent acts are not necessarily the most important to the regulatory process, note student R moving from the group to complete a solo activity in episode three, but this perspective does provide a clearer indication of process undertaken, in which more or less important acts can be identified. It is pertinent to remind the reader that the graph in figure 5.17 already excludes adjacencies which occurred only once in order to reduce data to a manageable amount to construct the graph. If this reduction is continued further, the most frequent elements of the process of regulation of learning can be drawn out more clearly. Figure 5.18 shows two further graphs, the first displaying transitions which occurred more than twice, and the second, on the right, displaying those which occurred on more than three occasions.

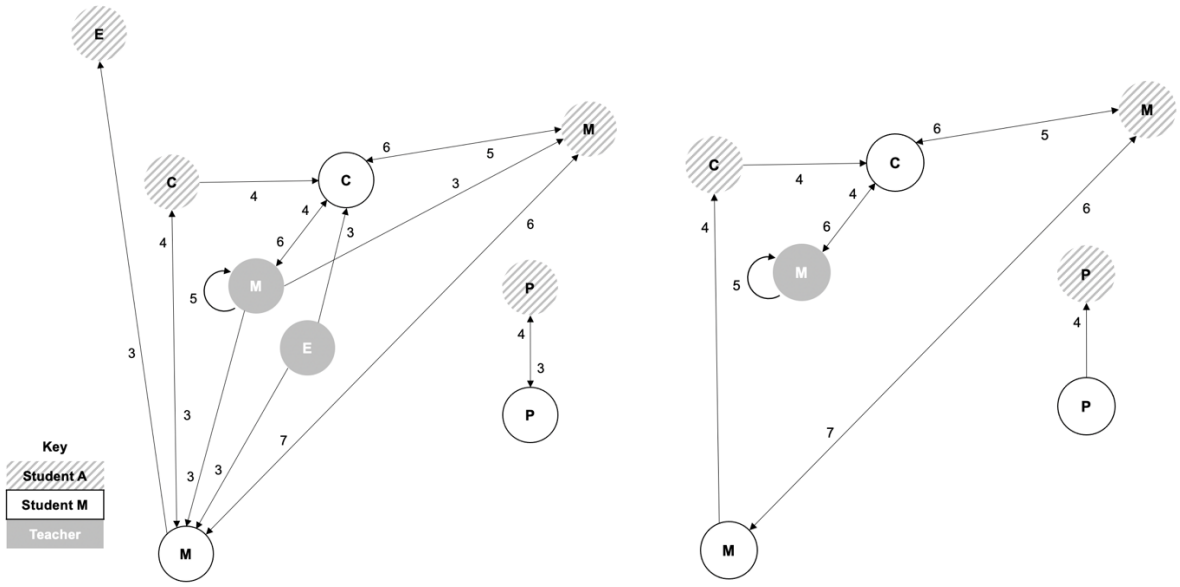


Figure 5.18: Further reduced graphs emphasise the most frequent aspects of the regulation of learning displayed in episode four.

The further reduced graphs in figure 5.18 emphasise the importance of monitoring and controlling acts in this episode. While evaluation appears in the first graph, it was not displayed frequently enough by either the teacher or student A to appear in the second, most reduced graph. Monitoring by the teacher appears in the most reduced graph, however, indicating it's centrality to the process appearing here. Controlling acts are seen to have followed monitoring acts frequently, which is not a surprise considering the nature of the function of these acts within the overall process of regulation of learning. There is clear sharing of the monitoring process between student A and student M, with a significant number of instances where monitoring acts from both students follow each other. Interestingly this same reciprocity is not seen to the same extent with the monitoring acts by the teacher, which are most frequently followed by other monitoring acts by the teacher indicated by the self-loop, and controlling acts by student M, who appears to be the primary link between the students and the teacher in this sense. One particularly striking aspect of this graph is that when further reduced, and links that occurred only twice are removed, the graph splits into two; one graph contains monitoring, controlling and evaluating acts, the other contains only planning acts. This is surprising and perhaps suggests a lack of clear direction after planning acts. While both students clearly co-operated regarding planning, as there was a frequent, reciprocal link between planning acts by both students, there is no recurrent adjacency with other types of regulatory act, which suggests that the acts that followed planning acts varied in type and varied by the individual who carries them out. While this could suggest a dynamic, responsive approach to regulation of learning, on the other hand it could also suggest an underdeveloped process for following planning acts. This may have led to a range of other acts then taking place and no clear pathway occurring in a reliable and repetitive manner.

The centrality of the monitoring functions is very clear in all of the graphs presented here. The term degree in graph theoretic statistics can be used to refer to the number of transitions to and from a node in a graph. In the graph shown in figure 5.17 this can be deduced in a number of ways. Firstly, in-degree denotes the number of unique transitions to a node, and out degree is the number of unique transitions from a node. The total degree is the sum of the in-degree and out-degree of a node. Initial consideration of non-weighted degree values provides information on the importance of different acts and the number of unique routes taken to them. Central acts, or those with the highest degree values, are suggestive of types of act which are inserted into the learning process regardless of the type of act preceding or succeeding. A summary of degree values for the graph shown in figure 5.17 is shown in table 5.14.

		Student A	Student M	Teacher
P	Frequency	8	12	3
	Degree	3	5	1
	In, Out	2, 1	2, 3	0, 1
M	Frequency	26	26	17
	Degree	13	13	8
	In, Out	8, 5	6, 7	3, 5
C	Frequency	12	24	
	Degree	5	11	
	In, Out	3, 2	5, 6	
E	Frequency	8	6	8
	Degree	4	2	6
	In, Out	2, 2	2, 0	3, 3
EM	Frequency	3		
	Degree	1		
	In, Out	0, 1		
D	Frequency		5	
	Degree		2	
	In, Out		1, 1	

Table 5.14: Degree values can give an indication of the centrality of types of act.

As can be seen in table 5.14, monitoring acts by both student A and student M have both the highest frequency and the highest degree. This relationship between frequency and degree is often, but not always observed. This reflects the visualisation in the directed graphs in figures 5.17, and particularly the prevalence of monitoring acts in the reduced graph in figure 5.18.

The comparatively low degree values for the monitoring acts by the teacher are reflective of the small number of types of act which follow these acts, as seen in the directed graphs in figures 5.17 and 5.18. This could suggest that the group has a far more rigid response to teacher monitoring than it does for monitoring by students, in other words there is a more established process for the group's response to monitoring by the teacher than by other individuals. The importance placed on the monitoring by the teacher, despite it being less frequent than monitoring by either student A and student M, and despite the teacher being a transient member of the collaborative group, is perhaps an indication of the authority over this process held by the teacher.

The types of act on the periphery of the process, namely emotional and motivational regulation and disengaged acts are unsurprisingly the least central to the process according to degree values. It can be postulated that while emotional and motivational regulation is undoubtedly important to the success of the core regulatory acts of planning, monitoring, controlling and evaluating, this is likely to be an

internalised process for the most part. The externalisations observed in the present episode and more broadly in the present study are less common. This aspect of regulation is far more individualised than planning for a task, for example so is perhaps accordingly less likely to be shared. It might be expected that disengaged acts and emotional and motivational regulation display a relationship. For example a motivational statement might follow a disengaged act, but this does not appear to have occurred in this group under these circumstances. Having said this, these relationships, such as the one seen between controlling and monitoring acts in figure 5.17, are difficult to distinguish when disengaged and emotional and motivational regulation are so uncommon. Relationships between these acts, or lack thereof, might be more likely to be unearthed when observing younger students, who perhaps therefore would be less motivated and less adept at emotional regulation than 17-18 year olds.

Stimulated-Recall Interview

Student A was the focus student as described in section 3.6 that was present in this episode. This stimulated-recall interview was conducted on the same day as the recorded episode. As with student R, because student A had completed a stimulated-recall interview already following episode two, little introduction was required. The same threat to trustworthiness exists here regarding the potential impact of recording and interviewing on behaviour. Once again, no unusual behaviours were noted based on knowledge of student A from prior recordings and the researcher's knowledge of student A as their teacher.

Student A was shown a clip of episode four in which student A and student M are working together without the teacher. Almost immediately, as seen in episode two, student A began comparing episode four with episode two, in which student A featured with student R. While not the intended focus of the interview, this was seen as inevitable and not unhelpful for the purposes of the research, so the interviewer allowed this to continue, particularly as there were no events of note where behaviour was different or exemplified a regulatory process in the episode involving student A and student M. As such, only two clips were shown to student A, one containing just student A and student M working together, the other with the addition of the teacher supporting the pair of students.

On viewing the initial clip, student A reflected that it was rare to be working with student R. This appeared important to student A and the comparison between the experience of working with student A and student R was unequivocal.

> *"With [student R] I would talk a lot. Like, I talk a lot and I've got more confidence with [student R]."*

This theme of confidence surfaces again, and student A reflected on the impact of this experience on help-seeking behaviours, which was not prompted by the interviewer, so reinforces the theme of help-seeking emerging from the data.

> *"I don't feel confident with someone to ask them to help me. I need to feel confident with someone to ask for help."*

As the interviewer asked why student A felt less confident with student M, student A did not make reference to any themes related to learning directly. Once again, the reasoning identified by student A was purely social in nature, and identified the pre-existing social relationships as the reason for the lack of confidence, which in turn has a direct impact on learning in collaboration.

> *"It's because we are not friends."*

The interviewer asked what student A did if she was stuck, since a lack of confidence ruled out asking student M for help according to student A.

> *"Well I try to figure it out myself."*

When asked again to describe the first clip, student A reported that student M was leading the group.

> *"So [student M] was doing all this stuff. So I basically just took notes about things that we were doing and [student M] was doing everything else. I don't know. [Student M] just was like that."*

This is interesting as it questions the data collected from the coded video. While student A seems to see taking notes as not contributing and reflects that student M is doing 'everything else', it appears that student A's note-taking and verbal contributions have a significant regulatory role to play within the dynamics of the group. It is clear from this that student A does not recognise this contribution. In fact, student A actually asserts that she 'learns better' with student R.

> *"Yeah, because, obviously I ask questions so even if they are like really stupid or really simple to answer I asked them, and I feel like I know now the stuff. But with [student M] obviously I don't ask. I try to keep it to myself because I think that maybe [student M] thinks like 'oh god is she stupid' or 'she doesn't know the stuff'. So I just keep it quiet and don't ask. So I guess like with [student R] it's easy to ask her because we have more confidence with her so yeah."*

The second clip included the teacher alongside student A and student M. Student A responded to the second clip by comparing the teachers from episode two and four, again with a help-seeking lens.

> *"I feel like they are teachers so obviously they are not going to think that I am dumb or something like they're just going to explain with patience like the things I need to do or the things I don't know. So obviously with teachers usually I don't have a problem, well at the beginning maybe but there's not a problem now."*

In this example, the reference to a problem appears to refer to difficulty in asking for help. Particularly interesting was the fact that when discussing disengaged behaviours, student A noted that these were more likely while learning topics seen previously, or subject matter student A was more confident with. This perhaps echoes the idea that students disengage when learning is either too challenging, or perhaps more frequently in the case of student A, not challenging enough.

Episode Summary

In this episode, monitoring acts are clearly central once again. Students A and M appear to share responsibility for these and there is a reasonable amount of reciprocity displayed between these two. In this group, unlike other episodes, the collaborative work appears to follow a fairly linear format, and planning, monitoring/controlling and finally evaluating phases can be seen in the timeline presented in figure 5.13. The teacher, despite not being present for the majority of the episode, has a significant impact on the dynamics of the group and monitoring by the teacher is an important component of the directed graph in figure 5.17. Student M is the clear conduit with the teacher, which does suggest student M held some authority over the regulation of learning of both student M and student A.

It is interesting to note the themes of the stimulated-recall interview with student A, in which student A notes key differences in her confidence compared to working with student R in episode two. Student A's perspective is that student M was in charge of the collaborative work. This is at odds with the acts recorded and coded by student A, who contributes a significant amount to the group, although the centrality of acts by student M does tend to be higher overall. The notes and narration by student A seem to still play an important role in the regulation of learning of the group.

The theme of help-seeking arose once again in the stimulated recall interview, and student A asserted that it was important to be comfortable and confident with others before asking for help, although interestingly this explicitly did not apply to teachers. This implicit authority of teachers also appears to come with implicit trust in this case. The outcome of this is that student A, despite contributing far less to the regulation of learning in episode two, felt that more learning took place. This of course raises issues with the student's understanding and recognition of learning itself, but is an interesting observation nonetheless.

5.7 After Episode Four

Perhaps at the start of my doctoral journey I was guilty of not fully realising the extent to which the work produced is context specific. That is obvious in the direct context of the research undertaken; comprehensive secondary school, university, hospital, but I would never have suspected that a global event would have such a drastic impact on not just my research but that of all researcher practitioners. COVID-19 has changed the face of education almost beyond recognition in a very short space of time. Schools closed in the UK on the 23rd March 2020 and most students did not walk through the gates again until September 2020. Following another surge in cases and deaths in the UK, schools were once again closed to all but the most vulnerable of students and children of critical workers on the 5th January 2021 and remained closed until the 18th March 2021. This absence from school and the learning, support, routine and refuge that it provides will have an astronomical impact on students across the world, the true nature of which we may well not know for many years. In terms of direct impact on this project, school closure has changed the nature of social learning, collaboration and socially shared regulation significantly. The focus of this project, namely late secondary age students, have moved from the inherently social environment of the classroom to sitting behind a computer screen or working from textbooks. Further than this, for a significant portion of time they have not collaborated face-to-face with anyone outside their own household. Many of the processes observed in lessons and discussed in stimulated-recall interviews physically cannot have taken place over the last few months. The effect of this on learning is difficult to quantify. Much of the literature makes it exceptionally clear that promoting students' regulation of learning is not the same as setting them off on their own, but the latter is precisely what has happened in response to a global pandemic in many cases.

