Trust and conflict in collaborative groups in engineering education: A multi-case study of using a computer orchestrated group learning environment with neurologically typical, autistic and ADHD students.

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This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy as part of the Doctoral Programme in e-Research and Technology Enhanced Learning.

This thesis results entirely from my own work and has not been offered previously for any other degree or diploma. Word count – 68,891 (permission for an overlong thesis for 68,920 words has been received).

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Abstract

Collaborative approaches, such as Flipped Classroom and Project Based Learning, are commonly used within engineering education. Challenges linked to group-work often render these approaches ineffective, inefficient and less inclusive. Self, Co and Shared regulation scripts offer a potentially efficient way to orchestrate group-work. However, over-scripting and successful transfer of skills to un-orchestrated environments pose challenges. Trust and conflict are important for team effectiveness but they have rarely been investigated within engineering education or scripting studies. Likewise, benefits of non-social prompts for inclusiveness has not been investigated. To this end, I developed a Computer Orchestrated Group Learning Environment (COGLE), which supports and promotes cooperation, group-wide mastery and encourages teammates to come together. I investigated its impact on acquiring knowledge, skills and attitudes necessary for team working. I also studied the transfer of these newly acquired skills to an un-orchestrated setting. This research contributes to the theory around use of computer orchestration for attitudes and regulation skills development. It explores important links between team effectiveness and conflict management, self-efficacy, team-trust and regulation skills. Two literal replication cases helped verify the findings related to COGLE use and a theoretical replication helped discard the rival theory explanations. In the theoretical replication case, students orchestrated their learning and working themselves. Within-case and cross-case analysis helped generate empirical evidence used in modifying the theoretical framework. COGLE helped neuro-typical and neuro-atypical students to engage in early and often communication, experienced reduced social awkwardness, and developed trust in each other in record time. It helped transfer goal-orientedness and regulations skills to un-orchestrated team task. Neuro-typical students improved their self-efficacy with neuro-atypical not that far behind and they delivered on team tasks together. Whereas in the theoretical replication case, clique formation, low cognitive trust, low self-efficacy, delayed communication, and partial completion highlighted the challenges of un-orchestrated collaborative settings.

Keywords: Team-working, orchestration, self-efficacy, trust, conflicts, regulation of learning and scripting.

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List of publications from this research.

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2. Malik, M., & Sime, J. A. (2020, September). Preparing teams of neuro-typical and neuro atypical students with a computer orchestrated group learning environment for collaborative work: A multi case study: In *2020 48th SEFI Annual Conference* (pp. 973-984).
3. Malik, M. (2019, January). Trust and conflict in group learning: the role of computer-orchestrated learning in supporting neurologically typical and atypical students in Engineering HE provisions. In *Advance HE STEM Conference 2019: Delivering Next Generation Higher Education in STEM*.
4. Malik, M. (2018, November). Trust and Conflict in group learning: The role of computer orchestrated learning. In 6*th Engineering Education Research Network Annual Symposium*.
5. Malik, M. (2016, November). Learning within a self-organised open course in engineering. In *4th Engineering Education Research Network Annual Symposium*.

Under review

1. Trust in teammates and self-efficacy development in neuro-typical and neuro-atypical students: A multi-case study. *IEEE Transactions of Education, Special Issue (invited paper).*

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List of Abbreviations

ADHD	-	Attention Deficit Hyperactivity Disorder
ASD	-	Autistic Spectrum Disorder
CM	-	Conflict Management
COGLE	-	Computer Orchestrated Group Learning Environment
COLT	-	Computer Orchestrated Learning Together
CoRL	-	Co-Regulation of Learning or Co-Regulated Learning
CSCL	-	Computer Supported Collaborative Learning
EE	-	Engineering Education
EER	-	Engineering Education Research
FC	-	Flipped Classroom
GWM	-	Group-Wide Mastery
HE	-	Higher Education
HEI	-	Higher Education Institution
IOP	-	Industrial and Organisational Psychology
LT	-	Learning Together
MCQ	-	Multiple Choice Question
MIT	-	Massachusetts Institute of Technology
MKO	-	More Knowledgeable Others
NAT	-	Neuro Atypical
NLG	-	Normalised Learning Gain
NT	-	Neuro Typical
Op Amp	-	Operational Amplifiers
PI	-	Peer Instruction
PjBL	-	Project Based Learning
QR	-	Quick Response
RQ	-	Research Question
SDT	-	Self-Determinism Theory
SGT	-	Script Guidance Theory
SOLT	-	Student Orchestrated Learning Together
SOWT	-	Student Orchestrated Working Together
SRL	-	Self-Regulation of Learning or Self-Regulated Learning
SSRL	-	Socially Shared Regulation of Learning
TEL	-	Technology Enhanced Learning
TIDEE	-	Transferable Integrated Design Engineering Education
UCL	-	University College London

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Chapter 1: Introduction

1.1 Background

Effective team working skills are an essential hallmark of graduates. In engineering, these skills play a crucial role in the success of real-world open-ended projects and are therefore in high demand by employers. In response to these demands and the requirements from the accrediting professional bodies, Engineering Education (EE) curricula in UK universities and beyond, have seen an increased adoption of collaborative approaches (Markes, 2006; Passow & Passow, 2017; Winberg et al., 2020). The assumption being that such approaches helps develop these skills in graduates (Bishop & Verleger, 2013; Jollands et al., 2012; Karabulut-Ilgu et al., 2018). Besides, learning too, as measured by performance of engineering students, is more effective in groups than individually with effect sizes varying from (Cohen's d=0.25) (Springer et al., 1999) to more recently (d=0.85) (C.-H. Chen & Yang, 2019).

Project Based Learning (PjBL) is an example of this approach and it involves teams of students resolving complex real-world problems (Graham, 2010; Hanney & Savin-Baden, 2013; Harmer & Stokes, 2014; Hmelo-Silver, 2004; Kennedy & Odell, 2014). In PjBL, the real-world project drives the student learning and engagement with content as needed. Flipped Classroom (FC), another example of this approach, also has been widely adopted by EE practitioners (Bishop & Verleger, 2013; Karabulut-Ilgu et al., 2018). Here students prepare, outside the classroom, individually for in-class collaborative active learning activities (Bishop & Verleger, 2013; Karabulut-Ilgu et al., 2018). A shift from a teacher-centric model, involving dissemination of information, to a more student-centric model, which involves more interactions, is what leads to skills development (J. Chen et al., 2020).

At this stage, I feel it is necessary to say what I mean by collaborative and cooperative approaches throughout this thesis. A detailed discussion around these is presented in section 2.1 as well. Whilst both collaborative and cooperative learning can be seen as constructivist approaches, PjBL and FC represent collaborative approaches. As highlighted by Bruffee (1995), Davidson & Major, (2014), Smith, (1992) and Forrestal in (Brubacher et al., 1990), in *collaborative learning* students work together on a *shared goal* of solving problems, designing projects and doing activities for enhancing learning. For these to be successful, they need to have some *pre-existing domain knowledge* in relation to the activity, problem or project they are working on (ibid). They may *extend their knowledge* and *skills* in the collaborative learning process as they apply their existing knowledge in achieving their *shared* goal (ibid). They may occasionally or regularly come *together* to *plan, carry out the work, monitor progress* and *review it* in order to meet their *shared goal* (ibid). However, as described in the next section, staff and students involved in their first year of an undergraduate engineering degree courses may face many challenges in sustaining these collaborative approaches. Staff here are expected to facilitate the collaboration to deliver the shared design, product or learning outcome.

Cooperative learning (see section 2.1 for more details) on the other hand, focuses on developing a perception that a teammate is linked with other teammates and that they cannot succeed without each other in their *mutual goal* (Davidson & Worsham, 1992; D. W. Johnson, 1991; Millis & Cottell Jr, 1997; Johnson & Johnson, 2002). Success in c*ooperative learning* is seen as *acquiring* the *knowledge, social and group processing skills* that may often be needed and assumed in PjBL, FC and other collaborative settings. *Learning together* fits well with the definition of *cooperative learning* (Johnson & Johnson, 2002). A computer orchestrated version of *learning together*, is used in this study to help students acquire knowledge by all teammates before asking them to apply their knowledge and skills to work on FC or PjBL activities and in the process extend their learning and skills further. The hope here is that this approach will also result in acquiring teamworking skills by all teammates.

1.2 Problem Statement

The effect sizes of collaborative approaches stated earlier are good but simply putting students in groups is often mistaken as a panacea (Volet et al., 2009). Using such approaches for developing knowledge and team working skills in first year undergraduate engineering degree student population, can actually be ineffective, inefficient and non-inclusive in practice.

Even trained staff have reported problems in the early stages of adopting PjBL or FC approaches (Bishop & Verleger, 2013; J. Chen et al., 2020). Students, too, may not engage due to an increased cognitive load linked to learning new content alongside development of interpersonal skills (ibid). This can force staff to flip back to teacher-centric approaches increasing their efforts and inefficiencies (ibid). Furthermore, social loafing poses a threat to effective teamwork (Borrego et al., 2013). Likewise, students, when grouped with unprepared students in FC, may perceive the collaborative in-class activities as unfair and ineffective, limiting the intended benefits for each student (Akçayır & Akçayır, 2018).

Diagnosis rates of neurologically atypical students (NAT) show that more NAT students are entering higher education today (Colorosa & Makela, 2014, HESA, 2021). NAT is an umbrella term for socio-communication disorders such as Attention Deficit Hyperactivity Disorder (ADHD) and Autistic Spectrum Disorder (ASD) (ibid).