A survey was produced in April 2021 to gather more information on how students have been learning at home from the perspective of the present study and to gather information on their experiences, if any, of collaboration in this time. The survey was put together quickly in order to gather experiences in a timely manner and asked for perspectives on the key differences in how students are learning. The survey was constructed online using the Qualtrics platform and opened to 86 curriculum year 12 students (16 to 17 years old, the penultimate year of schooling in England and Wales). Just over half responded, with 45 responses, giving a response rate of 52%. Due to a relatively small sample size and consideration of time constraints, the survey was not piloted. While the survey does not directly address the research questions outlined in section 3.4, the questions targeting the theme of the nature of collaboration were particularly striking. Students were asked the question 'How frequently do you discuss your work with one or more other person since school closed?' and given five options. A frequency diagram of responses can be seen in figure 5.19.

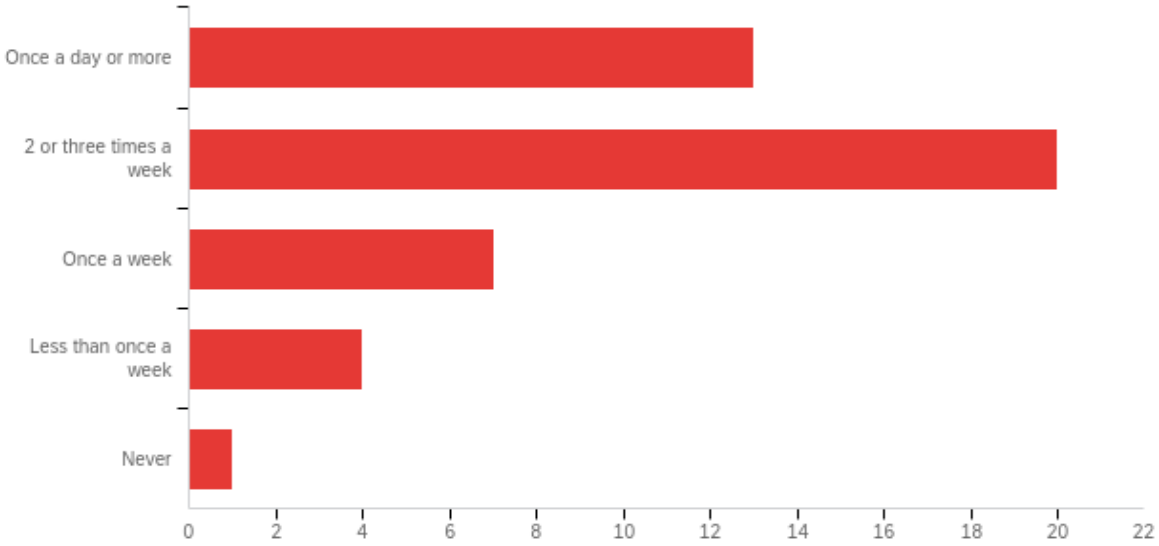


Figure 5.19: The question 'How frequently do you discuss your work with one or more other person since school closed?' yielded a range of responses.

Somewhat reassuringly, thirteen respondents (29%) reported discussing work with one or more other person at least once a day. Almost three quarters of respondents (n=33, 73%) reported speaking to others about work at least two or three times a week. A question following that reported in figure 5.20 sought to find out some more about the nature of the discussions, so students were asked first 'Have you done any group work (i.e. discussed work with more than one other person at the same time, in person or remotely) since school closed?', to which 29 out of 45 respondents (64%) answered 'yes'. However, the following question; What form did your group work take? Tick all that apply.' gave a potentially worrying indication of the collaboration taking place while students were not in their classrooms as normal. This question provided several options, and the responses are shown as a frequency diagram in figure 5.20.

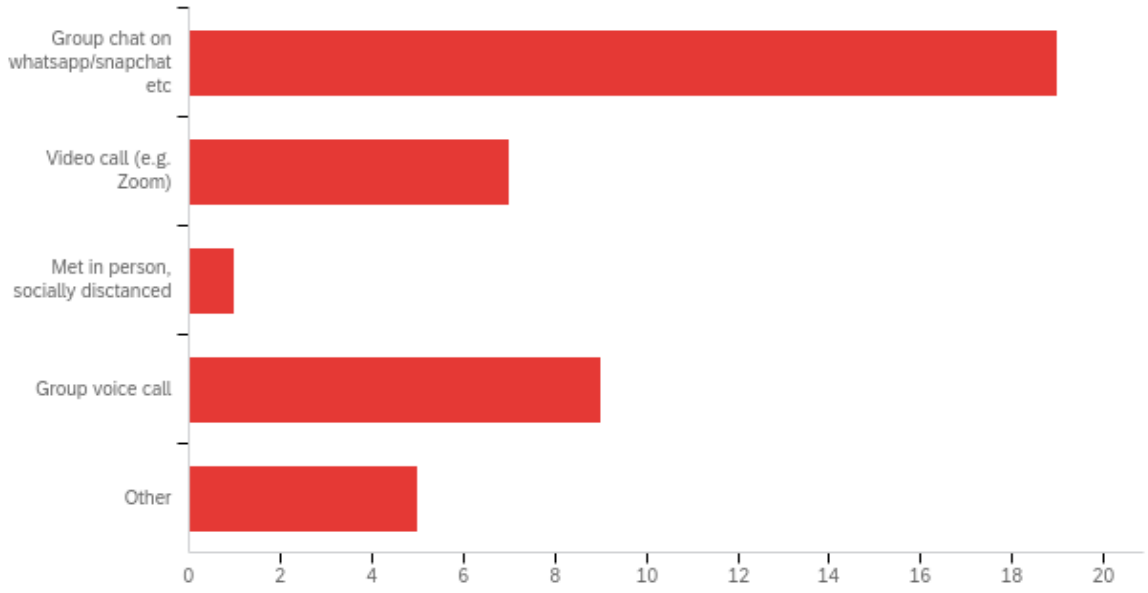


Figure 5.20: The most frequent platform for group interaction was recorded as messaging applications.

The most frequent response to this question indicated that students were using messaging and social media apps to communicate with groups about work (n=19, 46%). This is a strong indication of the limitations for student collaboration enforced by the closure or partial closure of schools and the impact of this on both the effectiveness of collaboration and that of regulation of learning is an area which requires further investigation when possible. Some students (n=16, 39%) were still engaging with groups via voice calls, the nature of which is inherently more fluid than text or image-based messaging, which suggests that students do appreciate the benefit in many cases of this kind of collaboration with peers.

5.8 Summary of Key Findings

In order to summarise the key findings in the present study, a joint display (Plano Clark & Sanders, 2015) is presented in this section. This visualisation, seen in table 5.15, displays the key findings and crucially, how they relate to and emerge from the data presented here. Plano Clark (2019) describes joint displays as visuals which explicitly relate quantitative and qualitative data, which are an effective way to communicate the integration process that has taken place. The value in the analytical and integrative thinking that is required to create joint displays is also noted and is certainly recognised in the present study. This type of synthesis forms part of the integration of the observation of lessons and the numerical data that resulted, with the qualitative data and stimulated-recall interviews. The concept of integration in mixed methods research is discussed in section 4.6, along with other aspects of how integration has taken place in the present study.

Suggestion from Results	Evidence
Social relationships strongly influence regulation of learning in collaboration.	• Lack of interaction in episode one attributed to lack of social relationships. • Student G identifying social factors in stimulated recall interview. • Student A comparing confidence when working with student R and student M dependent on relationship. • Patterns in direction of help-seeking towards individuals with an existing relationship.
Effective collaboration is required for effective regulation as a group.	• Lack of regulatory acts in episode one alongside lack of collaboration. • Graph theoretic statistics for episode two in comparison with episodes three and four show a difference in sharing and symmetry. • Differences in observations when the teacher was present in the group in episodes two and four.
The teacher has inherent authority over regulatory processes.	• Monitoring and control by the teacher in episode one. • Centrality of teacher acts in episodes two and four. • Asymmetry of teacher interaction suggesting inherent authority. • Changes in behaviour observed when the teacher left the groups in episodes two and four, increasing disengaged acts.
There is no clear set process for regulation of learning in collaboration.	• Directed graphs for episodes two, three and four, do not show a clear process, rather the employment of approaches as required.
The symmetry of regulatory acts and processes between peers is fluid and dynamic.	• Directed graphs for episodes three and four show a high level of fluidity. • Comparison of behaviours in different lessons by student A in stimulated recall interview illustrated different contributions. • Student R comparing behaviours when working with student A and student L.
Monitoring is a central process for the regulation of learning.	• Centrality of monitoring acts in directed graphs in episodes two, three and four was very clear. • Frequent repetition of the monitoring to controlling transition in episodes three and four.

Table 5.15: A joint display summarising the key themes within the findings across all episodes and data types.

As displayed in table 5.15, the rich data and depth of analysis presented in this chapter has produced some key themes worthy of further discussion. Some of these are perhaps unsurprising, considering the social context in which the present study is set, but nonetheless valuable as the present study has used an unusual naturalistic, interpretive approach.

The themes outlined in table 5.15 form the basis for the following chapter, in which the themes are discussed in more detail and related to theory and practice.

6 Discussion

6.1 Introduction

This chapter is concerned with the discussion of the results and analysis outlined in chapter five. In particular, with respect to their contributions to the research questions discussed and defined in chapter three. The data suggests several things, as shown in figure 5.15. These suggestions, drawn from the rich data collected and analysed from each episode in chapter five, are discussed in more detail in this chapter.

As discussed in section 3.1, the initial intention of the present study was to learn more about the phenomenon of regulation of learning in social settings, and as such improve this under-emphasised aspect of classroom practice. Crucially, when considering the first research question discussed in section 3.4, regulation of learning is observable in collaborative settings such as those described in the present study. In fact, it seems reasonable to suggest that this aspect of learning is significantly more observable in collaborative settings than it would be when considering the same students learning individually. In the former setting the process is, at least in part, externalised as part of the social interactions that take place in collaborative learning. When regulation is truly shared, it can be argued that the process itself is external and contained within the interactions between individuals themselves. In the latter setting, students are less likely to externalise the processes taking place when regulating learning on an individual scale. This externalisation of an otherwise internalised set of behaviours provides a significant opportunity for practitioners. As discussed in section 2.9, there is an ever-increasing range of interventions available to help develop and promote regulation of learning of school students of various ages. However, the phenomenon itself seems to be seen in many cases as somehow isolated from learning in the classroom. It is seldom considered by teachers, unlike behaviour, assessment for learning and so many other aspects of practice, including increasing amounts of neuroscience. There is an opportunity to develop the knowledge of teachers to enable them to recognise aspects of regulation of learning that are taking place in their own classrooms. As studies continue to develop practices to promote learning, teachers and other practitioners must be more than simply implementers of interventions. Practitioners must also be furnished with the ability to monitor and recognise regulation of learning in the same way that teachers implement assessment for learning. Collaborative learning in this sense makes this aspect of students' development visible. The more that teachers are able to see and identify regulation of learning in their own classrooms, the more linked to practice these considerations will be. Ideally, the less the development of this crucial aspect of learning will rely less on interventions which do not necessarily take into account the classroom context and capitalise on the opportunities to develop regulation of learning within it.

The present study was a naturalistic study that took place in functioning, ecologically valid secondary school classrooms. Previous studies in naturalistic classroom contexts (e.g. Bryce & Whitebread, 2012; Grau & Whitebread, 2012; Ucan & Webb, 2015), which are considered in more depth in section 2.10, have been successful in observing and analysing regulatory behaviours in classrooms of various types. In 91 minutes of coded video recording, 463 acts were coded as regulatory in nature, and every kind of code defined in the scheme in section 4.4 was observed. There can be little argument that acts which are intended to regulate learning are observable in the episodes outlined in the present study. Given that this is not new in itself, and similar acts have been observed in different contexts, it is important to consider what the acts observed in this study tell us about the nature of regulation of learning. Six suggestions from these can be seen in figure 5.15.

These six key suggestions can be clustered according to themes. In fact, three key themes can be identified in the six suggestions shown in table 5.15, emerging from the findings in chapter five. The three themes identified from the suggestions are the social landscape of the classroom, symmetry, authority over and responsibility for regulation of learning, and the manifestation of the regulatory process. The social landscape of the classroom explores the clear impact on regulation of learning by social relationships and perceptions. Symmetry, authority over and responsibility for regulation of learning refers to the theme of the unequal sharing of regulation of learning and the implications of authority for the collaborative process, particularly with respect to the teacher. Finally, the manifestation of the regulatory process discusses the nature of the process of regulation of learning observed within this context. These themes contribute to the theory underpinning what is known about the phenomenon of regulation of learning in naturalistic contexts and as such, have direct implications for practice.

It is important at this stage to consider carefully where these themes and suggestions fit within the research questions of the present study. Figure 6.1 shows a second joint display linking the suggestions from chapter five, the themes emerging from these, and the research questions underpinning the present study. The purpose of the joint display in figure 6.1 is to show how the suggestions from chapter five relate to the original research questions, and to provide some structure for this chapter. To allow for more fluid discussion, the three themes displayed in figure 6.1 are used as sub-sections as opposed to the research questions themselves. It is worth noting that there is a degree of conceptual crossover, so these themes should not be seen as distinct sections, but rather as a structure upon which the findings of the present study can be discussed with more clarity. Each theme and the suggestions from the data that form it are discussed in turn.

<table>
<tr><td rowspan="3">Research Question(s)</td><td colspan="3">Under what circumstances do students display regulatory acts during collaborative learning in small groups?</td><td colspan="3">How does a regulatory process emerge and function during collaborative learning?</td></tr>
<tr><td colspan="4">What are the individual differences in students' use of regulatory acts during collaborative learning?</td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="4">What relationship exists between regulatory acts observed during collaborative learning in small groups and what patterns and tendencies are evident?</td></tr>
<tr><td rowspan="2">Theme(s)</td><td colspan="3">The social landscape of the classroom.</td><td colspan="3">The manifestation of the regulatory process.</td></tr>
<tr><td colspan="3"></td><td colspan="2">Symmetry, authority over and responsibility for regulation of learning.</td><td></td></tr>
<tr><td>Suggestion from Findings</td><td>Social relationships strongly influence regulation of learning in collaboration.</td><td>Effective collaboration is required for effective regulation as a group.</td><td>The teacher has inherent authority over regulatory processes.</td><td>The symmetry of regulatory acts and processes between peers is fluid and dynamic.</td><td>There is no clear set process for regulation of learning in collaboration.</td><td>Monitoring is a central process for the regulation of learning.</td></tr>
</table>

Figure 6.1: A joint display outlines the themes within the suggestions from chapter five and links them to the original research questions of the present study.