Furthermore, NAT students are more likely to enrol on engineering and technology courses than other courses but are also at a disadvantage in collaborative settings without reasonable or other adjustments (Colorosa & Makela, 2014). Students in collaborative settings may face “a form of oppression and control” from their teammates, challenging the inclusivity of this approach (Ferreday & Hodgson, 2008, p. 640). For example, a vociferous student may pose a challenge to quieter and/or student(s) with socio-emotional, communicative or cognitive disorders, which may cause conflicts or cliques within teams (A. H. Anderson et al., 2018; Graham, 2010; Hanney & Savin-Baden, 2013; Harmer & Stokes, 2014; Sajadi & Khan, 2011). Besides, the practical demands on students of engaging in collaborative approaches, like PjBL and FC, can limit the effectiveness for many un/diagnosed NAT students but also some neuro-typical (NT) students (Kokotsaki et al., 2016; Taylor, 2005).

Irrespective of the NAT student numbers, under the Equality Act 2010 and the UN convention (GOV.UK, 2021), Higher Education Institutions (HEIs) are legally obliged to make reasonable adjustments for such students, when placed at a substantial disadvantage over students without disabilities. However, reasonable adjustments, such as individual assignments instead of group ones may amount to depriving the NAT students from developing skills needed in industry.

Many skills development initiatives acknowledge the inherent barriers linked to group-working, e.g., MIT’s GEL programme or Aalborg University’s PjBL programme on Leadership skills (Harmer & Stokes, 2014), Cooperative learning, Project Management (Lehmann et al., 2008) and group-work; ASD learners too, get separate social skills training (Barnhill, 2016; Chown et al., 2018). However, such non-contextual support can be ineffective and inefficient.

The demands of collaborative approaches make it very resource intensive, non-inclusive and ineffective in practice. Inclusive approaches for developing group-working skills for both NT and NAT students together may increase efficiency but these are rare (Taylor, 2005). This puts collaborative approaches at risk compared to teacher-centric or other approaches and engineering schools are either turning their backs to PjBL and FC (J. Chen et al., 2020; Graham, 2010) or have not adopted them.

In summary, a rethink, one that learns from other related disciplines such as Educational Psychology, Industrial and Organisational Psychology (IOP) and Computer Supported Collaborative Learning (CSCL), is needed to make collaborative approaches more effective, efficient and inclusive.

1.3 Purpose of this research

Zimmerman's (1989) socio-cognitive model of self-regulation of learning (SRL) and its extension by scholars through socio-cultural influences (Hadwin et al., 2018; Järvenoja et al., 2017) presents an opportunity for the much needed rethink highlighted above.

Several CSCL and Psychology researchers have focused on conflict, social loafing, communication, self-regulation and co-regulation in student teams over the past two decades (Dillenbourg & Hong, 2008; Fischer et al., 2013; Malmberg et al., 2017; Vogel et al., 2017). CSCL developers use Script Guidance Theory (SGT) for scripting conflicts to enable learning and to scaffold collaboration skills development (Fischer et al., 2013).

Over-scripting and multiple points of failure linked with scripting multiple stages have prevented successful interventions and progress in research on scripting Socially Shared Regulation of Learning (SSRL). Though there is limited success with scripting of

SSRL, scripting of self and co-regulation of learning (CoRL) has helped learners improve their group-awareness, socio-metacognitive and socio-emotional regulation skills (Bakhtiar et al., 2018; Borge et al., 2018; Dillenbourg, 1999; Näykki et al., 2017; Tchounikine, 2016; Winne & Nesbit, 2009). Orchestrating interactions through scripts has shown to have a small positive effect on learning (Hedge's g=0.24) and a medium positive effect on developing collaboration skills (Hedge's g=0.74) (Radkowitsch et al., 2020). Much of this research has been exploratory and in laboratories and no one has looked at the role of trust in all this, in much detail or reported successful internalisation of scripts.

Within EE, (Borrego et al., 2013) also highlights multiple models involving constructs such as social loafing, trust, conflict and team interdependence for improving team effectiveness. They call for EE researchers to focus on multiple psychological constructs, in real teams, thereby 'embracing the complexity' that is often left out in single construct, experimental psychology studies. Scripted interventions that promote regulation of learning thus promise to be an efficient way to reduce the cognitive load on students and the workload of staff engaged in collaborative approaches, but such studies are rare within EE. Therefore, more research is needed to advance both CSCL and EE, in particular around successful transfer of scripted skills to un-scripted environments and orchestrating SSRL successfully for NT and NAT students.

To this end, a contextual teacher-less intervention, called Computer Orchestrated Group Learning Environment (COGLE), see next section and chapter 3, which orchestrates interactions for learning and skills development was investigated for its effectiveness, efficiency and inclusiveness. This multi-case mixed methods research study holistically compares and contrasts the findings from two Computer Orchestrated

Learning Together (COLT) settings and one Student Orchestrated Learning Together (SOLT) setting, using triangulation to make a more valid, reliable and analytically generalisable contribution in this area (Leung, 2015).

In summary, this study addresses the gaps identified in CSCL and EE practice and research on: how to use technology to support on-campus NT, and NAT students in learning and developing their attitudes and skills for effective collaboration (see Chapter 2). By investigating the interrelationship between trust, conflict and its management in scripted interactions between NT and NAT students, this research contributes to the emerging CSCL literature on scripting regulation skills. This study also investigates how well these skills transfer to Student Orchestrated Working Together (SOWT) settings, without computer orchestration, which addresses yet another gap in the scripting literature.

1.4 COGLE

As highlighted above, CSCL systems can help free up resources needed in orchestrating learning and skills development. Most orchestration systems aid teachers in managing interactivity in class (Crouch & Mazur, 2001; Dillenbourg & Jermann, 2010). However, COGLE can be seen as a *cooperative learning* tool, which promises to be efficient as it is a teacher-less COLT system, which orchestrates peer-instruction (PI) and group-wide mastery (GWM) in small face-to-face groups, using a flexible PI script and a coercive GWM macro-script respectively. COLT may help with NAT and NT students interact with each other in a balanced way. Its support and repetitive nature may help with the internalisation of the skills being orchestrated.

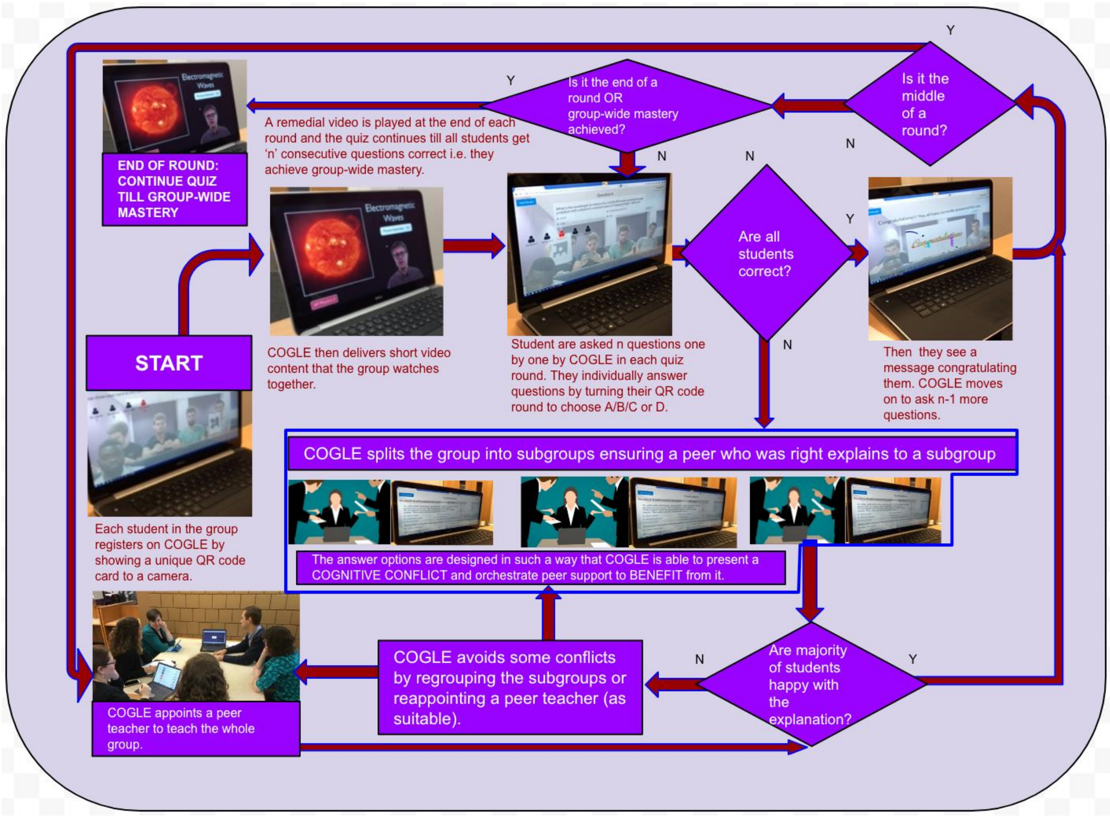

Figure 1 How COGLE works.

GWM, as opposed to individual mastery (Bloom, 1968), is a point when all students in a group, consecutively answer correctly a preset target number of questions. COGLE coerces teammates to work together to achieve this common goal, by resetting the target even if just one teammate answers incorrectly as a *penalty*. The PI-script pairs students with *conflicting* answer options to discuss a question after each mistake. Alternatively, students can also discuss things themselves. COGLE allows deferring discussion when *cognitive-conflicts* are unresolved and later also plays a remedial video on concepts causing conflicts. It shares performance data, with every teammate. See **Figure 1** and Chapter 3 for more details. COLT therefore has all the features of cooperative *learning* (see section 2.1).

1.5 Theoretical Framework

The theoretical framework guiding this study, see **Figure 2**, focusses on several factors that enhance team effectiveness and satisfaction. After reviewing educational psychology, CSCL, IOP and EE literature, as detailed in Chapter 2, scripting interactions and constructs such as trust, Conflict Management (CM) skills, SRL, CoRL, SSRL were included. Avoiding conflict or using a preferred but irrelevant CM style, may lead to group dysfunction and reduce team effectiveness (Staggers et al., 2008). The framework shows healthy and dysfunctional Conflicts may have a formative role in Trust (McAllister, 1995) alongside other factors like past performance, citizenship and interaction frequency (Bakhtiar et al., 2018; Ebert, 2009; D. Johnson & Grayson, 2005; McAllister, 1995). The IOP literature suggests that the absence of trust in teams also underlines group dysfunction (Lencioni, 2006).

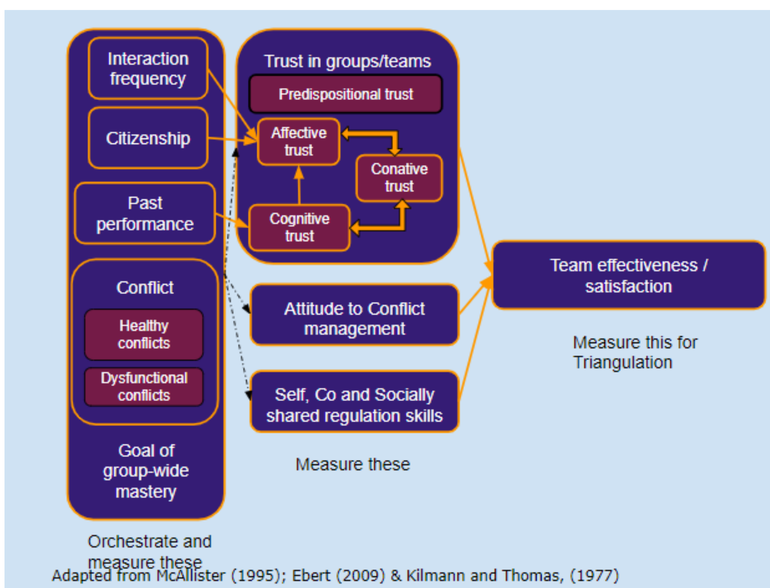

Figure 2 Theoretical framework.

Whereas, the presence of trust increases the chances of conflict resolution and team effectiveness and satisfaction (J. C. Anderson & Narus, 1990; R. M. Morgan &

Hunt, 1994). Ebert (2009) identified the debate on the direction of causality between trust and conflict, with researchers supporting both directions e.g., (J. C. Anderson & Narus, 1990; R. M. Morgan & Hunt, 1994) respectively. In COLT or SOLT settings either COGLE or a master orchestrator student orchestrates interactions between teammates, giving the opportunity to measure the antecedents of trust and regulation skills development as well as measure trust, regulations skills and their outcomes for triangulation purposes, contributing to relevant theories.

1.6 Research Questions

Supporting team skills development, as opposed to assuming that it gets developed, alongside supporting learning goals through computer orchestration may be an efficient, effective and inclusive way to enhance team effectiveness and satisfaction within EE (PjBL or FC) settings. COLT (or COGLE) may trigger and internalise regulation skills at Self, Co and Shared levels and suitable CM styles; help develop trust in each other and; encourage learning through its GWM goal of engineering topics. SOLT may equally achieve the same. Therefore, the research questions are:

RQ 1. How does learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated settings?

RQ 1.1 How does learning together in small groups affects a learner's attitude to conflict management?

RQ 1.2 How does learning together in small groups affects a learner's development of trust in their teammates?

1.7 Overview of Thesis

The overall focus of this study is on understanding how to make collaborative approaches inclusive, efficient and effective. This unique study fills several gaps identified in the literature review (see Chapter 2). Details of the research design and methodology are described in chapter 3. The case summaries in chapters 4 and 5 investigate the impact of COLT (two cases) on learning and team working skills of NT and NAT learners and chapter 6 does this for a SOLT case. This allowed the comparison of fostering through scripting a simple single goal of GWM and the computer orchestration of conflict presentation, its resolution and monitoring with the student-led interactions in the SOLT case. This helped investigate how NT and NAT students develop team trust, self-efficacy, and CM and regulation skills over several Learning Together (LT) sessions. Additionally, I investigated a SOWT activity to compare how COLT and SOLT impacts transfer of skills to un-orchestrated environments. Chapter 7 is dedicated to "lessons learned" by comparing the experiences within the three cases in relation to just the NAT participants. Likewise, Chapter 8 presents the results of pattern matching in the empirical data extracted from the three cases studies. Finally, Chapter 9 presents a discussion of the results in relation to the extant literature and presents the contributions of this work to theory, research methodology and practice. I show how some elements of SSRL were indeed internalised and used during the SOWT activity and highlight the importance of trust, self-efficacy and self-regulation for inclusive and efficient learning and team work skills development, which led to effective team working in COLT cases.

Chapter 2: Literature Review

Collaborative approaches, like PjBL, face several challenges as highlighted before. HEIs, including engineering schools, in the UK are either turning their backs on PjBL or are having to invest in extra support for developing team skills on top of domain knowledge teaching (Graham, 2010; Harmer & Stokes, 2014; Kokotsaki et al., 2016; Lehmann et al., 2008). FC also faces some of the problems faced by PjBL due to its collaborative nature (Karabulut-Ilgu et al., 2018). PjBL, FC, cooperative and collaborative learning all combine active and social learning, via peer interactions in small groups and therefore it is important to understand the differences to improve their effectiveness, efficiency and inclusiveness.

In order to understand how team effectiveness and efficiency can be improved for NT, ASD and ADHD learners a review of Engineering Education Research (EER), IOP, Technology Enhanced Learning (TEL) and CSCL literature was carried out. The main findings, which informed the research questions, are summarised in this chapter.

1. Depending on the amount of scaffolding needed, success in teamwork can come from cooperative and/or collaborative learning and working.
2. Incorrect focus on collaborative learning and working, instead of cooperative learning, at early stages of a degree programme that use FC or PjBL can render it ineffective and inefficient.
3. Many models for team effectiveness acknowledge reduction in social loafing as beneficial. Some models seek to avoid conflicts, whilst others suggest actively mining and resolving cognitive and conative conflicts as healthy.
4. Trust leads to team effectiveness and conflict resolution but we know little of how trust develops in short lived educational teams.

5. Self, Co and Shared regulation of learning and self-efficacy can lead to team effectiveness. However, contemporary educational psychology studies, including CSCL scripting studies have focused only on how these skills are developed and interlinked.
6. Successful inclusive interventions for developing team-working skills are rare. CSCL scripting offers some hope to realise inclusive, effective and efficient interventions.

Researchers and practitioners use the two terms, cooperative and collaborative learning, interchangeably. In reality, the two approaches have developed independently over a long time with important differences (Davidson & Major, 2014). The advent of learning technologies has also played a part in blurring the boundaries between the collaborative, cooperative learning. Crouch and Mazur's Peer Instruction (Crouch & Mazur, 2001) and Lyman's Think Pair Share (Lonchamp, 2012) approaches are a case in point. Further, replacing the term 'learning' with 'working' in these two terms also causes some confusion, which I aim to clarify. Group-working in everyday practice also does not conform to a pure form of either cooperative or collaborative, adding to confusion about these two terms (Ibid). There are similarities too between the two but for this research, I would like to point out the differences and their relationship with PjBL and FC activities from the outset.

2.1 Cooperative vs Collaborative Learning and Working

Innovators from separate disciplines, than those who developed collaborative learning, were involved in developing cooperative learning. They have separate research identities, in the shape of different conferences and journals. Despite this, the interrelationship between psychological constructs such as trust and conflict and its links with team skills development remains understudied.

Davidson & Major (2014), identified several works (Davidson & Worsham, 1992; D. W. Johnson, 1991; Millis & Cottell Jr, 1997) from primary through to higher education and highlighted the critical attributes of cooperative learning relevant to HE as:

1. Positive interdependence – having mutual goals and mutual respect/reward help learners stick together.
2. Individual and group accountability – the focus is on each person's and the group's development and outcomes.
3. Equal participation – like in an enjoyable game, you cannot play alone.
4. Simultaneous interaction – again like in an enjoyable game, effort is needed from all.
5. Development of team working skills – the focus on development is critical here, achievable usually in smaller groups.
6. Group processing skills – the focus on development of the whole group and the culture within it is critical here.
7. Structure – the role of the teacher is key as they structure it to foster development.

Examples of cooperative learning techniques are Think Pair Share (Lonchamp, 2012) and Jigsaw (Aronson, 1978). The role of the teacher is to structure and orchestrate socio-cognitive conflict, which stimulates reasoning (Piaget, 2003) as well as interactions with More Knowledgeable Others (MKO), to use the Vygotskian term, for developing knowledge, confidence and skills in learners (Doolittle, 1995).

Resolving conflicts is considered healthy for mastering knowledge as well as confidence and skills building (Dillenbourg et al., 1996; Ozturk & Hodgson, 2017; Piaget, 1997). This view is in contrast to the Vygotskian view, where interacting with MKOs is seen as key to realizing most benefits for the learners when learning together. Cooperative learning encourages and aims for mastery of knowledge, the social product, together in teams. However, reaching GWM depends on the structure and successful orchestration of interactions with all team members.

The major focus here is developing knowledge, development of higher order thinking skills, self-esteem and self-confidence of learners, intergroup relations, development of interpersonal skills and perspective taking (Davidson & Major, 2014) through teacher orchestrated activities. Much of the research on cooperative learning has taken place at school level, more HE based studies are needed.