6.2 The Social Landscape of the Classroom

The first theme identified in the suggestions from the results and analysis refers to the significant influence over regulation of learning held by the social landscape of the classroom. The underlying factors that affect behaviour on a social and emotional level remain in a naturalistic setting, so it is intuitive to say that existing social landscapes will affect future interactions, but the impact on learning processes such as regulation of learning is less well recognised and understood. The social landscape, or the existing social dynamics, expectations, and structure, became a consistent theme throughout the present study. While the majority of this landscape is invisible to the researcher, the consequences of the landscape are not. In this section, three suggestions from the data are discussed. Firstly, that social relationships strongly influence regulation of learning, secondly that effective collaboration and effective regulation of learning are intertwined, and finally the role of the teacher as an authority over the regulation of learning.

Existing Social Relationships

The first suggestion from the observations made is that existing social relationships strongly influence regulation of learning in collaboration. This suggestion emerged throughout all of the episodes. For example, the distinct lack of interaction in episode one was attributed to the lack of prior relationships amongst students. The contrasting reflections from student A in episodes three and four highlighted the differences in approach and attitude based on whether she was working with a friend or not. The fact that existing relationships impact social interaction should not come as a surprise but is seldom considered when discussing learning processes. In this context it clearly has a significant impact on the nature of the regulation of learning observed.

An important note on the influence of the existing social structure on the nature of sharing of regulation is that the observations made in the present study suggest that it is not wholly unconscious. In fact, the significance of this factor was brought to light primarily through the stimulated-recall interviews, suggesting that this is a factor that the students concerned were explicitly conscious of and able to reflect on. It is clear from stimulated-recall interviews in particular that social relationships were a key factor in the success or otherwise of regulation in groups. Both student G and student A put emphasis on the role of existing relationships in their decisions about collaboration, feelings of self-efficacy and help-seeking acts, seen as a form of controlling act. While it is not news that social relationships are an important factor in collaborative learning, this perspective on the impact on the ability of learners to regulate learning effectively is an important development in this area of understanding.

It does appear that the externalisation of regulatory acts, be they directly regulating the learning of others or not, either directly or indirectly regulates the learning of a group. It can also be said that this externalisation is inherently social in nature. For example, narration of a process by an individual might often be seen as self-regulation, but in fact, because that narration has been carried out in a context in

which other individuals will hear it, this might then impact subsequent acts by others. It can be argued that in this context, this cannot be strictly considered self-regulation as it will impact the rest of the social group. This externalisation begins to bring the process of regulation of learning out of individual minds and into the realm of interactions themselves. In light of this perspective, it is perhaps unsurprising that this process is more successful between individuals who already have a social relationship as this will come with greater mutual understanding, respect and trust.

Collaboration and Regulation

The data from the recorded episodes also suggests that effective collaboration and effective regulation are closely related. The lack of collaboration in the whole of episode one and phases of episode two meant that regulation of learning was not observable to any substantial degree. This highlights the intertwined nature of the sharing of regulation of learning, be it symmetrical or otherwise, and effective collaboration. Based on even the small sample addressed in the present study, the intertwined nature of collaboration and shared regulation are clear. It is not possible to say that one relies upon the other, one emerges from the other or one causes the other, but rather that they appear to be so closely related as to be two sides of the same coin. It is reasonable to hypothesise that collaboration and shared regulation, both as defined in chapter two, cannot exist in isolation of one another. This is in support of suggestions by Mercer (2013) that when students collaborate in an exploratory way, they must also be regulating the collaborative task. This also reflects analogous findings by Grau et al. (2018), who found a significant correlation between dimensions of shared regulation and exploratory talk across a range of age groups. The latter was conducted in a much larger, tightly controlled experimental context, so it is interesting to note that the same phenomenon is observable in just a small number of in-depth analyses in a naturalistic classroom environment.

The relationship between collaboration and shared regulation is also highlighted when considering student-teacher interactions. When examining episode two, it was clear that the teacher was leading the regulation of learning and is central to the process observed. In stark comparison, students R and L in episode three displayed a significant degree of symmetry and reciprocity and were effectively regulating the group's progress alongside effective collaboration. When this collaboration was disrupted by the intervention of the teacher, the same interruption was seen in the regulatory process. This reinforces the hypothesis that for effective group regulation of learning to take place, individuals must be effectively collaborating. Both of these constructs require reciprocity, communication and are reflexive, dynamic processes. In fact it is reasonable to see regulation of learning in groups as a form of collaboration, as individuals collaborate to plan, monitor, control and evaluate group functions to best reach group goals. This contrasts with asymmetrical, directive interactions such as the planning acts seen in episode two from the teacher.

It is perhaps appropriate to conceptualise shared regulation as a form of collaboration, but collaboration on a regulatory plane. This conceptualisation goes some way to explain a number of the suggestions that have emerged from the data collected.

The Role of the Teacher

The third suggestion from the results and analysis relates to the inherent authority held by the teacher. This authority is also held over the process of regulation of learning itself. It was to be expected that the teacher would have a significant impact on the regulation of learning that took place, not just through task design, which has not been an explicit focus of the present study, but also through their more dynamic support and interaction with groups during collaboration itself. As discussed in chapter two, when considering the effects of teacher input on the potentially delicate and ill-understood phenomenon of social regulation of learning, it is important to acknowledge not just the supportive role teachers can play but also the potential for disruption. These differing outcomes of teacher input are clear in the results of the present study, particularly the controlling presence of the teacher in episode two. More investigation into this aspect of the phenomenon is crucial to support the further development of practice that is mindful of regulation of learning amongst collaborating students. However, it is strongly suggested from the extensive data collected from the small number of recorded episodes in the present study that the impact of teacher input is strongly related to the idea of authority, another aspect of the existing social landscape of the classroom. While the authority can be assumed to lie with the teacher in a teacher-student interaction, the concept of symmetry was clearly observed in student-student exchanges too, for example between students A and R and R and L in episodes two and three respectively.

The following section examines the themes of authority, symmetry, and responsibility in more detail. Clarity of language is paramount. The idea of authority is important, as it suggests an inherent power held by an individual, which would be a reasonable assumption for a teacher. However, the concept of responsibility will also be discussed, as this term removes the innate idea of power and suggests an element of choice, in other words a decision, either individually or collectively, that an individual will take responsibility for an aspect of the regulation of learning. The symmetry of interactions or acts refers to the balance of authority or responsibility held by individuals interacting.

6.3 Symmetry, Authority Over and Responsibility for Regulation of Learning

An undeniable part of social interaction and social relationships is balance, or imbalance, of responsibility, authority, agency, and ultimately, power. It has been observed with considerable certainty in this study that the realm of regulation of learning is no exception to this. As seen in section 2.8, the concept of authority within classroom talk is not a new concept. Mortimer and Scott (2003) describe this idea by defining different types of talk. When the function of the classroom talk is regulatory, as seen in the present study, it follows that there can be authority over regulation in a similar way.

This concept has been observed and identified as a key theme in the present study, with some individuals in the episodes analysed clearly taking a leading role in the regulation of learning for the whole group. For example, the teacher had clear authority in episode two, whereas student L and student R took responsibility over aspects of the regulatory process in episode three. This is in contrast to the idea that shared regulation consists of equal contributions to all aspects of regulation by all parties. Rather it seems more fitting to see shared regulation as a complete jigsaw, with individuals contributing different aspects of the full picture. This is an important contribution to the existing knowledge of the nature of social forms of regulation.

The role of the teacher is highlighted as one holding inherent authority throughout the episodes with teacher involvement. In each case, the teacher's acts are central to the regulatory process and influence the direction of the group's behaviour significantly. Regulatory acts by teachers were asymmetrical and a distinct change in behaviour between students was observed when the teacher left the groups in episodes two and four.

The suggestions encompassed by this theme are discussed in more detail in this section. The section therefore considers the fluidity observed in the dynamic process of regulation, moving on to discuss the nature of the process itself.

Fluidity

The data collected as part of this study suggests a fluid and dynamic sharing of regulation between peers when they work collaboratively. It is clear that individuals do not have set roles but rather respond to needs on an individual and group level. This becomes clear when the ideas of symmetry and reciprocity are considered. Used by Grau et al. (2018) as a dimension to investigate the relationship between types of talk and socially shared regulation. This idea of symmetry allows discussion of regulatory acts without having to define them discretely as self, co- or shared regulation. Similarly, in the present study it seems more appropriate to discuss the degree of symmetry and reciprocity as a proxy for the degree of sharing of regulatory responsibility and authority. This symmetry changed from episode to episode and moment to moment, suggesting regulation of learning was dynamic and responsive.

The symmetry and reciprocity of regulation of learning between peers is variable and dynamic. In several cases, there is clear and effective sharing of responsibility for regulatory processes, perhaps most notably between student L and student R in episode three. In other cases, there is a stark reliance on others, highlighted by the reflection on the different roles played in different groups during the stimulated recall interview with student A, for example. While the present study is not broad enough in scope to draw comparisons and conclusions in this area, it is reasonable to suggest that the social

factors mentioned in section 6.2 and student perception of the competence of peers play a significant role in defining this dynamic, as these reasons were described in stimulated-recall interviews with both student A and student R.

One type of act which is inherently asymmetrical is help-seeking. Help-seeking acts, the conditions in which these occurred and at whom they were directed, were recurring considerations throughout the recordings made as part of the present study. This single type of controlling act seems important, highlighted both by the frequency of its occurrence, and its repeated mention as part of the stimulated-recall interviews. Conceptual clarification of the function of help-seeking acts is necessary here, which can help to clarify their importance. It would be an over-simplification to think that socially shared regulation, whichever guise it takes, is unidirectional. In other words, it is hard to justify the idea that sharing regulation only involved one individual regulating another. Be this process directive, or more reciprocal in nature, it is only one side of the story. Help-seeking is such a clear theme in the present study and deserves specific mention because it gives another perspective. Not only do individuals in the present study offer regulation to others, but they request it too. This has been referred to as a deferral earlier in the present study, but this is not meant in the sense that responsibility is shirked, rather that effective deployment of help-seeking in fact requires a well-developed and sophisticated ability to recognise one's own efficacy. It also requires a recognition of the capabilities of others, and therefore appropriate targeting of an individual who can provide the appropriate regulatory assistance. This is seen frequently in episode two, wherein student R and student A request help from the teacher where needed, but also in episode three, wherein student L requests help from student R and student G very frequently.

> *"How are we going to make sure that all of this goes in there?"*

This quote is a prime example of the complex nature of the regulatory process, and more specifically identifying it. In this short utterance, student L has made a clear comparison between their understanding of a situation, in this case that the likelihood of some of the solid missing the intended target is high, against a goal, namely that all of the solid is added to the water in the container, and recognised that these two don't align. This is the monitoring process, but the utterance itself is coded as controlling, as it indicates an action to adjust or correct a course of action because student L asks, rhetorically or otherwise, how the group can make sure this happens, indicating that the monitoring process has taken place but further action is required. The use of the word 'we' in this instance is crucially important, as it indicates the recognition by student L that this is a shared goal and suggests that she assumes that all of her group sees this. It also calls for help on a shared basis, in contrast with the same utterance but using 'I' or 'you' in place of 'we'. 'How am I going to make sure that all of this goes in there?' would suggest that student L sees it entirely as her responsibility, whereas 'how are you going to make sure that all of this goes in there?' suggests a degree of authority. In this example, while student L would be suggesting that the responsibility for adding all of the solid lied externally, she is still

clearly monitoring this process, despite it not being her own. In actual fact, as indicated by the use of 'we', this is a symmetrical regulatory act, because of the clear sharing of goals, responsibility and monitoring process by student L, and is representative of the rest of the episode when considering interactions between student L and student R in particular.

For help-seeking to be effective, it must be targeted. If targeted and timely, this type of act certainly is a controlling act, as it involves the recognition of a shortcoming, the recognition of a solution, and a change in direction to relate the two. Several examples of this process can be seen in episodes two and three in particular. These highlight the essential role these behaviours appear to play in the regulation of learning in a collaborative group. This reflects previous findings by Ucan and Webb (2015) where they noted that expressions of misconceptions or uncertainty through questions often led to co-regulation, or as it has been so far conceptualised in the present study, asymmetrical regulatory acts. This is a key example of when individuals taking responsibility for aspects of the regulatory process has been observed. It is not surprising that requests for assistance often lead to help by way of asymmetric regulatory acts, but it is important to note that effective collaboration will involve an aspect of this. While asymmetrical on an individual scale, as seen in episode three, reciprocity of help-seeking can also indicate effective collaboration and effective sharing of regulation on a more macroscopic scale.

Teacher-Student Interactions

Echoing findings by Ucan and Webb (2015), teacher interactions with groups were found to be asymmetrical, described as co-regulation by Ucan and Webb when looking at regulation during science enquiry activities. Both episodes three and four were science experiments, and both of these episodes displayed a high degree of sharing of regulation between group members. Help-seeking in all of the episodes frequently led to asymmetrical regulation by the teacher, whereas responses to help-seeking by students was much more symmetrical, and often led to a phase of shared regulation. This was particularly obvious when student R and student L were working together during episode three.