In *collaborative learning*, a teacher helps the students to develop independence through interdependence (Bruffee, 1995). There is less focus on structure and accountability than in cooperative learning (ibid). Students enhance understanding together by sharing already developed knowledge to explore differences and agreements Mathews (1996) in (Davidson & Major, 2014). Healthy conflicts here, in addition to supporting development of knowledge of some, are more likely to help correct the beliefs and knowledge of the MKOs and correct over-confidence. This can help bring people with similar interests, knowledge and needs together, which is why this has spurred an interest in Learning Communities (Gabelnick et al., 1990; Wenger, 2011).

Next, a summary of the critical attributes of collaborative learning as defined by several researchers (Bruffee, 1995; Davidson & Major, 2014; Smith, 1992) and Forrestal in (Brubacher et al., 1990) is:

1. Shared goals for understanding, solutions or creating a product.

2. Exploration and engagement with new material in relation to their existing knowledge.
3. Application of knowledge (new and existing) to problems or products.
4. Reflections and presentation of their learning.
5. Independence through interdependence.
6. Teacher joins in with student discussions.

In summary, cooperative learning is more suited to learning and mastering topics and developing confidence and skills, as will be used in this study in the COLT phase and presented itself in the SOLT phase organically and late. While, collaborative learning is more suited to advancing knowledge alongside peers and MKOs, PjBL and FC sessions, including the SOWT session in this work, aligns well to this type of constructivist learning. There are significant differences between the roles a teacher plays as well as the knowledge and skills of those taking part from the beginning.

Appending the word "working" to either cooperative or collaborative needs further exploration. The application of cooperative working in delivering group projects is limited to preparing learners for the project as in COLT (and SOLT in some extent). This is because, the structuring of cooperative group-work well enough to deliver the entire project would mean a lot of work for the teacher and it would restrict outcomes and limit the freedom of learners. This is where collaborative and other forms of team working such as PjBL and FC comes in.

Collaborative working, as challenging as it may sound, gives a context for collaborative learning. For example, a shared goal of delivering a successful PjBL project can motivate learners to take substantive responsibility in pulling together and organising themselves in enhancing and applying their knowledge to deliver the project as is explained in next sections.

2.2 Project Based Learning

In PjBL, it is the real-world nature of the project (or problem), which gives the learners the drive and a context where they are expected to further their knowledge and skills. As no one solution is deemed as the only correct solution, PjBL gives learners enough freedom to practice independence and self-regulation. However, the project needs to be motivating enough to allow learners to self-organise and learn topics and skills themselves and work with their peers.

There are claims of PjBL being successful in the literature. e.g., McMaster, Monash, UCL and Aalborg Universities run either additional workshops or modules for engineering students to help them learn design and professional skills such as team working and problem solving (Mills & Treagust, 2003; Mitchell et al., 2021) in addition to either taught and/or self-organised learning. Due to the hierarchical knowledge structure in engineering knowledge, if learners are left to self-organise and choose topics they think they need for the project, gaps may creep into their knowledge, which can cause problems (Ibid).

Therefore, academics involved in PjBL often find themselves acting as advisors or consultants and deliver teaching on relevant topics in response to student demands. These additional pressures leave management and academics feeling that PjBL is costly and may damage the student experience (Ryberg et al., 2020).

Difficulties arise, for example, when academics see PjBL as purely collaborative and self-directed and assume that learners have appropriate knowledge or are capable of extending their knowledge as needed. Reports of successful implementations of PjBL, like in Monash and Aalborg universities, do take this into account and project and problem based learning is introduced at higher levels and project-assisted learning is used in earlier years where the teacher controls the learning activities that help develop technical knowledge and team working skills through the project (Mills & Treagust, 2003). However, all implementations of PBL/PjBL may not make this distinction.

2.3 Flipped Classroom

Students in FC format, are required to individually engage with content prior to working in-class to enhance their knowledge and understanding through active learning activities designed by the academic. However, in FC too, students and academics face the similar challenges as collaborative learning (Karabulut-Ilgu et al., 2018). Effectiveness of FC is stunted as students often: miss sessions; do not engage with content before sessions and; are overwhelmed by the demands placed on them (Karabulut-Ilgu et al., 2018). For FC to be effective, engaging with content before the active learning in class is crucial. Equally important is the orchestration of the class when students are learning together. Much like PjBL, implementations of FC may miss one of these elements. Where students do engage and classroom orchestration is carried out well, research evidence suggests that student knowledge and additionally collaboration skills are enhanced (Radkowitsch et al., 2020; Ryberg et al., 2020).

To summarise, whilst the outcomes of cooperative learning are learning and development of team skills, the outcomes of collaborative working are collaborative learning that happens within the context of producing the work together and collaborative work. However, implementations of collaborative approaches like PjBL and FC, in early stages of a graduate level course, may wrongly focus on collaborative working and place less emphasis on the cooperative knowledge and skills building needed for collaborative working. Just putting learners in groups does not ensure success in a collaborative activity. Problems appear when the independence levels of the students or the level of the knowledge they possess does not match expectations. *Cooperative learning* presents an opportunity to develop the skills and knowledge needed in PjBL and FC and this will be explored in this study.

The next section explores models of team effectiveness.

2.4 Models of Team Effectiveness

It is important to understand how teams become effective and how to transform ineffective teams, in order to address the problems identified in this research. So, first, the EE literature around team effectiveness was reviewed for solutions and models used.

Borrego et al. (2013, p. 472), reviewed several frameworks and models used by practitioners to enhance team effectiveness through mostly non-technological, traditional approaches (e.g., Tuckman’s stages, Adams’ model etc.). They concluded, that most models *“sought to avoid social loafing and conflict while building trust to ensure equal team effort.”* for effective team working.

Educational research often cite, Tuckman's (1965) stages in team formation, see **Figure 3**, which recognises the need to avoid as well as to engage with conflict in the forming and storming stages respectively.

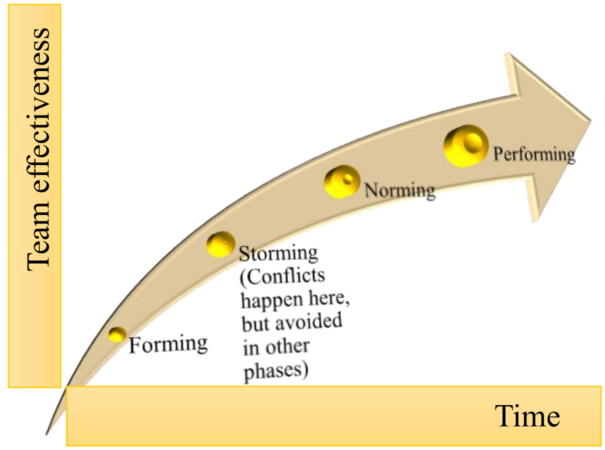

Figure 3 Tuckman's stages of team development.

However, educational researchers have linked the formation of cliques with the general tendency of avoiding conflicts (Staggers et al., 2008). The linear nature of Tuckman's model can render it ineffective in benefitting from conflicts that do not happen in the storming stage (ibid). Short-term affective conflict avoidance can be fruitful in dealing with trivial issues, heated arguments and power imbalance (low power) situations, however, long-term conflict avoidance is generally bad (Staggers et al., 2008; Thomas, 1992). Actively mining cognitive and conative conflicts and jointly resolving them is beneficial for effective team working (ibid). However, how psychological constructs like trust and conflict are interlinked remains understudied in EE and in wider educational research. Since (Borrego et al., 2013) highlighted the scarcity of such research, there has been some EE research that has sought to study the role of or trust and/or conflict in team effectiveness (Neumeyer & McKenna, 2014; Neumeyer & Santos, 2020; Shi & Mohamad, 2020). However, these articles only study the impact of trust on conflict resolution and performance (Neumeyer & Santos, 2020; Shi & Mohamad, 2020) or conflict resolution on team effectiveness (Neumeyer & McKenna, 2014). Even in the wider education literature, researchers have borrowed from psychology, the idea that trust is crucial for conflict resolution, e.g., (Ozturk & Hodgson, 2017). The reverse causality, however, has been underexplored in the wider education literature too (Fransen et al., 2011). Although conflict is seen as crucial for learning, educational settings do not lend themselves well to studying its impact on trust. Trust takes time to build and learning teams are short lived compared to those in industry (ibid). Understanding the role of conflict in building trust and in turn its impact on team effectiveness, may help design educational interventions that support development of team skills alongside domain knowledge construction in a much more efficient way. This presents a great opportunity to apply IOP (and CSCL) research to EE. In particular, to understand how (computer orchestrated) educational teams build trust and the role that conflict and its resolution plays in it.

The search for technology solutions within EE context resulted in only a handful of studies (Bishop & Verleger, 2013; Iqbal et al., 2014; Kosa et al., 2016; Li et al., 2014; Rayyan et al., 2016; Sancho-Thomas et al., 2009; Veletsianos & Shepherdson, 2015). This led to the review of the wider CSCL and psychology literature on supporting teams in making them more effective.

Over the past decade, psychology and CSCL researchers have both independently and in cross disciplinary teams, focused on understanding and fostering metacognitive, motivational, emotional and behavioural regulation at individual and increasingly at a social/collaborative level (Panadero & Järvelä, 2015). Triggered by conflicts or socio-emotional challenges, individuals and groups attempt to regulate themselves and others in order to overcome challenges (Järvenoja et al., 2017). e.g., Azer et al. (2013), suggest that group dynamics benefit if dominating behaviour is suppressed and personality conflicts avoided. They highlight the importance of etiquette, respect and care towards others, effective social and communication skills as well as accountability and management of conflict of interest.