One theme that is immediately noticeable is the difference between the symmetry and reciprocity of student-teacher interactions in comparison with those between peers. In complete contrast to the fluid reciprocity shown between peers, student-teacher interactions observed within this study were exclusively asymmetrical in nature. In fact, these interactions could be described as directive, highlighted by the teacher's response when questioned by student G in episode three. This is not necessarily a surprise, as it became clear that teachers have different goals to students, exemplified in episode one when the teacher's own regulation against these goals was momentarily externalised. This asymmetry is also likely to be affected by the fact that teachers are more often than not, more proficient regulators than students, so students may rely on their input somewhat, as seen in episode two. Teachers, with their different goals and greater regulatory proficiency are therefore not in collaboration with students and were not observed sharing regulatory responsibility as a result. What was certainly

observed was the potential of the authority held by the teacher to actively disrupt the sharing of regulation between students.

In the present study, teacher interaction with learners was usually when correction was required. These acts would often take the form of monitoring or controlling acts, with the intended function of stimulating reflection or simply correcting the course of the group's collaborative work. The authority of the teacher is inherent, so when this occurred, the regulation of learning between peers restarted from the input by the teacher rather than being cumulative throughout. This disruption may well ultimately mean students reach their goals, again usually set by the teacher, faster, but removes the opportunity for true reflection and collaborative monitoring and collaboration. The asymmetry in teacher-student interaction was generally a key cause of this disruption, to the point that even the physical proximity of the teacher had an impact on the regulatory acts observed in episodes two and three. This is certainly a finding which requires careful consideration in terms of its implications for practice. It is reasonable to suggest, based in part on the reflections of students G, A and R, that effective shared regulation is more likely to emerge swiftly amongst a group of known, trusted peers. This dynamic can be easily changed by the addition of another peer or the teacher, and practitioners need to be mindful of the resulting asymmetries when designing tasks, groups or even when working with groups of students while they collaborate. A balance between teacher support and student or group agency must be struck to ensure that the opportunity for shared regulation is not lost to a desire for efficiency of outcome.

In order to emphasise this point we can consider regulation of learning as a domain in the classroom in the same way that knowledge is seen. It is widely accepted that increased knowledge is a positive outcome when a learner leaves a classroom. It should be emphasised that it is a belief of the author that an increased ability to regulate learning should be seen in the same light. In the same way that the consideration of knowledge as the teacher's responsibility could be damaging, the same can be said for the idea that the teacher must have responsibility for the regulation of learning of all their students is disempowering for the students. Equally, when considering the more active concept of authority, the idea of the teacher being the authority of knowledge in the classroom is perhaps somewhat out-of-date. Likewise, the teacher should not be seen as the authority on regulation of learning. In fact, as seen in the present study, this authority can significantly hinder the regulation of learning by the students, as seen in episode two and four in particular. Teachers need to be able to carefully navigate the landscape of regulation in the classroom. They must provide support and challenge where required from the perspective of regulation of learning, avoid spoon-feeding and depriving students of the opportunities to develop their regulation, and conversely to provide sufficient scaffolding that learners are not left floundering. To be able to do this with any semblance of proficiency, teachers must first be able to recognise and understand the landscape of regulation of learning. Teachers need to understand the nature and function of the components of regulation of learning. They need to be able to identify when it is happening effectively and its conspicuous absence. Only when this is the case, can teachers effectively intervene or react appropriately to ensure regulation of learning is not just a concept

considered by researchers and psychologists, but is considered on the same footing as knowledge and motivation in the classroom.

Individual Differences

Significant individual differences in regulatory acts emerged, with limited patterns identified when looking at individuals across groups. This could be due to the limitations placed upon the scale of the present study, but certainly confirms that other factors such as group make-up, task type, teacher involvement and so on have a significant enough impact on behaviours so as to make individual tendencies indistinguishable. There is some emerging evidence that two key factors have a disproportionate impact on the nature of regulation of learning: teacher involvement and group construction. The involvement of the teacher in episode two, despite the teacher clearly intending to play a supportive role, meant that the students in this group undertook very little social regulation of learning themselves, so much so that disengaged acts were displayed frequently after the teacher left the group. These same students then took on roles displaying significantly more authority over aspects of regulation in other groups, and interviews identified the interpersonal relationships with other individuals and perceived confidence as key reasons for these differences.

It appears from the present study, that students take the path of least resistance when regulating learning. In other words, when a stronger regulator of learning is present, students are frequently seen to defer to them. This is often, but not exclusively, the teacher. From an alternative perspective, when students identify that stronger regulation in an area is required and are able to provide it, they do so. This perspective suggests the fluid approach allows the group to regulate, or at least attempt to, according to individual and group level requirements. This is clearly an exceptionally dynamic process, underpinned by appropriate monitoring processes. Arguably, in the same way that students must be challenged by difficult content to develop both knowledge and confidence, the same is true for regulation of learning. It can be posited that if students are always able to rely on an external regulator, they will not develop either the skills to effectively regulate their learning, nor the self-efficacy and confidence to attempt it. An extreme example of this was seen in episode two, wherein the students present were not provided with the opportunity to plan their learning at all, and disengaged acts emerged when the teacher left. The suggestion that emerged from the stimulated-recall interviews that this was commonplace draws into question the opportunities for these students to develop their planning approaches to learning in challenging situations. More broadly speaking, it is important that regulation of learning in the classroom is a shared responsibility and is actively considered as such by both learners and practitioners. Once again, there are parallels with conceptualisations of collaborative learning. It is accepted that providing groups with all the answers would disrupt the development of effective collaboration. The same appears to apply to the regulation of learning.

Monitoring has been frequently seen as a crucial part of the manifestation of regulation in collaboration. In many forms, monitoring has been observed in almost every stage of the present study and can be seen playing a central role in the regulation of learning in every one of the direct graphs in figures 5.4, 5.8 and 5.17. The central role that appears to be played by monitoring is discussed further when considering the theme of the regulatory process itself, which draws together other aspects of the findings discussed so far.

6.4 The Manifestation of the Regulatory Process

The final theme emerging from the results refers to the process of regulation of learning. An intention of this study was to examine patterns and tendencies and elicit information of how regulation of learning manifests. In fact, what was observed was a distinct lack of a clear, overarching pattern or process common to groups or individuals. The lack of a clear overarching pattern, process or cycle in the episodes observed is as telling as the presence of one. The apparent lack of structure gives clear indications about the nature of regulation of learning in situ. It questions the current understanding of this phenomenon and the models that exist to describe it. Rather than a discrete, staged process, it seems more apt to see regulation of learning in collaborative settings as fluid and fractal in nature. It may be that this increased complexity in the process of regulation reflects the increased complexity of the system in which it is situated. In other words, it might be unsurprising that the process of regulation of learning is more discrete in a highly controlled, experimental setting, whereas it is significantly more complex when taking place in the complex social setting of a naturalistic classroom.

At odds to the cyclical models shown in chapter two, the processes revealed by the use of directed graphs did not display a cyclical structure. Instead, alongside the timelines, the employment of the different aspects of regulation appeared to be driven by need and proficiency. It is reasonable to suggest that the process and pattern observed in each episode depended on both group and individual characteristics. This ties to the finding that the symmetry of regulatory acts appears to be fluid and dynamic, with individuals contributing to different extents dependent on need. The only indication of a consistent process was the relationship between monitoring and the other types of act observed. Monitoring acts were central in each episode and displayed a strong relationship with controlling acts in each case.

Patterns and Tendencies

In the present study, analysis of coded regulatory acts using directed graphs has allowed identification of some patterns of activity, alluding to tendencies on an individual or group level. By focussing on the most frequent adjacencies, core regulatory patterns were identified. These patterns and tendencies were present in the groups which collaborated effectively and where large numbers of regulatory acts were observed by participants. Crucially, the underlying patterns were different in nature between episodes, and individuals contributed differently to the groups they were in. This seems to echo the

findings of Ucan (2017), who noted that different patterns of temporal change in regulation were identified for each group and individual and appeared to be associated with characteristics at these two levels.

It is reasonable to suggest that the regulation of learning that manifests in the classroom as a dynamic, responsive process which adapts to the needs of the group, the individuals within it, the task at hand and so on. It is no surprise, with this in mind, that no clear cycle was observed within the recorded episodes in the present study. Rather than a three-or-four-phase process as seen in section 2.2, it perhaps might be more accurate or representative to consider the regulation of learning in the contexts seen in the present study as a four-component model. The consideration of the core aspects of regulation of learning; planning, monitoring, controlling and evaluation, as components rather than phases removes the implication that they are ordered in some way.

Having said this, a strong relationship was seen in all four of the episodes between monitoring acts and controlling acts. Often, controlling acts followed monitoring acts. This is indicative of an important, central process to the regulation of learning across the various contexts seen in the present study. The controlling acts fall broadly into two categories which might be called outward and inward in direction. Controlling acts directed outward, in other words help-seeking, seek a change in direction or contribution from another. Frequently in examples seen in the episodes in chapter five, controlling directed outwards was directed specifically at the teacher. Controlling acts directed inwards comprise of a specific change or idea which comes from a member of the group in question, as opposed to a request for such a contribution. These are important distinctions, as the inward controlling acts might be indicative of a more refined ability to regulate learning in contrast to a request for help in regulating learning.

Monitoring

Phases of forethought, volition and evaluation were not observed in the present study. Perhaps not unexpectedly though, controlling acts often followed monitoring acts, which fits with the roles of both types of act. However, the acts do not appear to form a linear process, or even a cycle, as many of the theoretical frameworks discussed in section 2.2 might suggest. Instead, it appears that regulatory acts of various kinds are deployed when required by individuals to aid the progress of the group towards shared goals. If there is an individual in the group such as a teacher who has more inherent authority, it makes sense for the group and the individuals within it to rely somewhat on the contributions of the more adept regulator. The non-linear process is instead dynamic, with large numbers of variable pathways, some more frequent and well-defined than others. Instead of viewing regulation of learning as a cyclical phenomenon, which in some sense can be seen in episode three, it is perhaps more accurate to see the acts of planning, monitoring, controlling and evaluation as a toolkit of approaches and functions which can be called on when required. Monitoring was clearly required frequently and

appeared to underpin the other processes, while emotional and motivational regulation was less frequently externalised as individuals were less able to rely on others for this individualistic aspect of regulation. It might be argued that the cycle is better seen as a fractal, wherein smaller and smaller cycles and patterns are seen as the resolution becomes greater and greater. From one moment to the next, a multitude of regulatory acts can be observed, contributing to the progress of the group, and on a longer timescale, a similar pattern can be observed over time. All of these acts were determined by the requirements of the group, and as the graphs make clear, iterations and trial and error appeared to be a tendency of the groups and individuals observed. Since there is no set process, individuals employed a variety of acts in a variety of orders, but perhaps those trials that were more successful are those that are repeated and form the core process seen in the reduced graphs in figures 5.9 and 5.18. This core process, as well as the other attempts surrounding it, appears to be different for each group, but the monitoring function was clearly a key in deciding next steps, reflected by the consistent presence of controlling acts alongside them.

Monitoring is a central aspect of the regulatory process, and arguably the key component of the process which, if effective, defines the format of the rest of the process. Alongside this, it is arguably the most difficult aspect of the process to recognise through observations. It was the type of code with the lowest Kappa value, as discussed in section 4.4, and was often over-identified in this coding. The issue here is that monitoring is often internal and often implied by an act, as opposed to the other five codes used in the present study, which are externalised and more explicit in their function. It could be argued, therefore, that further work on recognition of metacognitive monitoring in naturalistic settings would be a valuable endeavour to make the process of regulation more visible in practice, particularly as monitoring holds such a crucial role within the overall process.

It is important to recognise that in many cases, monitoring can be assumed to have taken place before controlling acts, even if it is not observed. For example, a change in direction of a group's activity induced by a student while working on a problem requires monitoring to have taken place, whether it is observable or not. The student themselves could have compared progress against shared goals and recognised a shortcoming or alternative approach, leading to what would be coded as a controlling act in the present study. The initial stage could be described as monitoring, but is internalised and individualistic, despite group goals and activity being the subject of the monitoring process. Alternatively, controlling acts from said student could follow monitoring by another student. In this case the monitoring process is likely to be observable before controlling takes place. In other words, the controlling student has not internally monitored progress against goals, but another student has done so, and externalised this for the controlling student to recognise and respond to. It is perhaps therefore reasonable to suggest that the more visible monitoring is within a group, the more this aspect of regulation is shared. By extension, because of the central nature of monitoring, perhaps the more visible monitoring is, the more regulation in general is being shared within a group. Referring to the present study, this can be exemplified by observations in episode one in comparison with those in episode

three. It can't be said that regulation was not taking place in episode one, but if it was, it was internal, individualistic, and therefore not observed in any notable quantity, with the exception of help-seeking leading to asymmetrical sharing between teacher and student. In this context, students can be seen as islands. Regulation, where it takes place, is taking place within their individual minds. In contrast, the sheer amount of narration and sharing of metacognitive processes in episode three means regulation itself can be conceptualised differently. Instead of regulation existing or taking place within each students' head, it was vocalised, externalised, and therefore existed and functioned as a set of social interactions and communication. To use Vygotskyan language, this is a contrast between regulation as an intramental, individual metacognitive function and an intermental, collective function and endeavour. The latter scenario, wherein students fluidly share responsibility for regulation of group learning, fits with the concept of the social brain as discussed by Mercer (2013), and while not explicitly outlined within the research questions, this scenario provides students with a key opportunity to develop their regulatory process and competence by co-constructing the process. This is again in contrast with the reliance on the regulatory authority of the teacher observed in both episodes one and two.

When viewing the observed regulatory acts as a whole, the data within the present study refutes the idea of a clear process. Instead, the acts observed are in response to need, and the temporal changes vary from individual to individual and group to group depending on characteristics of these systems as well as external factors. While further work is required to identify the factors involved in this convoluted system, there are clear indications of the importance of social factors on the nature of regulation of learning as discussed in section 6.2. It could be hypothesised that when observing the process of regulation of learning on an ever-decreasing scale, that recurring patterns might be observable, akin to a fractal pattern. However, the expected planning, monitoring evaluation style structure was conspicuously absent from the observed systems in the present study. Instead, a dynamic, fluid and externalised employment of regulatory acts was observed. This has exciting implications for the observation of regulation in practice, which is discussed in the next section.

6.5 Chapter Summary

This chapter has outlined the key findings from the analysis of the recorded episodes and stimulated-recall interviews in this study. The nature of regulation in collaborative groups has been explored and it is clear that, unlike many of the models discussed in chapter two, it is a fluid, dynamic process, heavily influenced by social relationships and the authority of individuals involved. The parallels between regulation of learning and collaboration have been discussed, and there is some compelling evidence for regulation of learning as an extramental phenomenon, existing within interactions themselves, once again calling into questions many of the conceptualisations discussed in chapter two.

7 Implications and Impact

7.1 Introduction

This penultimate chapter reflects on the impact and implications of the present study on the multiple spheres it exists within, from macroscopic to individual in scale. It is important to look back on the impact and look forward to the implications of research of any kind to ensure its value. This concept of reflection has been central to the doctoral journey throughout the present study and in many ways these reflections, and the learning that has taken place because of them, is as important as the research content itself.

Firstly, the impact and implications with regard to theory are discussed, drawing on the themes discussed in section 6.1. As a practice-based study, conducted by a practitioner, the impact on and implications for practice are discussed, before a reflection on the impact and implications on a more personal level on the researcher themselves.

7.2 Implications for Theory

In sum, the implications of the present study in terms of the theory and conceptualisation of regulation of learning in collaborative settings are in two key areas. Firstly, the present study builds on previous work to question the idea that regulation can be seen as a cyclical or ordered process in all but the most tightly controlled experimental conditions. It is more reasonable to suggest that, with monitoring at the core, other functions are employed by individuals and groups where required rather than in a particular sequence. This is at odds with some models of regulation, specifically self-regulated learning and the cyclical Zimmerman model (2000), but builds on the suggestion that regulation can be loosely sequenced and recursive in nature as described by Winne and Hadwin (1998).

Secondly, the present study has looked in significant depth at the relationship between regulation of learning and collaboration and found some initial evidence supporting the hypothesis proposed by Mercer (2013) that socially shared regulation could be intermental in nature. In other words, the manifestation of socially shared regulation not just within but as the interactions between group members themselves suggests that rather than conceptualising shared regulation of learning as individuals sharing the processes which take place within their own heads, the fluid and dynamic regulatory process are contained within the observed interactions themselves. The regulatory acts observed within the present study are not only symptomatic of regulatory processes on an individual scale, they are also regulatory processes themselves on a group level. Tentative development of the conceptualisation of regulation is exciting in that it emphasises the potential accessibility of these processes to the teacher, and certainly suggests a significant opportunity for practitioners to foster, influence and develop these processes in the classroom.

7.3 Methodological Contributions

The design of the present study considered the need for naturalistic perspectives on the phenomenon of regulation of learning. The research design incorporating the use of both video observation and stimulated-recall interviews allowed for the observation and appropriate interpretation of regulatory acts in situ. The use of directed graphs allowed for the elucidation of patterns within the coded data, which could then be interpreted using granular analysis of utterances and reflections in the stimulated-recall interviews. In line with existing claims, it was clear that both individual and group-level analyses were required to build a full picture of the regulatory process (Iiskala et al., 2011; Ucan, 2017). This continues to build on the emerging approach to regulation as a shared venture and moves away from the individual as the unit of analysis in understanding regulation.

It was abundantly clear that the use of mixed methods and the development of a robust process for interpretation was crucial. The perspectives provided by the stimulated-recall interviews were invaluable in adding the individual voices and reflections to the interpretation of group dynamics. In particular, the use of this method has real potential to add a great deal to the understanding of the field, as well as to other phenomenon which involve inferences of process from individual acts.

The use of directed graphs to model and visualise processes and patterns displayed by the groups in this study was novel and pivotal to identify key tendencies and relationships between regulatory acts. The ability to visualise large amounts of data in this way to identify patterns, then to return to the data to identify important acts on an individual level helped build a particularly rich picture of the functions of the groups in this study. This technique has significant potential in developing understanding of the process of regulation.

7.4 Implications for Practice

As a practice-based research project, the impact of this work on classroom practice is arguably the most important measure of its success. The present study has affirmed the belief in the importance of the development of an understanding of regulation of learning among practitioners. The deepening of the understanding of the phenomenon within classrooms resulting from the present study offers a new perspective for practitioners and emphasises the idea that this crucial aspect of learning is taking place in classrooms across the world. If the purpose of education is to develop young people as learners beyond the classroom it cannot be ignored. While there is an argument that the processes required for appropriate regulation of learning to take place are developed frequently without intervention from teachers, the potential for a greater understanding and acknowledgement of the importance of regulation of learning in the classroom to have a significant impact on learning is difficult to question.

In my own classroom, my teaching practice at every stage is now grounded in the work done as part of this thesis. When designing activities or planning lessons or series of lessons, I ensure there are

opportunities for students to regulate their learning. I also ensure there are opportunities for feedback on this process and explicit teaching of regulatory approaches. I find myself conducting microanalyses of regulation of learning while teaching, which allows me to recognise and support the process accordingly. The ability to recognise aspects of regulation of learning in situ is an invaluable outcome of this project and allows far more effective intervention and support for students. It also allows for better recognition of when teacher input might be disruptive or unnecessary.

Outside my own classroom practice, I have been invited into a number of classrooms since the completion of the data collection phase of this project to observe and provide feedback on the regulation of learning taking place, as well as the teaching approaches employed. At the time of writing, I have run a number of sessions on the nature of regulation of learning for teachers to raise awareness of this essential aspect of classroom-based learning. At this stage, this work focusses on the phenomenon itself, namely what regulation of learning is, why it is important and how it can be recognised in practice. This is as opposed to discussing particular approaches or interventions, though there is clear scope for this work to continue in this direction in the future, and the toolkit of approaches and impact mentioned in figure 3.4 is under development as part of this work.

For those reading this thesis as a teacher in any context with parallels to that seen in the current project, I hope it goes some way to persuade of the importance of considering regulation in our practice. The extent to which the specific observations, findings and conclusions hold true in other settings is of course variable, but regulation of learning should nevertheless be seen as an essential and inescapable part of the learning landscape in social settings. The more practitioners are aware and alert to this, the more we will learn about the nature of this otherwise hidden aspect of learning, and the better our teaching and learning will be as a result.

When considering the role of the teacher, the present study also reiterates the importance of considering authority during collaboration. One simple recommendation is for teachers to recognise their own authority over learners when it comes to regulation of learning and to tread very carefully in order to provide opportunities for trial and error and the resulting development of shared regulation of learning during collaborative learning. This is no different to approaches to other forms of knowledge. Simply providing the answer to students is not necessarily helpful. In a similar vein, acknowledgement of the impact of these authority dynamics between learners with existing social relationships will allow for better design of collaborative groups to best foster and sustain sharing of regulation. While it requires further investigation, there is certainly a great deal that can be learnt from the extensive research into collaborative learning in this respect.

7.5 Implications for the Researcher

The implications of the doctoral journey for the researcher who undertakes it should not be underestimated. Both generally, in terms of understanding of research methods and critical engagement with developments in the field, and more specifically, in terms of understanding and conceptualisation of regulation of learning and its implications for my own practice, the opportunities to learn and explore as part of the present study have been invaluable. Reflecting momentarily on the specific implications for my own practice, as a direct result of the in-depth study of the phenomenon of regulation of learning in the classrooms of other practitioners, I have found myself developing a lens through which I can recognise regulatory behaviours, their function and their symmetry in collaborative learning contexts. As practitioners, we are able to assess a huge number of different factors, often automatically, in order to adapt our teaching to ensure the best outcome for the learners in front of us. This could be recognising a student who finds a task difficult, planning the classroom so students are supported effectively by peers, or using formative assessment to gather information on understanding. I now add to this armoury the ability to assess and address regulatory behaviours in collaboration and have found myself adapting my practice in response to these cues. Be they planning, monitoring or disengaged acts, each act provides an insight into the regulatory landscape of the social classroom. This insight holds a huge amount of potential for the development of teaching and learning to consider and incorporate regulation. This moves away from the current intervention-based approach to promoting and fostering regulation of learning, towards a sustainable, holistic consideration of this concept as central to learning, as opposed to beneficial but distinct. There is work to be done to ensure that all practitioners sufficiently understand regulation as a concept and are able to begin to see the regulatory landscapes within their own classrooms and adapt their practice accordingly. Awareness of the nature and importance of regulation amongst my own peers is limited, but there is hope. As seen in the traction gained presently by concepts such as cognitive load and retrieval practice, there is a significant opportunity to educate practitioners and embed practice into classrooms which is led by robust research into regulation in order to better develop students as self-aware regulators of learning for the rest of their lives.

8 Conclusions

8.1 Introduction

This final chapter concludes the thesis. Following on from the implications of the findings discussed in chapter seven, limitations of the present study are discussed, followed by future directions for research and closing remarks.

8.2 Limitations

A wide range of analytical techniques were employed on a range of types of data to best address the research questions in this study. In order to appropriately interpret the findings of the study it is essential to consider the limitations of the approach employed.

Firstly, the scale of the study focussed on depth of data as opposed to breadth. The small number of students allowed a deep understanding of the phenomenon in this limited number of cases. This inherently means that the findings in these specific contexts are not generalisable. This also means that the small number of episodes considered could not be directly compared due to confounding factors in the unique contexts of the individual episodes. While suggestions of factors and tendencies could be made in chapter six, they remain suggestions and further research into factors affecting the emergence of the phenomenon is required. The same is true when considering discussions around individual differences, and the present study has been unable to consider traditional aspects of individual differences such as self-perceptions or motivation.

It should be noted that because I was the only researcher analysing the data collected, the interpretations of the data collected may have been influenced by my own positions. As discussed in section 3.7, the stimulated-recall interviews served to question or corroborate these interpretations of observation data. While at least one stimulated-recall interview was completed following each of the four episodes, given further time it would have been beneficial to complete these with all students involved in each group, and additionally to complete a similar protocol with each teacher to better understand the impact of their role. Using stimulated recall interviews in this way to triangulate student perspectives as well would have avoided unreliable detention or reflections on regulation of learning by students.

On a similar note, the coding scheme developed was sufficiently comprehensive for the episodes discussed in chapter five. Again, I was the only researcher to apply the scheme to recordings, and it was clear early in the project that coding of non-verbal acts was rarely possible due to uncertainty in interpretation. While non-verbal acts are less likely to be interactional, further work on understanding the regulatory implications of non-verbal interactions would be valuable to the field.

8.4 Future Directions

Future directions for research can be suggested straight from the key findings outlined in chapter six and can be defined as five areas of interest; regulation and collaboration, factors affecting the function of social regulation, individual differences, authority and the role of the teacher, and the nature of regulatory control.

Firstly, the intersection of the fields of regulation of learning and collaboration deserves further attention. The interplay of these two areas is clear, but our understanding of the nature of the relationship between them remains limited. Further investigation and ultimately theorisation here will develop our understanding of both fields significantly. Information from such studies will further allow the development of practice to ensure their successful enaction in classroom settings.

The continued exploration of the function of regulation in naturalistic settings is warranted, continuing to investigate this phenomenon in different contexts, with different individuals and interventions. The continued building of this picture will further develop our understanding of the phenomenon and aid the development and implementation of increasingly effective classroom practice to develop students as effective regulators. Careful design of studies may allow for more effective identification of factors that affect the success or otherwise of group-level regulation of learning.

This study has been limited in its ability to consider individual differences and work that considers conventional individual differences such as motivation and self-concept would be incredibly valuable. For example, how do individual differences in self-concept influence the manifestation of shared regulation? This would go beyond the relatively limited insight of the present study, that there are differences in implementation of regulatory acts between individuals and in turn provide further insight into how individual learners can be supported in developing their regulatory proficiency, how socially shared regulation can be supported and any reciprocal relationships between regulation and individual differences.

A key theme of authority and asymmetry was identified in the current study. In particular, the authority of the teacher as regulator was noteworthy. Further research in this area of practice would be valuable, with the objective of learning more about the student-teacher dynamic in regulatory terms. This would allow practitioners to develop a clear understanding of their effect on regulatory landscapes in the classroom and develop and promote practices which ensure students develop into proficient regulators of learning in a variety of settings. If the ability of students to enact appropriate regulatory acts is considered as procedural knowledge, it becomes clear that the role of the teacher cannot simply be to provide regulatory input, but to support the development of said knowledge. The findings in this thesis would suggest that supporting the emergence of effective social regulation would be an appropriate way to allow students to practice this.

While not considered in this thesis, in light of current directions within policy and curriculum development, the relationship between regulation and knowledge deserves particular attention. In other words, to what extent does the regulatory proficiency, conceptualised in the present study as authority when in a social context, depend on procedural knowledge of the individual? Is a learner a better regulator simply because they have more knowledge of the task at hand and approaches or strategies that can be enacted to reach the corresponding goals? This conceptualisation has clear implications for the role of the teacher in developing learners as regulators.

Leading directly on from this, metacognitive control, or what an individual knows how to enact and the effectiveness of their implementation, is somewhat under-represented in the research on regulation of learning. While there is a clear link between metacognitive monitoring and controlling acts in the present study, interventions or case studies designed to better understand how metacognitive control can be influenced would make a significant contribution to classroom practice. For example, an intervention in which students are taught tactics and strategies to guide group processes. With further options about how to proceed when metacognitive monitoring identifies the necessity of a change in direction, beyond the help-seeking commonly seen in the present study, more may be learnt about the relationship between metacognitive monitoring and control and a more thorough picture of shared regulation developed.