This suggests that studying interrelations between Self, Co and Shared regulation of learning and trust and conflict and its management may provide an opportunity for improving inclusiveness, effectiveness and efficiency of support in collaborative activities. Alongside other constructs, the regulation of learning theory used here is suitable as this research investigates development of skills and attitudes of students towards team working and being independent and shared goal driven team citizens, ready for collaborative activities. Researchers have extended educational psychologist Barry Zimmerman's theory of Self-Regulated Learning (SRL), to multiple levels on a social continuum. This growing body of literature aims to explain how a learner within a team, regulates themselves and some others, i.e. through self and co-regulation of learning (CoRL) in face of challenges; and how the entire group regulates the actions of each other for the group's success in meeting shared goals i.e. through SSRL and explains how individuals become more effective in team working by regulating self, others and the team (Panadero & Järvelä, 2015).

Exploratory research points to correlates of SSRL, such as: goal driven interactions (Miller & Hadwin, 2015); high level content processing (Summers & Volet, 2010); high interaction and joint active participation (Isohätälä et al., 2017; Volet et al., 2009); socio-emotional and socio-cognitive monitoring (Näykki et al., 2017; Vuopala et al., 2019); positive interdependence (Hurme et al., 2019); psychological safety (Isohätälä et al., 2020; Kim et al., 2018); and a positive team climate (Bakhtiar et al., 2018). The last four reinforce the need to study trust formation within teams and the first two point towards self-efficacy - this study is the first to explore these two potential antecedents of

SSRL. Development of SSRL relies on meta-cognitive and meta-emotional awareness of group members and group processes. People regulate themselves and others in order to overcome cognitive-conflicts and/or socio-emotional challenges faced during collaboration (Järvenoja et al., 2017). Like trust, SSRL takes time and frequent social interactions to develop (Järvelä et al., 2016; Splichal et al., 2018). Recent work in this area shows that development of SSRL skills happens in a cyclical manner (Järvelä et al., 2019; Sobocinski et al., 2017), indicating several attempts are needed before mastering this complex skill set. New ways to measure various SSRL markers are needed to progress research outside of laboratories and into real world settings.

2.5 Enhancing self-efficacy and Self-regulation of students

The concept of self-efficacy is credited to Bandura's (2010), Social Cognitive Theory which suggests that personal factors, behaviour and environmental influences are dynamically interlinked and can help predict human behaviour. Many researchers have highlighted the links between self-efficacy and self-regulation with motivation and student learning (Pajares, 2006; Panadero et al., 2012; Panadero & Järvelä, 2015; Schunk, 2003; Schunk & Ertmer, 1999). Several educational practices that can help enhance a student's self-efficacy beliefs are also interlinked with those practices that help exercise and enhance self-regulation skills. For example, the role of goal setting, self-assessment, feedback, mastery, scripted interventions, vicarious learning, reflection and teaching and learning from peers to enhance self-efficacy of students (Adams, 2004; Koh & Frick, 2009; L. Wang et al., 2004).

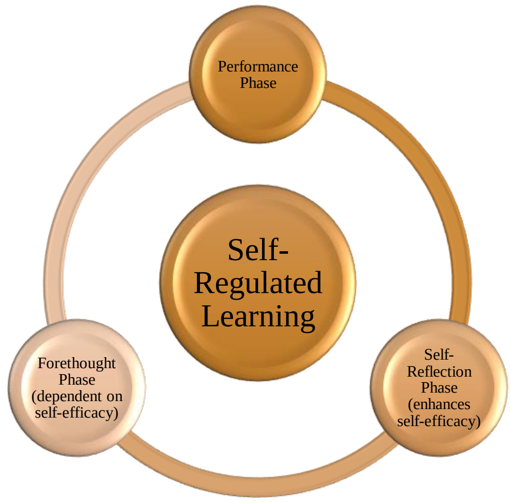

Figure 4 Cyclic phases of Self-Regulated Learning.

SRL involves a cyclic process of planning, execution and evaluation. Like any kind of control system, the concept of self-regulation, benefits from feedback from others as well as from self-assessment (see **Figure 4**). Scripting interventions and peer support when scripting is faded have been shown to enhance SRL skills in students (Puustinen & Pulkkinen, 2001; Wecker & Fischer, 2011; Winne, 1997; Zimmerman, 1990). However, self-efficacy is often linked to the first phase of SRL i.e. the forethought phase, indicating that it is needed for SRL to emerge (Puustinen & Pulkkinen, 2001; SAEZ et al., 2020). The cyclic nature of SRL suggests that peers may enhance each other through shared reflections and feedback to each other. This study explores the link between self-efficacy, SRL, CoRL, and SSRL.

2.6 Trust in Teams

Trust has been operationalised both objectively and subjectively, within different research domains. Whilst sociologists (Lewis & Weigert, 1985; Luhmann, 2018) see it as a social reality that is reciprocal and intersubjective, and measure it more qualitatively; Social-psychologists (Johnson-George & Swap, 1982; Rempel et al., 1985) consider it as a state in an individual's mind and measure it more quantitatively (Lewis & Weigert, 1985).

Trust is conceptualised either as: a relatively more stable personality trait/tendency referred to as general/pre-dispositional /propensity to trust others (Balliet & Van Lange, 2013; Costa & Anderson, 2011; Ebert, 2009; Mayer et al., 1995); or dependent on specific situations, persons or organisations referred to as specific trust (Mayer et al., 1995). Specific trust has formative dimensions including affective, cognitive (McAllister, 1995) and behavioural or conative trust (Aiken & Boush, 2006). Formatively, trust is defined as "something that leads to trust" (Ebert, 2009, p.67). Reflective measures of trust involve a measurement of future intention or "the suspension of vulnerability and uncertainty" (ibid, p.67). There is no agreement on the labels and the number of dimensions used to measure and report trust; nor in the use of a reflective versus formative model. However, the literature agrees that trust assumes greater significance in effective collaboration where a lack of familiarity or higher conflict of interest (competition) exists (Balliet & Van Lange, 2013; Ebert, 2009).

Literature on trust also points in the direction of it being multi-faceted (Ebert, 2009). Cognitive, affective and conative are three such dimensions and so is early or pre-dispositional trust (Balliet & Van Lange, 2013; Costa & Anderson, 2011; Ebert, 2009; Mayer et al., 1995). Different facets of trust are found to be dependent on different behaviours and past-experiences of teammates. Studies show that interdependence, caring for each other, citizenship, likeability of team members and frequency of social interactions between teammates affect affective trust; and past performance leads to cognitive trust in each other, both of which in turn lead to team effectiveness (Ebert, 2009; D. Johnson & Grayson, 2005; McAllister, 1995). Time is another factor that effects development of cognitive and affective trust (Webber, 2008). Webber (2008), showed that, affective and cognitive trust develops after at least 8 weeks of un-orchestrated / independent interactions in learning teams and is related to extra-role behaviours and in-role behaviours respectively. It is important to note that in this research Webber allowed teams to be self-selecting, which may affect the time it takes to establish affective and cognitive trust, making it quicker when friends form teams. To this end, Webber posits that random teams should be given even more time or team members should engage in team building activities to develop affective and cognitive trust in each other. Development of trust therefore relies on multiple factors, however, socio-communication skills and activities form a strong basis of it. Autistic and those who experience socio-communication challenges, therefore, exhibit differences in trust development when compared with neuro-typical children (Yang et al., 2017). Yang et al. (ibid) also show that non-social cues improve trust and deception behaviours of autistic children, suggesting that their non-social learning is intact and can be exploited in this way. COGLE benefits from this as it orchestrates interactions between teammates using textual cues.

2.7 Conflict and Conflict Resolution in Teams

Whilst the term trust is important in business, sociological and psychological literature on team working, conflict receives greater attention in educational literature. Conflict can be conceptualised both as healthy (functional) or unhealthy (dysfunctional) (Ozturk & Hodgson, 2017). Conflicts can be cognitive and affective but also be power related (ibid). They are quick to appear in learning teams and they have the potential to make a team stronger or make them dysfunctional. Some students may find themselves being overpowered and subject to “a form of oppression and control” by others in the group (Ferreday & Hodgson, 2008, p.640). For example, students with some degree of socio-emotional, communicative or cognitive challenges, may suffer in the presence of more vocal students in the groups leading to team dysfunction.

Avoiding conflict in early stages of team working can lead to formation of cliques that are detrimental for group-work (Staggers et al., 2008). Avoided or suppressed, conflict continues to simmer under the surface and group members have to learn to live with its consequences (ibid). Interpersonal conflicts may indeed be better deferred until the team trust level increases and conflicts get resolved due to an increased understanding between each other. In newly formed groups the type of conflict that is most beneficial in triggering learning, when resolved quickly, is cognitive conflict (Piaget, 1997). Cognitive conflicts may be resolved in a cooperative (counter) argumentation phase within teams (Dillenbourg et al., 1996). However, this is strongly influenced by the existence of a higher-level goal of achieving an agreement (ibid) and the amount of structure in learning teams put in place by the academic. To have this goal agreed right from the start in a newly formed group is rare and like trust it also takes time and several interactions.

We know little about how different forms of conflict affect building trust and developing the regulation skills needed in resolving conflicts. Ozturk & Hodgson (2017), proposed a model that shows the dynamic role of conflict and its management within blended group environments. Their model suggests that when conflicts present, they should be resolved in order to improve learning, quality of outputs, group-working and to reduce anxiety. The triggers of interpersonal conflict highlighted in their model are: learning culture, ontological security, group size, technological factors and distribution of power. They merge pre-dispositional trust and affiliation (affective trust) issues into (low) ontological security and link it with dysfunctional affective conflict or breakdown.

Likewise, they link a poor learning culture with a tendency to avoid cognitive conflict altogether.

Over time students may develop approaches to manage and resolve conflict such as: accommodating, avoiding, competing, collaborating and compromising, in different situations (Kilmann & Thomas, 1977; Thomas, 1992). Other researchers have categorised these differently as: Harmonising (accommodating), Avoiding, Directing (competing), Cooperating (collaborating) and Compromising (Kraybill, 2005). The interchangeable use of cooperating and collaborating is evident here too, but as I am focussing on developing skills necessary for collaboration using cooperative learning techniques, I will go with the terminology used by survey I am using, which was designed by Kraybill and continue to refer this to as Cooperating/Cooperative. The models that highlights the role of group and communication skills, such as assertiveness, and cooperativeness are the Kilmann & Thomas's (1977), model of conflict or the Style Matters ® model (Kraybill, 2005), see **Figure 5**. Thomas (1992), suggests that CM modes or styles are useful in predicting someone's intentions (and not desires or values) given a specific situation. Styles other than cooperating (say avoiding) may be appropriate in certain circumstances (say affective conflict) such as a short-term coping intention (ibid). The *cooperative* style is the ideal preference for teams where social relations and goals are well established. The *directing* style represents preferences for own goals over the goals of the team and is more selfish and harmful to team working. This indicates that for an effective team, a directing nature (low focus on relationships) needs balancing with cooperativeness (high focus on relationship).

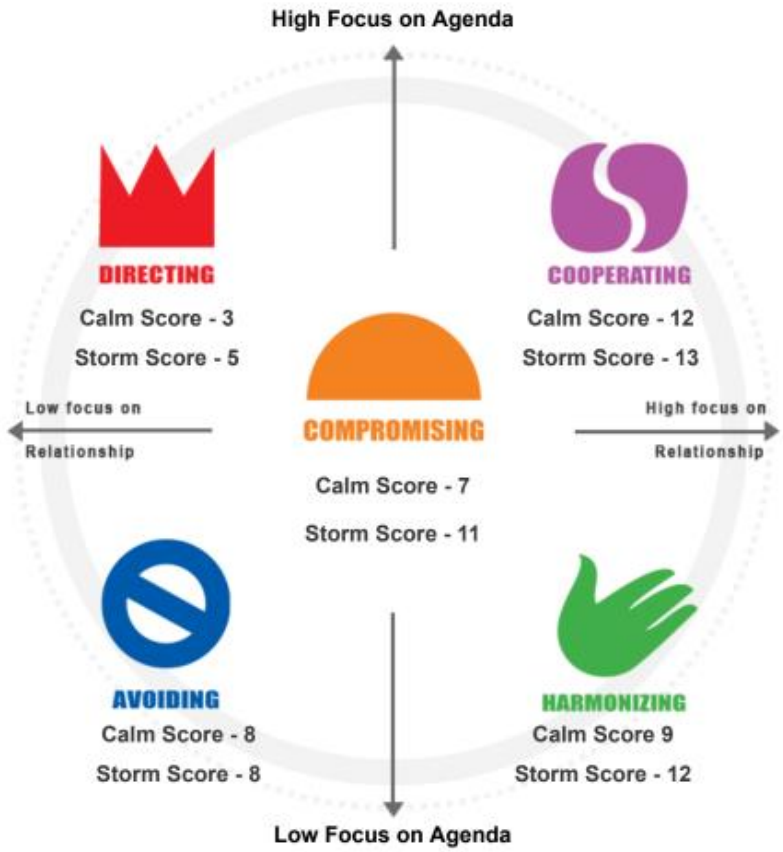

Figure 5 Conflict Management Styles – The Styles Matter ® Survey.

Specific conflict management training such as (Cochran et al., 2018) has cost implications. Leever et al. (2010), suggests that individual factors, such as self-efficacy, knowledge and experience; relationships, personality, attitudes and experience of others; context of conflict and other personal motives such as clarification, increasing cooperation, avoiding escalation and creating learning opportunities may determine style preferences in professionals. Practicing conflict resolution and developing self-efficacy are seen as important factors too (Brett et al., 1996; O’Connor & Arnold, 2002). First year undergraduate students often take the path of least resistance and show preference for *avoidance* of conflicts, whereas Engineering students may use the *directing style* (high focus on agenda but low on relations) more commonly (Plate, 2014). Both *directing* and *avoiding* (low focus on agenda and relations) styles come at a cost of learning and cooperation between team members, leading to clique formations. Likewise, the *harmonising* style represents an individual who gives preferences to social relations over goals and is not suitable for effective team working. The *compromising* style acts as a portal to and from a preference for *cooperative* style as individuals transition from/to the remaining three styles.

In nursing, the use of student generated cases studies points towards an engaging way to learn CM skills alongside learning domain knowledge (Fuhs, 1980). Training designed to develop CM styles in students, is often separate from the acquisition of core domain knowledge within EE. There are no in-situ intervention studies, which help enhance and/or maintain preference for *cooperative* style or another style for that matter. Using repeated conflicts to master CM styles and building trust with teammates has been suggested (Lencioni, 2006) for business leaders, but not implemented in any educational interventions so far. This study investigates the effects of an in-situ scripted intervention that supports GWM of content through orchestrated cognitive conflicts and study its impact on CM style changes.

2.8 Team working support for neurologically atypical learners

There are differences in the degree to which NT, ASD and ADHD students are affected by problems in group-work (Ames et al., 2016; Gelbar et al., 2014). ASD and ADHD students are more likely to be affected by socio-cognitive and socio-emotional challenges. For example, autistic learners may find it challenging to resolve conflicts (Zolyomi et al., 2018). They may also be highly trusting of others (Yi et al., 2013, 2014). This may be due to their socio-communication challenges and difficulties in identifying how to distrust others (Yang et al., 2017; Yi et al., 2014). They may have difficulty interpreting or incorporating the nonverbal and interpersonal communication that completes the whole message (Grandin, 2008). Thereby, they may be perceived less trustworthy due to their reduced ability to respond and express themselves fully in in-task and out-of-task social interactions with teammates. ADHD learners may find it hard to stay on task (Sajadi & Khan, 2011). As ADHD also effects a person's social and communication abilities, these learners may also be perceived as less trustworthy if they choose not to fully express themselves whilst trying to focus on other tasks. Another challenge for ASD students is related to their willingness to manipulate their belief in others (Yirmiya et al., 1996), which may come in handy in CoRL. NT learners may also exhibit these problems but to a lesser degree or more rounded coping strategies. Nevertheless, team working affects NT and NAT students and both groups need support however, effective and inclusive interventions were not found in the literature (A. H. Anderson et al., 2017; Aresti-Bartolome & Garcia-Zapirain, 2014; Cai & Richdale, 2016; Camargo et al., 2019; Desideri et al., 2020; Madriaga & Goodley, 2010; Martin et al., 2020). Prompts have been shown to be effective in autistic persons in acquiring skills in individual settings, however, it takes much longer for these skills to be mastered and when mastered it may take some effort to fade the stimulus control from the prompting to more natural setting (Den Brok & Sterkenburg, 2015).

With a lack of good inclusive interventions, HEIs are currently having to invest in separate resources, providing inadequate non-contextual social skills support for students with ASD and ADHD (A. H. Anderson et al., 2017; Barnhill, 2016; Chezan et al., 2012; Chown et al., 2018; Gelbar et al., 2014; Kuder & Accardo, 2018) and separate team working support for NT students (Harmer & Stokes, 2014; Lehmann et al., 2008).

ASD learners may experience academic and non-academic (social, emotional, practical, communicative and sensory) barriers (Ames et al., 2016; Gelbar et al., 2014). Theory of Mind (ToM) hypothesis and related research suggests that ASDs may incorrectly interpret social situations (Baron-Cohen et al., 1985; Frith & Happé, 1994), may struggle with cognitive flexibility (Larson et al., 2012) and in situations with conflict they may be either very emotionally charged or based on past experiences avoid conflict altogether. Poor cognitive flexibility may lead to difficulties in knowing alternatives and change management. Once again, support with regards CM for ASD and ADHD students is non-existent in the higher education literature.

Challenges highlighted above could lead to frustrations for ASD and ADHD students and/or for those they are engaged with socially, leading to conflicts and breakdown in working relationships. This could over time create a 'fear of conflict' in learners with ASD and also loss of 'affective trust' in them by others. Equally, when a high trusting ASD student realises they have been left out in a team, it can be a painful experience and can be detrimental for ASD students and indeed for others in the longer term.

UK HEIs rely on institutional support or reasonable accommodations made for ASD learners, which are mainly non-academic and practical in nature, such as: extra time in exams and extended deadlines for assignments, separate testing locations, accommodation stability and scribes / audio recorders, additional time with tutors, group skills training and social support groups (Chown et al., 2018; Gelbar et al., 2014; Kuder & Accardo, 2018; Mulder & Cashin, 2014; Van Hees et al., 2015). Accommodations such as an alternate individual assignment, instead of group based or a one-on-one presentation as opposed to a group, may seem OK at first but they do not even the playing field for

ASD students and may even marginalise or be detrimental to them by keeping them away from real world situations that they are likely to face later in the workplace or social settings (Madriaga & Goodley, 2010; Mulder & Cashin, 2014).