8.5 Closing Statement

Students across the globe continue to learn in the social setting of a classroom. While the benefits of being able to regulate learning in social settings are widely accepted, how this process emerges and is sustained is still not well-understood in naturalistic settings. This thesis has sought to contribute to this question and develop our understanding of group-level regulation in ecologically valid classroom settings. In general terms, the findings of this study have highlighted the important intersection between collaborative learning and regulation of learning theories, as well as questioning the idea that regulation of learning has a set process. Instead, the process of regulation appears fluid and dynamic, heavily influenced by existing social relationships, individual and group-level characteristics and the concept of authority. It remains my hope that the insights provided in this thesis will inform researchers and practitioners and contribute in some small way towards a better understanding of this complex phenomenon, in turn leading to better practice in developing students as confident and proficient regulators of the learning of themselves and others.

References

Adler, P. A., & Adler, P. (1994). Observational techniques. In *Handbook of qualitative research* (pp. 377–392). Sage Publications, Inc.

Allal, L. (2011). Pedagogy, didactics and the co-regulation of learning: A perspective from the French-language world of educational research. *Research Papers in Education*, *26*(3), 329–336. https://doi.org/10.1080/02671522.2011.595542

Alozie, N. M., Moje, E. B., & Krajcik, J. S. (2010). An analysis of the supports and constraints for scientific discussion in high school project-based science. *Science Education*, *94*(3), 395–427. https://doi.org/10.1002/sce.20365

Bakhtiar, A., Webster, E. A., & Hadwin, A. F. (2018). Regulation and socio-emotional interactions in a positive and a negative group climate. *Metacognition and Learning*, *13*(1), 57–90. https://doi.org/10.1007/s11409-017-9178-x

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bandura, A. (1991). Social Cognitive Theory of Self-Regulation. *Organizational Behavior and Human Decision Processes*, *50*, 248–287.

Bandura, A. (2001). Social Cognitive Theory: An Agentic Perspective. *Annual Review of Psychology*, *52*(1), 1–26. https://doi.org/10.1146/annurev.psych.52.1.1

Bannert, M., Reimann, P., & Sonnenberg, C. (2014). Process mining techniques for analysing patterns and strategies in students' self-regulated learning. *Metacognition and Learning*, *9*(2), 161–185. https://doi.org/10.1007/s11409-013-9107-6

Bassey, M. (1999). *Case study research in educational settings*. Open University Press.

BERA. (2011). *Ethical Guidelines for Educational Research*. British Education Research Association. http://www.bera.ac.uk/researchers-resources/publications/ethical-guidelines-for-educational-research-2011

Boekaerts, M. (2016). Engagement as an inherent aspect of the learning process. *Learning and Instruction*, *43*, 76–83. https://doi.org/10.1016/j.learninstruc.2016.02.001

Boekaerts, M. (2017). Cognitive load and self-regulation: Attempts to build a bridge. *Learning and Instruction*, *51*, 90–97. https://doi.org/10.1016/j.learninstruc.2017.07.001

Boekaerts, M., & Cascallar, E. (2006). How Far Have We Moved Toward the Integration of Theory and Practice in Self-Regulation? *Educational Psychology Review*, *18*(3), 199–210. https://doi.org/10.1007/s10648-006-9013-4

Boekaerts, M., & Corno, L. (2005). Self-Regulation in the Classroom: A Perspective on Assessment and Intervention. *Applied Psychology*, *54*(2), 199–231. https://doi.org/10.1111/j.1464-0597.2005.00205.x

Boekaerts, M., Zeidner, M., & Pintrich, P. R. (1999). *Handbook of Self-Regulation*. Elsevier.

Bronfenbrenner, U. (1981). *The Ecology of Human Development: Experiments by Nature and Design*. Harvard University Press. http://ebookcentral.proquest.com/lib/cam/detail.action?docID=3300702

Bryce, D., & Whitebread, D. (2012). The development of metacognitive skills: Evidence from observational analysis of young children's behavior during problem-solving. *Metacognition and Learning*, *7*(3), 197–217. https://doi.org/10.1007/s11409-012-9091-2

Bryman, A. (2004). *Social Research Methods by Bryman, Alan 2nd* (2nd ed.). OUP Oxford.

Butler, D. L. (2011). Investigating Self-Regulated Learning Using In-Depth Case Studies. In B. J. Zimmerman & D. H. Schunk (Eds.), *Handbook of Self-Regulation of Learning and Performance* (pp. 345–360). Taylor & Francis Group.

Cano, F., García, Á., Berbén, A. B. G., & Justicia, F. (2014). Science Learning: A path analysis of its links with reading comprehension, question-asking in class and science achievement. *International Journal of Science Education*, *36*(10), 1–23. https://doi.org/10.1080/09500693.2013.876678

Clark, A.-M., Anderson, R. C., Kuo, L., Kim, I.-H., Archodidou, A., & Nguyen-Jahiel, K. (2003). Collaborative Reasoning: Expanding Ways for Children to Talk and Think in School. *Educational Psychology Review*, *15*(2), 181–198. https://doi.org/10.1023/A:1023429215151

Cleary, T. J. (2006). The development and validation of the Self-Regulation Strategy Inventory—Self-Report. *Journal of School Psychology*, *44*(4), 307–322. https://doi.org/10.1016/j.jsp.2006.05.002

Cleary, T. J., Callan, G. L., Malatesta, J., & Zimmerman, B. J. (2015). Examining the Level of Convergence Among Self-Regulated Learning Microanalytic Processes, Achievement, and a Self-Report Questionnaire. *Journal of Psychoeducational Assessment*, *33*(5), 439–450.

Cleary, T. J., Callan, G. L., & Zimmerman, B. J. (2012). Assessing Self-Regulation as a Cyclical, Context-Specific Phenomenon: Overview and Analysis of SRL Microanalytic Protocols. *Education Research International*, *2012*, e428639. https://doi.org/10.1155/2012/428639

Cresswell, J. W. (2017). Choosing a mixed methods design. In J. W. Cresswell & V. L. Plano Clark (Eds.), *Designing and Conducting Mixed Methods Research* (pp. 58–88). SAGE Publications. https://us.sagepub.com/en-us/nam/designing-and-conducting-mixed-methods-research/book241842

Cresswell, J. W., & Plano Clark, V. L. (2017). *Designing and Conducting Mixed Methods Research* (3rd ed.). SAGE Publications. https://us.sagepub.com/en-us/nam/node/52708/print

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Day, S. P., & Bryce, T. G. K. (2011). Does the Discussion of Socio-Scientific Issues require a Paradigm Shift in Science Teachers' Thinking? *International Journal of Science Education*, *33*(12), 1675–1702. https://doi.org/10.1080/09500693.2010.519804

Demetriou, H. (2013). The Case Study. In E. Wilson (Ed.), *School-based Research: A guide for education students* (2nd ed.). SAGE Publications.

Denley, P., & Bishop, K. (2010). The potential of using stimulated recall approaches to explore teacher thinking. In S. Rodrigues (Ed.), *Using analytical frameworkds for classroom research: Collecting data and anaylsing narrative* (pp. 109–124). Routledge.

Dignath, C., Buettner, G., & Langfeldt, H.-P. (2008). How can primary school students learn self-regulated learning strategies most effectively?: A meta-analysis on self-regulation training programmes. *Educational Research Review*, *3*(2), 101–129. https://doi.org/10.1016/j.edurev.2008.02.003

Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, *3*(3), 231–264. https://doi.org/10.1007/s11409-008-9029-x

Dignath, C., & Büttner, G. (2018). Teachers' direct and indirect promotion of self-regulated learning in primary and secondary school mathematics classes – insights from video-based classroom observations and teacher interviews. *Metacognition and Learning*. https://doi.org/10.1007/s11409-018-9181-x

Efklides, A. (2011). Interactions of Metacognition With Motivation and Affect in Self-Regulated Learning: The MASRL Model. *Educational Psychologist*, *46*(1), 6–25. https://doi.org/10.1080/00461520.2011.538645

Ellefson, M. R., Baker, S. T., & Gibson, J. L. (2018). Lessons for Successful Cognitive Developmental Science in Educational Settings: The Case of Executive Functions. *Journal of Cognition and Development*. https://www.tandfonline.com/doi/pdf/10.1080/15248372.2018.1551219?needAccess=true

Ellefson, M. R., Baker, S. T., & Gibson, J. L. (2019). Lessons for Successful Cognitive Developmental Science in Educational Settings: The Case of Executive Functions. *Journal of Cognition and Development*, *20*(2), 253–277. https://doi.org/10.1080/15248372.2018.1551219

Endedijk, M. D., Brekelmans, M., Sleegers, P., & Vermunt, J. D. (2016). Measuring students' self-regulated learning in professional education: Bridging the gap between event and aptitude measurements. *Quality & Quantity*, *50*(5), 2141–2164. https://doi.org/10.1007/s11135-015-0255-4

Ercikan, K., & Roth, W.-M. (2006). What Good Is Polarizing Research Into Qualitative and Quantitative? *Educational Researcher*, *35*(5), 14–23. https://doi.org/10.3102/0013189X035005014

Erickson, F. (1986). Qualitiative Methods in Research on Teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 119–161). Macmillan Publishing Company.

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing Naturalistic Inquiry: A Guide to Methods* (1st ed.). SAGE Publications.

Eshel, Y., & Kohavi, R. (2003). Perceived Classroom Control, Self-Regulated Learning Strategies, and Academic Achievement. *Educational Psychology*, *23*(3), 249–260. https://doi.org/10.1080/0144341032000060093

Flinders, D. J. (1992). In search of ethical guidance: Constructing a basis for dialogue 1. *International Journal of Qualitative Studies in Education*, *5*(2), 101–115. https://doi.org/10.1080/0951839920050202

Flyvberg, B. (2004). Five misunderstandings about case study research. In C. Seale & G. Gobo (Eds.), *Qualitative research practice* (pp. 390–404). SAGE Publications.

Freebody, P. R. (2003). *Qualitative Research in Education: Interaction and Practice*. SAGE Publications. https://methods.sagepub.com/book/qualitative-research-in-education

Grau, V., Lorca, A., Araya, C., Urrutia, S., Ríos, D., Montagna, P., & Ibaceta, M. (2018). Socially Shared Regulation of Learning and Quality of Talk: Age Differences in Collaborative Group Work in Classroom Contexts. *New Directions for Child and Adolescent Development*, *2018*(162), 11–39. https://doi.org/10.1002/cad.20261

Grau, V., & Whitebread, D. (2012). Self and social regulation of learning during collaborative activities in the classroom: The interplay of individual and group cognition. *Learning and Instruction*, *22*(6), 401–412. https://doi.org/10.1016/j.learninstruc.2012.03.003

Grolnick, W. S., & Ryan, R. M. (1987). Autonomy in children's learning: An experimental and individual difference investigation. *Journal of Personality and Social Psychology*, *52*(5), 890–898. https://doi.org/10.1037/0022-3514.52.5.890

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In *Handbook of qualitative research* (pp. 105–117). SAGE Publications.

Gumperz, J. J., & Hymes, D. H. (1972). *Directions in sociolinguistics: The ethnography of communication*. Holt, Rinehart and Winston.

Hadwin, A. F., & Järvelä, S. (2011). Introduction to a special issue on social aspects of self-regulated learning: Where social and self meet in the strategic regulation of learning. *Teachers College Record*, *113*(2), 235–239.

Hadwin, A. F., Järvelä, S., & Miller, M. (2011). Self-Regulated, Co-Regulated and Socially Shared Regulation of Lerning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Handbook of Self-Regulation of Learning and Performance*. Routledge.

Hadwin, A. F., Järvelä, S., & Miller, M. (2016). Self-regulation, co-regulation and shared regulation in collaborative learning environments. *Handbook of Self-Regulation of Learning and Performance. New York: Routledge*.

Hadwin, A. F., Nesbit, J. C., Jamieson-Noel, D., Code, J., & Winne, P. H. (2007). Examining trace data to explore self-regulated learning. *Metacognition and Learning*, *2*(2–3), 107–124. https://doi.org/10.1007/s11409-007-9016-7

Hargreaves, L., & Wolfe, S. (2007). Observing closely to see more clearly. In J. Moyles (Ed.), *Beginning teaching, beginning learning* (pp. 205–220). Open University Press.

Hennessy, S., Howe, C., Mercer, N., & Vrikki, M. (2020). Coding classroom dialogue: Methodological considerations for researchers. *Learning, Culture and Social Interaction*, *25*(100404). https://doi.org/10.1016/j.lcsi.2020.100404

Hennessy, S., Rojas-Drummond, S., Higham, R., Márquez, A. M., Maine, F., Ríos, R. M., García-Carrión, R., Torreblanca, O., & Barrera, M. J. (2016). Developing a coding scheme for analysing classroom dialogue across educational contexts. *Learning, Culture and Social Interaction*, *9*, 16–44. https://doi.org/10.1016/j.lcsi.2015.12.001

Holloway, I. (1997). *Basic Concepts for Qualitative Research*. Wiley.

Hymes, D. (1964). Introduction: Toward Ethnographies of Communication. *American Anthropologist*, *66*(6), 1–34. JSTOR.

Iiskala, T., Vauras, M., Lehtinen, E., & Salonen, P. (2011). Socially shared metacognition of dyads of pupils in collaborative mathematical problem-solving processes. *Learning and Instruction*, *21*(3), 379–393. https://doi.org/10.1016/j.learninstruc.2010.05.002

Isohätälä, J., Järvenoja, H., & Järvelä, S. (2017). Socially shared regulation of learning and participation in social interaction in collaborative learning. *International Journal of Educational Research*, *81*, 11–24. https://doi.org/10.1016/j.ijer.2016.10.006

Janssen, J., Erkens, G., Kirschner, P. A., & Kanselaar, G. (2012). Task-related and social regulation during online collaborative learning. *Metacognition and Learning*, *7*(1), 25–43. https://doi.org/10.1007/s11409-010-9061-5

Järvelä, S., & Hadwin, A. F. (2013). New Frontiers: Regulating Learning in CSCL. *Educational Psychologist*, *48*(1), 25–39. https://doi.org/10.1080/00461520.2012.748006

Järvelä, S., & Järvenoja, H. (2011). Socially Constructed Self-Regulated Learning and Motivation Regulation in Collaborative Learning Groups. *Teachers College Record*, *113*(2), 350–374.