Group skills training is common but more effective in improving social and academic related skills when designed for ASD learners and focussed on set topics (first order scaffolding) (Hillier et al., 2018; Van Hees et al., 2015). Although, Hillier et al. (2018), present some additional information in their study on retention and attainment, they recognise that little research has been carried out on assessing the impact of group skills training (second order scaffolding) for real world collaborative situations and academic outcomes in general. Social support groups with other ASD learners are also desired but less frequently used (Kuder & Accardo, 2018; Van Hees et al., 2015). However, ASD learners do benefit from practicing specific social skills in different environments (Chezan et al., 2012). Given that some ASD students may have a natural affinity for computers (Blamires & Gee, 2002), technological solutions have been developed for supporting students with social skills impairment, e.g., virtual world based social skills training (Bosseler & Massaro, 2003; DeAngelis, 2009; Kuder & Accardo, 2018); scripting and regulation of collaborative learning (Boyle & Sánchez, 2017; Zhang et al., 2018; Zolyomi et al., 2018); multi-touch table top displays (Hourcade et al., 2012; Silva et al., 2015) and modelling desired group skills through videos (Koegel et al., 2016; Kuder & Accardo, 2018). However, many such interventions are still in experimental stages and mainly used with children and not with higher education students. Furthermore, group support for learning and/or doing collaborative tasks in context, like scripting based studies (Boyle & Sánchez, 2017), have received little attention and this study aims to fill this gap in the literature.

Researchers have noted that support for ASD students is often inadequate citing idiosyncratic student responses during evaluations (A. H. Anderson et al., 2017). Some 40% (54 adult ASD respondents) from across the UK reported challenges with social interaction such as group-work where only 39% of them received institutional support (Beardon et al., 2009). A recent systematic review on support for ASD students, only reported 1 (out of 9) study where academics structured and facilitated group-work (Gelbar et al., 2014) and a recent UK wide survey of ASD support and accommodations at HEIs, reported several individual focussed or personalised services and only one group focussed service (Chown et al., 2018). Due to the diverse nature of ASD challenges, researchers have called for even more personalised and tailored support for individual ASD students (A. H. Anderson et al., 2017; Gelbar et al., 2014; Kuder & Accardo, 2018). However, unless institutions seeks to address systemic barriers, which need to be brought down, such support may actually marginalise or be detrimental, depriving them of a chance to engage and acquire skills like other students (Hastwell et al., 2017; Madriaga & Goodley, 2010; Mulder & Cashin, 2014). Novel inclusive support that moves teaching and learning towards best practice is needed and is even appreciated by ASD learners where present (A. H. Anderson et al., 2017; Cai & Richdale, 2016; Madriaga & Goodley, 2010).

The next section looks at findings from the two overlapping research domains of IOP and CSCL relating to regulation of self, others and teams before I describe the theoretical framework and summarise this review.

2.9 Psychology and CSCL literature on regulation of learning

Several CSCL and psychology researchers have increasingly, over the past two decades, combined efforts to focus on tapping into the benefits of conflict; limiting social loafing; enhancing communications and understanding Self, Co and SSRL of students in teams (Dillenbourg & Hong, 2008; Fischer et al., 2013; Malmberg et al., 2017; Vogel et al., 2017). Crook (2011), highlighted that due to warnings issued over the addictive nature of computers when it was first introduced in the classrooms, CSCL as a field has focussed a lot more on collaboration through computers than collaboration at computers (Beatty, 2002). Notable exceptions are studies on the use of CSCL scripts for enhancing domain knowledge and regulation of collaboration skills as well as group aware technologies. There are three lines of research relevant here, where collaboration has happened between CSCL and psychology researchers. First, one looks at the role of cognitive conflicts in enhancing learning (Betbeder & Tchounikine, 2003; Dillenbourg & Hong, 2008; Fischer et al., 2013). The second line of research investigates the role of scripting SRL, CoRL and SSRL in developing skills for team effectiveness (Bodemer & Dehler, 2011; Dillenbourg & Hong, 2008; Dillenbourg & Tchounikine, 2007; Isohätälä et al., 2020; Janssen et al., 2011; Järvelä et al., 2016; Näykki et al., 2017; Panadero & Järvelä, 2015; Splichal et al., 2018; Vogel et al., 2017). The third involves studying group awareness technologies and learning analytics that provide visualisations of cognitive, behavioural or group/social processes to students (Kilinska & Ryberg, 2019) and are also helpful in regulating coordination of collaboration (Bodemer & Dehler, 2011; Janssen et al., 2011; Schnaubert & Bodemer, 2019; Sobocinski et al., 2017). Some of the group awareness technologies merge scripting in order to enhance awareness related outcomes for various stages of SSRL to help build SSRL skills (Järvelä et al., 2016). Very few studies were found to be effective in supporting NAT students with scripting and prompting regulation skills.

In CSCL research, Script Guidance Theory (SGT) has guided research on scripting interactions and cognitive conflicts to enable learning and scaffold collaboration for those who may not have internal collaboration scripts (Fischer et al., 2013) or even to help trigger the same during collaboration in accordance with the dynamic memory theory (Schank, 1999). Scripts can therefore orchestrate collaboration and are used to *"Enhance the probability that knowledge generative interactions such as conflict resolution, explanation or mutual regulation occur during the collaboration process"* (Dillenbourg & Tchounikine, 2007, p. 1).

Another related theory that underpins the success of scripting regulation skills is the Self-Determination Theory (SDT) of motivation (Deci & Ryan, 1985). It posits that learners become self-motivated in a learning environment that makes them: more self-confident by making them more competent; more part of a team by enhancing their relatedness to their teammates; but also more autonomous as they take control of the tasks themselves and internalise or remember the triggered scripts. Studies on internalisation of scripts are very rare however e.g., (X. Wang et al., 2017) & (Näykki et al., 2017)). One of the seven principles of SGT states that increased transactivity leads to better knowledge acquisition (Fischer et al., 2013) and helps model interactive behaviour of individuals in a group. Internalisation and/or triggering of scripts for the co-construction of knowledge can enhance motivation and develop the competence of learners. In fact, CSCL scripts have been shown to support domain knowledge (d=0.2) and collaboration skills development (d=0.9) both 'at' (face-to-face settings) and "through" computers (online settings) compared to un-orchestrated CSCL (Vogel et al., 2017). A revisited meta-analysis shows the effectiveness of CSCL scripts in enhancing domain knowledge (g=0.24) and collaboration skills (g=0.72) compared with un-orchestrated online and blended CSCL settings (Radkowitsch et al., 2020). Scripting achieves structure and orchestrates learner interactions resulting in these gains. Micro-scripts may be used to prompt learners (e.g., what/when to say/think) within discussions and operate at a finer grain and may be seen as too coercive. Macro-scripts, on the other hand operate at a higher level, and may allow students to choose specific roles as long as they agree to meet some higher level constraint, such as converging on an answer in the case of ArgueGraph (Dillenbourg & Tchounikine, 2007).

For developing SRL and CoRL skills, scripting information sharing, argumentation and negotiations, as defined in the collaborative framework by Liu et al. (2016), has been effective. Very few studies, however, have investigated the transfer of these scripted skills into un-scripted environments. Transfer has been more successful where adaptable scripts are used (X. Wang et al., 2017) or where students practice the scripted interactions multiple times (Näykki et al., 2017) and where there was support to help students in challenging situations (ibid).

Furthermore, studies of scripting SSRL involving co-ordination skills, as defined in Liu et al. (2016), like planning, monitoring and reviewing are still mostly exploratory in nature, e.g., (Hurme et al., 2019) and (Splichal et al., 2018)) with some exceptions (e.g., (Bakhtiar et al., 2018; Vuopala et al., 2019) where controls were used in the research design. These studies show that orchestrating multiple stages through scripts is more challenging. Findings often report one or two stages of SSRL being orchestrated successfully despite attempts at shared planning, monitoring and reflection stages (ibid). Appropriation of scripts by students in response to the script's coercion, its cognitive load, the rigidity of the resulting learning environment, and over-scripting, are some of the factors stated for lack of success (Dillenbourg, 2002; Dillenbourg & Tchounikine, 2007; Wise & Schwarz, 2017).

The meta-analysis by Radkowitsch et al. (2020), claims no negative effect of over-scripting on student motivation in experimental/quasi-experimental studies, however, they did not code the studies for the level of scripting when doing their analysis and there were no SSRL studies included. Studies identified by Radkowitsch et al. (2020) show that for enhancing domain knowledge, single prompt scripts are more effective than multi-prompt scripts and likewise scripting one to two collaborative activities is more effective than scripting multiple collaborative activities. This means that over-scripting can reduce the effectiveness of scripts in enhancing both domain knowledge and collaboration, as students may lose sense of control and therefore motivation. It may be that the scripts used in these studies were carefully designed using SGT principles and have avoided over-scripting. But the moderator analysis for a different outcome actually supports that less scripting can be more effective when comparing the number of prompts and types of collaborative activities. Dillenbourg & Tchounikine (2007), called for script designs to be flexible without compromising the intrinsic and extrinsic constraints, to avoid over-scripting.

As none of the included studies in this meta-analysis were on SSRL scripting, I summarise my findings of the review on SSRL scripting next. Panadero et al. (2012), showed student's SRL skills and not the scripting intervention influenced display of SSRL skills during scripted interactions. In another study, overall, students engaged the most with the orienting script as compared to monitoring and reflection scripts (Vuopala et al., 2019). However, they engaged more in monitoring content understanding when they engaged in co-creation and more in task difficulty when less engaged in co-creation (ibid). Incoming conditions, positive climate and interactions were seen as important for scripting SSRL successfully, as the self-efficacy of the teammates, the initial working conditions and ongoing interactions, and the emotions they produced influenced the display of regulatory skills by the learners (Bakhtiar et al., 2018). Thus, studies reflectively highlight the need for trust between the teammates, psychological safety and self-efficacy before regulatory skills are displayed but none actually investigates the potential link between trust, self-efficacy and triggering and internalisation of regulation skills. Likewise, many of the key points highlighted in the exploratory research on CoRL and SSRL above also need to be investigated in CSCL scripted environments for confirming their role in triggering and internalising the regulation scripts.