Järvelä, S., Järvenoja, H., Malmberg, J., & Hadwin, A. F. (2013). Exploring Socially Shared Regulation in the Context of Collaboration. *Journal of Cognitive Education and Psychology*, *12*(3), 267–286. https://doi.org/10.1891/1945-8959.12.3.267

Järvelä, S., Malmberg, J., & Koivuniemi, M. (2016). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learning and Instruction*, *42*(Supplement C), 1–11. https://doi.org/10.1016/j.learninstruc.2015.10.006

Järvelä, S., Volet, S., & Järvenoja, H. (2010). Research on Motivation in Collaborative Learning: Moving Beyond the Cognitive–Situative Divide and Combining Individual and Social Processes. *Educational Psychologist*, *45*(1), 15–27. https://doi.org/10.1080/00461520903433539

Järvenoja, H., Järvelä, S., & Malmberg, J. (2015). Understanding Regulated Learning in Situative and Contextual Frameworks. *Educational Psychologist*, *50*(3), 204–219. https://doi.org/10.1080/00461520.2015.1075400

Järvenoja, H., Volet, S., & Järvelä, S. (2013). Regulation of emotions in socially challenging learning situations: An instrument to measure the adaptive and social nature of the regulation process. *Educational Psychology*, *33*(1), 31–58. https://doi.org/10.1080/01443410.2012.742334

Kapur, M. (2011). Temporality matters: Advancing a method for analyzing problem-solving processes in a computer-supported collaborative environment. *International Journal of Computer-Supported Collaborative Learning*, *6*(1), 39–56. https://doi.org/10.1007/s11412-011-9109-9

Keefer, M. W., Zeitz, C. M., & Resnick, L. B. (2000). Judging the Quality of Peer-Led Student Dialogues. *Cognition and Instruction*, *18*(1), 53–81. https://doi.org/10.1207/S1532690XCI1801_03

Kingir, S., Tas, Y., Gok, G., & Vural, S. S. (2013). Relationships among constructivist learning environment perceptions, motivational beliefs, self-regulation and science achievement. *Research in Science & Technological Education*, *31*(3), 205–226. https://doi.org/10.1080/02635143.2013.825594

Lajoie, S. P., & Lu, J. (2012). Supporting collaboration with technology: Does shared cognition lead to co-regulation in medicine? *Metacognition and Learning*, *7*(1), 45–62. https://doi.org/10.1007/s11409-011-9077-5

Larson, B. E. (2000). Classroom discussion: A method of instruction and a curriculum outcome. *Teaching and Teacher Education*, *16*(5–6), 661–677. https://doi.org/10.1016/S0742-051X(00)00013-5

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE Publications. https://us.sagepub.com/en-us/nam/naturalistic-inquiry/book842

Malmberg, J., Järvelä, S., & Järvenoja, H. (2017). Capturing temporal and sequential patterns of self-, co-, and socially shared regulation in the context of collaborative learning. *Contemporary Educational Psychology*, *49*, 160–174. https://doi.org/10.1016/j.cedpsych.2017.01.009

Malterud, K. (2001). Qualitative research: Standards, challenges, and guidelines. *The Lancet*, *358*(9280), 483–488. https://doi.org/10.1016/S0140-6736(01)05627-6

McCaslin, M. M., & Burross, H. L. (2011). Research on individual differences within a sociocultural perspective. *Teachers College Record*, *113*(2), 325–349.

Mercer, N. (2010). The analysis of classroom talk: Methods and methodologies. *British Journal of Educational Psychology*, *80*(1), 1–14. https://doi.org/10.1348/000709909X479853

Mercer, N. (2013). The Social Brain, Language, and Goal-Directed Collective Thinking: A Social Conception of Cognition and Its Implications for Understanding How We Think, Teach, and Learn. *Educational Psychologist*, *48*(3), 148–168. https://doi.org/10.1080/00461520.2013.804394

Mercer, N., & Howe, C. (2012). Explaining the dialogic processes of teaching and learning: The value and potential of sociocultural theory. *Learning, Culture and Social Interaction*, *1*(1), 12–21. https://doi.org/10.1016/j.lcsi.2012.03.001

Mercer, N., & Littleton, K. (2007). *Dialogue and the Development of Children's Thinking: A Sociocultural Approach*. Routledge.

Mercer, N. M., & Hodgkinson, S. (2008). *Exploring Talk in School*. SAGE Publications.

Meyer, D. K., & Turner, J. C. (2002). Using Instructional Discourse Analysis to Study the Scaffolding of Student Self-Regulation. *Educational Psychologist*, *37*(1), 17–25. https://doi.org/10.1207/S15326985EP3701_3

Mitchell, J. C. (1983). Case and situation analysis. *The Sociological Review*, *31*(2), 187–211. https://doi.org/10.1111/j.1467-954X.1983.tb00387.x

Molenaar, I., & Järvelä, S. (2014). Sequential and temporal characteristics of self and socially regulated learning. *Metacognition and Learning*, *9*(2), 75–85. https://doi.org/10.1007/s11409-014-9114-2

Morse, J. M. (1991). Approaches to Qualitative-Quantitative Methodological Triangulation. *Nursing Research*, *40*(2), 120–123.

Mortimer, E. F., & Scott, P. H. (2003). *Meaning Making in Secondary Science Classrooms*. Open University Press.

Nolen, S. B., & Ward, C. J. (2008). Sociocultural and situative approaches to studying motivation. In M. L. Maehr, S. Karabenick, & T. Urdan (Eds.), *Advances in Motivation and Achievement: Social psychological perspectives on motivation and achievement* (pp. 425–460). Emerald. http://commonweb.unifr.ch/artsdean/pub/gestens/f/as/files/4655/16700_150758.pdf

Pajares, F. (2008). Motivational Role of Self-Efficacy Beliefs in Self-Regulated Learning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Educational Psychology Handbook: Handbook of Self-Regulation of Learning and Performance* (pp. 111–140). Taylor & Francis Group.

Panadero, E. (2017). A Review of Self-regulated Learning: Six Models and Four Directions for Research. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.00422

Panadero, E., & Järvelä, S. (2015). Socially shared regulation of learning: A review. *European Psychologist*, *20*(3), 190–203. https://doi.org/10.1027/1016-9040/a000226

Panadero, E., Klug, J., & Järvelä, S. (2016). Third wave of measurement in the self-regulated learning field: When measurement and intervention come hand in hand. *Scandinavian Journal of Educational Research*, *60*(6), 723–735. https://doi.org/10.1080/00313831.2015.1066436

Patrick, H., & Middleton, M. J. (2002). Turning the Kaleidoscope: What We See When Self-Regulated Learning is Viewed With a Qualitative Lens. *Educational Psychologist*, *37*(1), 27–39. https://doi.org/10.1207/00461520252828537

Patton, M. Q. (2014). *Qualitative Research & Evaluation Methods* (4th ed.). SAGE Publications. https://us.sagepub.com/en-us/nam/qualitative-research-evaluation-methods/book232962

Perry, N. E. (1998). Young children's self-regulated learning and contexts that support it. *Journal of Educational Psychology*, *90*(4), 715–729. https://doi.org/10.1037/0022-0663.90.4.715

Perry, N. E. (2013). Understanding classroom processes that support children's self-regulation of learning. In C. Howe, D. Whitebread, N. Mercer, & A. Tolmie (Eds.), *Self-regulation and dialogue in primary classrooms* (pp. 45–67). British Psychological Society.

Perry, N. E., & Rahim, A. (2011). Studying Self-Regulated Learning in Classrooms. In B. J. Zimmerman & D. H. Schunk (Eds.), *Educational Psychology Handbook: Handbook of Self-Regulation of Learning and Performance*. Routledge.

Perry, N. E., VandeKamp, K. O., Mercer, L. K., & Nordby, C. J. (2002). Investigating Teacher-Student Interactions That Foster Self-Regulated Learning. *Educational Psychologist*, *37*(1), 5–15. https://doi.org/10.1207/S15326985EP3701_2

Piaget, J. (1975). *L'équilibration des structures cognitives: Problème central du développement [Equilibriation of cognitive structures: The central problem of development]*. Presses Universitaires de France.

Pintrich, P. R. (2000a). Chapter 14—The Role of Goal Orientation in Self-Regulated Learning. In *Handbook of Self-Regulation* (pp. 451–502). Academic Press. http://www.sciencedirect.com/science/article/pii/B9780121098902500433

Pintrich, P. R. (2000b). The Role of Goal Orientation in Self-Regulated Learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 451–502). Academic Press.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & Mckeachie, W. J. (1993). Reliability and Predictive Validity of the Motivated Strategies for Learning Questionnaire (Mslq). *Educational and Psychological Measurement*, *53*(3), 801–813. https://doi.org/10.1177/0013164493053003024

Plano Clark, V. L. (2019). Meaningful integration within mixed methods studies: Identifying why, what, when, and how. *Contemporary Educational Psychology*, *57*, 106–111. https://doi.org/10.1016/j.cedpsych.2019.01.007

Plano Clark, V. L., & Sanders, K. (2015). The Use of Visual Displays in Mixed Methods Research. In M. T. McCrudden, *Use of Visual Displays in Research and Testing: Coding, Interpreting, and Reporting Data* (pp. 177–206). Information Age Publishing.

Plowright, D. (2011). *Using Mixed Methods: Frameworks for an Integrated Methodology*. SAGE Publications.

Ponitz, C. E., McClelland, M. M., Jewkes, A. M., Connor, C. M., Farris, C. L., & Morrison, F. J. (2008). Touch your toes! Developing a direct measure of behavioral regulation in early childhood. *Early Childhood Research Quarterly*, *23*(2), 141–158. https://doi.org/10.1016/j.ecresq.2007.01.004

Post, Y., Boyer, W., & Brett, L. (2006). A Historical Examination of Self-Regulation: Helping Children Now and in the Future. *Early Childhood Education Journal*, *34*(1), 5–14. https://doi.org/10.1007/s10643-006-0107-x

Punch, K. F. (2005). *Introduction to Social Research, Second Edition: Quantitative and Qualitative Approaches* (2nd ed.). SAGE Publications.

Puustinen, M., & Pulkkinen, L. (2001). Models of Self-regulated Learning: A review. *Scandinavian Journal of Educational Research*, *45*(3), 269–286. https://doi.org/10.1080/00313830120074206

Reeve, J. (2009). Why Teachers Adopt a Controlling Motivating Style Toward Students and How They Can Become More Autonomy Supportive. *Educational Psychologist*, *44*(3), 159–175. https://doi.org/10.1080/00461520903028990

Samuelstuen, M. S., & Bråten, I. (2007). Examining the validity of self-reports on scales measuring students' strategic processing. *British Journal of Educational Psychology*, *77*(2), 351–378. https://doi.org/10.1348/000709906X106147

Schepens, A., Aelterman, A., & Van Keer, H. (2007). Studying learning processes of student teachers with stimulated recall interviews through changes in interactive cognitions. *Teaching and Teacher Education*, *23*(4), 457–472. https://doi.org/10.1016/j.tate.2006.12.014

Schoor, C., & Bannert, M. (2012). Exploring regulatory processes during a computer-supported collaborative learning task using process mining. *Computers in Human Behavior*, *28*(4), 1321–1331. https://doi.org/10.1016/j.chb.2012.02.016

Schoor, C., Narciss, S., & Körndle, H. (2015). Regulation During Cooperative and Collaborative Learning: A Theory-Based Review of Terms and Concepts. *Educational Psychologist*, *50*(2), 97–119. https://doi.org/10.1080/00461520.2015.1038540

Schunk, D. H., & Ertmer, P. A. (2000). Self-regulation and academic learning: Self-efficacy enhancing interventions. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation*. Elsevier.

Seedhouse, D. D. (1988). *Ethics: The Heart of Health Care* (2nd ed.). Wiley-Blackwell.

Smith-Donald, R., Raver, C. C., Hayes, T., & Richardson, B. (2007). Preliminary construct and concurrent validity of the Preschool Self-regulation Assessment (PSRA) for field-based research. *Early Childhood Research Quarterly*, *22*(2), 173–187. https://doi.org/10.1016/j.ecresq.2007.01.002

Snape, D., & Spencer, L. (2003). The Foundations of Qualitative Research. In J. Ritchie & J. Lewis, *Qualitative research practice: A guide for social science students and researchers*. SAGE Publications.

Stake, R. (2005). Qualitiative case studies. In N. Denzin & Y. Lincoln (Eds.), *The sage handbook of qualitative research* (3rd ed., pp. 443–466). SAGE Publications.

Tang, M., & Neber, H. (2008). Motivation and self-regulated science learning in high-achieving students: Differences related to nation, gender, and grade-level. *High Ability Studies*, *19*(2), 103–116. https://doi.org/10.1080/13598130802503959

Thoutenhoofd, E. D., & Pirrie, A. (2015). From self-regulation to learning to learn: Observations on the construction of self and learning. *British Educational Research Journal*, *41*(1), 72–84. https://doi.org/10.1002/berj.3128

Tight, M. (2010). The curious case of case study: A viewpoint. *International Journal of Social Research Methodology*, *13*(4), 329–339. https://doi.org/10.1080/13645570903187181

Timmons, K., Pelletier, J., & Corter, C. (2016). Understanding children's self-regulation within different classroom contexts. *Early Child Development and Care*, *186*(2), 249–267. https://doi.org/10.1080/03004430.2015.1027699

Ucan, S. (2017). Changes in primary school students' use of self and social forms of regulation of learning across collaborative inquiry activities. *International Journal of Educational Research*, *85*, 51–67. https://doi.org/10.1016/j.ijer.2017.07.005

Ucan, S., & Webb, M. (2015). Social Regulation of Learning During Collaborative Inquiry Learning in Science: How does it emerge and what are its functions? *International Journal of Science Education*, *37*(15), 2503–2532. https://doi.org/10.1080/09500693.2015.1083634

Vann, K., & Cole, M. (2004). Method and methodology in interpretive studies of cognitive life. In Z. Todd, B. Nerlich, S. Mckeown, & D. D. Clarke, *Mixing Methods in Psychology: The Integration of Qualitative and Quantitative Methods in Theory and Practice*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/cam/detail.action?docID=199956

Veenman, M. V. J. (2011). Alternative assessment of strategy use with self-report instruments: A discussion. *Metacognition and Learning*, *6*(2), 205–211. https://doi.org/10.1007/s11409-011-9080-x

Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higer Education*, *49*, 205–234. https://doi.org/10.1007/s10734-004-6664-2

Vermunt, J. D., & Verloop, N. (1999). Congruence and friction between learning and teaching. *Learning and Instruction*, *9*(3), 257–280. https://doi.org/10.1016/S0959-4752(98)00028-0

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction*, *19*(2), 128–143. https://doi.org/10.1016/j.learninstruc.2008.03.001

Volet, S., Vauras, M., & Salonen, P. (2009). Self- and Social Regulation in Learning Contexts: An Integrative Perspective. *Educational Psychologist*, *44*(4), 215–226. https://doi.org/10.1080/00461520903213584

Vygotsky, L. S. (1978). *Mind in Society. The Development of Higher Psychological Processes*. Harvard University Press.

Wang, M.-T., & Holcombe, R. (2010). Adolescents' Perceptions of School Environment, Engagement, and Academic Achievement in Middle School. *American Educational Research Journal*, *47*(3), 633–662. https://doi.org/10.3102/0002831209361209

Weinstein, C. E., & Palmer, D. P. (2002). *Learning and Study Strategies Inventory (LASSI): User's manual* (2nd ed.). H & H Publishing.

Weinstein, C. E., Palmer, D. P., & Acee, T. W. (2016). *Learning and Study Strategies Inventory (LASSI): User's manual* (3rd ed.). H & H Publishing.

Weinstein, C. E., Schulte, A. C., & Palmer, D. P. (1987). *Learning and Study Strategies Inventory* (1st ed.). H & H Publishing.

Whitebread, D., Bingham, S., Grau, V., Pasternak, D. P., & Sangster, C. (2007). Development of Metacognition and Self-Regulated Learning in Young Children: Role of Collaborative and Peer-Assisted Learning. *Journal of Cognitive Education and Psychology*, *6*(3), 433–455. https://doi.org/10.1891/194589507787382043

Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., Almeqdad, Q., & Demetriou, D. (2009). The development of two observational tools for assessing metacognition and self-regulated learning in young children. *Metacognition and Learning*, *4*(1), 63–85. https://doi.org/10.1007/s11409-008-9033-1

Wilson, E., & Stutchbury, K. (2013). Ethics in Educational Research. In E. Wilson (Ed.), *School-based Research: A Guide for Education Students* (2nd ed., pp. 90–102). SAGE Publications.

Winne, P. H. (2014). Issues in researching self-regulated learning as patterns of events. *Metacognition and Learning*, *10*(2), 229–237. https://doi.org/10.1007/s11409-014-9113-3

Winne, P. H., Gupta, L., & Nesbit, J. C. (1994). Exploring Individual Differences in Studying Strategies Using Graph Theoretic Statistics. *Alberta Journal of Educational Research*, *40*, 177–193.

Winne, P. H., & Hadwin, A. F. (1998). Studying as Self-Regulated Learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in eductional theory and practice* (pp. 277–304). Erlbaum. http://www4.ncsu.edu/~jlnietfe/Metacog_Articles_files/Winne%20%26%20Hadwin%20%281998%29.pdf

Winne, P. H., & Perry, N. E. (2000). Measuring Self-Regulated Learning. In P. R. Pintrich & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 531–566). Academic Press. http://www.sciencedirect.com/science/article/pii/B9780121098902500457

Wolters, C. A. (2003). Regulation of Motivation: Evaluating an Underemphasized Aspect of Self-Regulated Learning. *Educational Psychologist*, *38*(4), 189–205. https://doi.org/10.1207/S15326985EP3804_1

Yin, R. K. (2013). *Case Study Research: Design and Methods*. Thousand Oaks, CA, USA.

Zheng, L., & Yu, J. (2016). Exploring the behavioral patterns of Co-regulation in mobile computer-supported collaborative learning. *Smart Learning Environments*, *3*(1). https://doi.org/10.1186/s40561-016-0024-4

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 13–35). Elsevier.

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

Zimmerman, B. J. (2008). Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects. *American Educational Research Journal*, *45*(1), 166–183. https://doi.org/10.3102/0002831207312909

Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a Structured Interview for Assessing Student Use of Self-Regulated Learning Strategies. *American Educational Research Journal*, *23*(4), 614–628. https://doi.org/10.3102/00028312023004614

Zimmerman, B. J., & Schunk, D. H. (2011). Self-Regulated Learning and Performance: An Introduction and an Overview. In B. J. Zimmerman & D. H. Schunk (Eds.), *Educational Psychology Handbook: Handbook of Self-Regulation of Learning and Performance* (pp. 1–14). Routledge.

Appendices

Appendix A: Sample Consent and Information Letters

Principal Consent Letter

Dear [Principal],

I am writing to seek permission to carry out a research project into how students regulate their behaviour and learning in the social environment of the classroom. This project will form part of my work towards a Doctor of Education degree at the University of Cambridge.

This initial stage of research will involve questionnaires, and audio-visual recordings of lessons, which will be analysed for various learning behaviours. The learning experience of the students will not be affected and permission will be sought from the students themselves throughout the project. Later stages of research may involve other data collection methods, but further permissions will be sought for these where appropriate.

All information collected as part of the study will be kept strictly confidential (subject to legal limitations). Any data generated in the course of the research may be kept securely in paper or electronic form for a period of up to five years, after which it will be destroyed.

The results of this research will be published in my Doctor of Education thesis, which will be available from the University of Cambridge Faculty of Education Library. Within this and any other publications, all participants and the school will be anonymised to ensure no data is traceable back to the source.
If you wish to discuss this project further with my supervisor, Dr Elaine Wilson, she can be contacted at ew208@cam.ac.uk. I am very grateful for your continued support.

Yours faithfully,

Mr T Harriott

By signing below, I confirm that I have read and understood the information above, and I give permission for anonymised data of students to be used in this research project. I understand that data will be kept strictly confidential and that I can withdraw my permission at any time.

Signed_____ Date_____

Student Consent Letter

Dear Student,

I am currently undertaking research towards a Doctor of Education degree from the University of Cambridge. At this early stage, the research is focussing on how students regulate their learning and behaviour in the social environment of the classroom.

I would like to request permission for the use of your data in this pilot study. This initial stage of research will involve questionnaires, and audio-visual recordings of lessons, which will be analysed for various learning behaviours. These are not detailed here so as not to affect your behaviour. Later stages of research may involve other data collection methods, but further permissions will be sought for these where appropriate. Beyond being recorded, your lessons will not be affected.

All information collected as part of the study will be kept strictly confidential (subject to legal limitations). Any data generated in the course of the research may be kept securely in paper or electronic form for a period of up to five years, after which it will be destroyed. You may withdraw your permission for the use of your data at any point.

The results of this research will be published in my Doctor of Education thesis, which will be available from the University of Cambridge Faculty of Education Library. Within this and any other publications, all participants and the school will be anonymised to ensure no data is traceable back to the source.
If you wish to discuss this project further, please feel free to contact me at the email address above, or my supervisor, Dr Elaine Wilson, at ew208@cam.ac.uk. I am very grateful for your support.

Yours sincerely,

Mr T Harriott

By signing below, I confirm that I have read and understood the information above, and I give permission for my anonymised data to be used in this research project. I understand that my data will be kept strictly confidential and that I can withdraw my permission at any time.

Full Name_____

Signed_____ Date_____

Parent Information Letter

Dear Parent/Guardian,

I am currently undertaking research towards a Doctor of Education degree from the University of Cambridge. At this early stage, the research is focussing on how students regulate their learning and behaviour in the social environment of the classroom.

I am writing to you today to inform you that your child has given permission for the use of their data in this pilot study. This initial stage of research will involve questionnaires, and audio-visual recordings of lessons, which will be analysed for various learning behaviours. These are not detailed here so as not to affect the behaviour of students. Later stages of research may involve other data collection methods, but further permissions will be sought for these where appropriate. The learning experience of the students will not be affected.

All information collected as part of the study will be kept strictly confidential (subject to legal limitations). Any data generated in the course of the research may be kept securely in paper or electronic form for a period of up to five years, after which it will be destroyed. Your child may withdraw their permission for the use of their data at any point.

The results of this research will be published in my Doctor of Education thesis, which will be available from the University of Cambridge Faculty of Education Library. Within this and any other publications, all participants and the school will be anonymised to ensure no data is traceable back to the source.

If you wish to discuss this project further, please feel free to contact me at the email address above, or my supervisor, Dr Elaine Wilson, at ew208@cam.ac.uk. I am very grateful for your support.

Yours sincerely,

Mr T Harriott

Appendix B: Fleiss' Kappa Statistics

	Planning	Monitoring	Controlling	Evaluating	Emotional/ Motivational	Disengaged	None
q	0.09	0.37	0.08	0.10	0.08	0.05	0.24
b	0.08	0.23	0.07	0.09	0.08	0.04	0.18
κ1	0.726	0.763	0.803	0.779	0.906	0.890	0.778
s.e.	0.05	0.05	0.05	0.05	0.05	0.05	0.05
z	14.83	15.57	16.39	15.90	18.51	18.17	15.88
p	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

m	3
n	139
pa	0.74
pe	0.23
κ	0.666
s.e.	0.02
z	27.80
p-value	0.00

α	0.05
lower	0.62
upper	0.71

Appendix C: Example Transcript and Coding of Video Recording

Time	Actor	Target	Transcript	Code	Notes
0:00	H	T	What do we do?	C3	H is seeking help with goal-setting
0:10	T	H	Basically you calculate the enthalpy of the reactants and products.	P5	T clarifies direction by providing a goal for H. In this sense T takes authority over planning
	H		[Writes down definition of bond enthalpy as teacher recites it]	P3	Although this could be through habit, arguably H is preparing her learning environment with this action by recording important information
1:03	H	J & T	[off-topic comment] (inaudible)	D2	H distracts others with an off-topic comment. Note that the targets get back on task, suggesting strong controlling processes.
	H		[Copies notes from board to sheet]	-	In this example, it has been judged that this is a surface-level action so does not qualify as P3.
	H		[Reading resource]	-	H is on task, but this behaviour is not an acute regulatory act
1:58	H		[Not listening to teacher, gets calculator to work out question]	EM1	Despite the interjection being by the teacher, this is coded as resisting

					distraction as H aims to complete the calculation.
2:10	J	H	Did you get minus 26?	M2	This is not explicitly comparative so is coded as reviewing progress rather than evaluative, despite the summative, closed question.
	H	J	For the first one? …No.	C2	Simple response to request.
	J	H	Yeah you break the reactants to form the products.	M5	Whilst this is feedback to H from J, it is a simple correction so M5 fits more closely than M4 or M1.
	H	J	Oh yeah… *Minus* 26?	M3	Simple correction of error.
	J	H	[Nods]	-	Not deemed to be a significant regulatory act.
3:49	Y	H	Hey [H] [turns from neighbouring desk behind H]	C3	Seeking help.
	H	Y	Yeah? [Does not turn around]	EM1	Does not get distracted, continues work, so this is coded as resisting distraction.
	Y	H	So it's reactants minus products?	C3	Seeking help. Not M2 as starting from scratch.
	H	Y	No, reactants minus products.	C2	Assisting peer.

4:21	A	H	So it's not products minus the other ones?	C3	Seeking help.
	J	A	No it's reactants minus products.	C2	Assisting peer.
	H	A	[Looks towards Anthony waiting for response]	-	Not deemed to be a significant regulatory act.
	T	J	Is it not meant to be the other way around? If it's plus there [gestures towards work] shouldn't it be minus…	M2	Reviews method. Could be coded as seeking help alongside M2, but the actor is asking to confirm a technique rather than starting from scratch.
	H	T	[Stops writing] No, no, no it's because when-	-	
4:38	J	T	-It's minus 40 minus 72.5.	C2	Assisting peer.
	H	T	No, no, no it's because you need to [gestures moving hands closer and further apart] … break the bonds but it's products that form the bonds. They get energy… [strikes desk with elbow in frustration].	M4	Reflective feedback, more metacognitive than a simple correction.
5:01	T	H	OK from 1845 to get to 1885, yeah? You need 40 right? So is it not plus 40? Like it gains, 'cause then if you do 1845 plus 40 you get 1885.	M1	Commentating on new process. Could also be coded as C1 as strategy has changed.
	H	T	Yeah, it's *plus* 40! [continues writing]	C1	Strategy has changed, this is judged to be a verbalisation of this.

5:31	Y	H	[H], did you get minus 40?	M2	
	H	Y	No, plus 40.	M3	Coded as error correction rather than assisting as it is a single correction wit no recourse to process or improvements.
	Y	H	He (teacher) said reactants minus products.	-	
	H	Y	No it's plus 40.	M3	Error correction.
6:27	H		CO_2 is carbon in the middle and O on either side so C double bond O yeah [continues writing].	M1	Commentating.
6:50	H	Y	[using calculator] [Y], it is minus.	E1	Comparative statement about final answer against previous iterations so coded as evaluation of outcomes
	Y	H	You know for that one [shows paper to H] you would normally times that by that [points].	M1	Commentating.
	H	Y	(inaudible)	-	Cannot code.
7:43	H	J & T	(inaudible – off topic)	D2	Distracting others.
7:52	H		[working despite J and T's off-topic discussion]	EM1	Resisting distraction (having initiated it).
8:20	H		[checks nails]	D1	Has lost concentration but is not distracting others.

8:28	H		[distracted by jacket]	D1	
9:42	H	Y	What did you get for question seven?	M2	Reviewing could arguably be help seeking instead.