To summarise, scripts, in general and also for SSRL, are appropriated and internalised differently by learners (Borge et al., 2018; Näykki et al., 2017; Tchounikine, 2016). In addition, the success of shared planning, monitoring, evaluation and reflection stages within the SSRL model (Miller & Hadwin, 2015) are dependent on how previous stages unfold. This makes the later stages more challenging for learners (Bakhtiar et al., 2018; Näykki et al., 2017; Winne, 1997). Such dependencies and diversity in learner knowledge and skills, makes it very hard for SSRL to be successful when each of these stages is scripted separately (Bakhtiar et al., 2018; Borge et al., 2018) and may easily be perceived by learners as over-scripting (Dillenbourg, 2002).

2.10 Theoretical framework

Conflicts that are constructively resolved are healthy for collaborative learning and developing team working skills (Dillenbourg et al., 1996; Ozturk & Hodgson, 2017; Piaget, 1997). However, unresolved affective or cognitive conflicts may lead to dysfunctional groups and clique formation (Staggers et al., 2008; Thomas, 1992). Thus, iterative presentation and orchestration of conflict resolution should help train students in regulating their own behaviour and that of others and develop trust in teammates which is much needed in order to resolve conflicts, thereby resulting in effective un-orchestrated teams.

Zimmerman's SRL theory and its extension into the social in the form of CoRL and more recently SSRL, explains how shared goals, planning, monitoring and reflections can make individuals become more effective in regulating collaboration at different levels (Panadero & Järvelä, 2015). SRL involves planning, monitoring and reflecting your own actions to achieve individual goals against a set standard (Panadero & Järvelä, 2015; Winne & Nesbit, 2009). Learning together iteratively, in a cooperative way, towards a shared goal of GWM is seen here as crucial in triggering and achieving SRL, CoRL, and SSRL and team effectiveness. However, success in triggering all of these in teams has been limited(Bakhtiar et al., 2018; Borge et al., 2018; Näykki et al., 2017). Triggering regulation, in particularly SSRL, through a simple goal of orchestrating and achieving GWM has not been studied before.

Likewise, the positive role trust plays in team effectiveness has also been well established in organisational psychology literature(Ebert, 2009; McAllister, 1995). Here, trust in a teammate is formed when enough positive knowledge about their past performance (cognitive trust), likeability (affective trust) and reliability (conative trust) accumulates over time, for example through frequent social interactions and through their good citizenship behaviour (Ebert, 2009; D. Johnson & Grayson, 2005; McAllister, 1995). Pre-dispositional trust is dependent on the person themselves (Balliet & Van Lange, 2013; Costa & Anderson, 2011; Mayer et al., 1995). Conative trust or behavioural trust is dependent on and feeds back into affective and cognitive trusts. Affective trust has been shown to be linked with good citizenship behaviour, such as listening and helping each other in a group and frequency of interactions that lead to positive socio-emotional climate within the group (Bakhtiar et al., 2018). Cognitive trust is linked with the knowledge about the knowledge someone has in order to do a task at hand. High trust amongst team members has shown to help in quick conflict resolution in organisational teams (J. C. Anderson & Narus, 1990; R. M. Morgan & Hunt, 1994). A goal of GWM, in an iterative and cooperative way, provides here a great opportunity for studying: self-efficacy, SRL and learning gain; trust development between team members; the role of orchestrated conflict and its resolution; and how it impacts on triggering and internalising CoRL and SSRL skills and achieving team effectiveness.

The need to develop CM skills for enhancing team effectiveness and satisfaction is well established (Kilmann & Thomas, 1977). Practicing conflict resolution is necessary for developing CM skills over time.

Thus, the development of trust, CM and regulation skills all need practice through iterative social interactions and time. Script Guidance Theory (SGT) posits that a target behaviour, such as SSRL, can be modelled in individuals by scripting it repeatedly, causing internalisation of an appropriated version of the external script (Dillenbourg & Hong, 2008; Fischer et al., 2013; Wise & Schwarz, 2017).

The theoretical framework highlights the known interrelationships between trust and its antecedents, conflict and its management, regulation of learning and team effectiveness, which guides the investigations in this study.

2.11 Summary of Research

Efficiency and effectiveness of collaborative pedagogies, such as PjBL and FC, has been both criticised and praised. Mining and resolving certain types of conflict seems to have multiple benefits and therefore instead of scripting knowledge acquisition as well as SRL, CoRL and SSRL in disjointed efforts, research efforts are beginning to merge e.g., (Fischer et al., 2013; Ozturk & Hodgson, 2017; Splichal et al., 2018). SSRL is seen as the highest level of regulation of collaboration (Panadero & Järvelä, 2015). Studying the orchestration of presentation and resolution of conflicts can therefore be fruitful in enhancing team effectiveness and it gives an opportunity to study the development of trust and its links with conflict within student teams. Indeed, very few studies investigate the effects of removing scripting and checking for internalisation within an un-orchestrated environment. A new, more flexible approach for scripting SSRL alongside learning together is therefore needed and what this study investigates. Finally, a more inclusive approach to addressing the needs of NT and NAT students in collaborative approaches in needed, which is also investigated.

Chapter 3: Research Design, Methodology, Methods and Analysis

3.1 Introduction

The research questions in this study focus on how and why students change their skills and attitudes within COLT and SOLT environments and its transfer as demonstrated in SOWT. An additional focus is on NAT students in teams with NT students. The purpose is to contribute to theory as well as evaluate the efficacy of COLT and SOLT environments in preparing, groups of NT and NAT students, for teamwork.

In the following sections, I highlight the research questions, my epistemological and ontological views. I then describe and justify the research design, data collection methods and analysis methods adopted. Finally, I explain my role as a researcher and developer and discuss the limitations of this approach.

3.2 Research Questions

The research questions are:

RQ 1. How does learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated settings?

RQ 1.1 How does learning together in small groups affects a learner's attitude to conflict management?

RQ 1.2 How does learning together in small groups affects a learner's development of trust in their teammates?

3.3 Epistemological and Ontological considerations

My pedagogical beliefs around GWM, cognitive conflicts and scaffolding for cooperative learning settings informed the creation of COGLE. My research motivation is primarily to improve outcomes related to team working in educational settings.

Researching the interrelations between self-efficacy, trust, conflict, conflict-management and regulation skills allows me to engineer better orchestration systems. My approach fits Dewey's definition of pragmatism, as I engaged in a cycle of inquiry, joining my beliefs with my actions (D. L. Morgan, 2014). Orchestrated environments, involve real subjects who are dynamic beings, undergoing development of skills, attitudes and knowledge. Orchestration scripts can repeatedly guide and prompt interactions with teammates, which can help develop the skills and attitudes predictably. The teammates negotiate and contest dialectically, the nature of reality, with each other and COGLE scripts. Pragmatism is therefore a suitable ontology for investigating and developing orchestrated environments and theory around them.

The previous chapter highlights the debates around subjective vs objective operationalisation of constructs mentioned in the theoretical framework. In line with my pragmatic epistemological stance, I chose to measure and analyse data at multiple points (time), contexts (cases) and sources (mixed methods). This helped with triangulation as well as capturing and interpreting the dynamic nature of these constructs. Likert and free text surveys were used to take quick snapshots (less burdensome for participants) of constructs being studied. Interviews together with the free text surveys provided detailed qualitative data. Together these helped understand how and why constructs changed over time allowing for contribution to theory. Normalised learning gains and interview data helped understand the impact of learning in SOLT and COLT environments on self-efficacy of teammates.

3.4 Research design

The existence of theory around the use of computer and student orchestration of learning together, team effectiveness, trust and conflict resolution calls for a "gaps and holes" approach to the design of this case study research while developing existing theory (Ridder, 2017). Pattern matching between the propositions from existing theories and the empirical findings in this research helped confirm old and identify new relationships between constructs and thereby develop theory through analytical generalisation (ibid).

In line with the pragmatic approach, a mixed methods comparative case study research design was chosen to improve understanding (how and why) of a contemporary phenomenon in a real-life bounded context using typical and unique cases (Merriam, 1988; Yin, 2017). Yin highlights in (Cooper et al., 2012) that case studies focus on a much greater number of variables of interest than data points and relies on multiple sources of data used with triangulation. Data and methodological triangulation and literal replication were used to improve the validity of this case study research (Yin, 2013).

Two COLT cases following a literal replication logic were purposefully selected to generate valuable rich insights. One SOLT case following a theoretical replication logic was purposefully selected to generate contrasting insights for theoretical reasons. Case summaries and cross-case pattern matching allowed: on the one hand, confirming of new antecedents and relationships between the constructs and modifying theory through analytical generalisation and discarding rival explanations (Atkinson et al., 2003; Ridder, 2017, p. 209); and on the other, enhancing practice around supporting team effectiveness through computer orchestration. Multiple cases strengthen the findings adding to their transferability (Cresswell, 1998; Lincoln & Guba, 1985; Merriam, 1988; Stake, 1995; Yin, 2017).

3.5 Methods

I will now describe the participants, the research sites and when, how and what data I collected in this study and explain their use in answering the research questions. The case summaries provide a detailed timeline of the data collection.

3.51 Participants

Three different courses were purposefully chosen, where FC and PjBL were already in use, to recruit participants for the three cases on a voluntary basis. Random samples may or may not give the richness, validity and depth achieved from a purposefully sampled case (Ridder, 2017). Voluntary participation in this study meant students did not feel compelled to join the study. However, the number of participants (n=23) who did join were deemed sufficient for the nature of the study. To minimise impact on trust, participants from first year of each course were put into teams randomly and I also confirmed before the study that none of the teammates knew each other beforehand.

Likewise, as shown in **Table 1**, I collected information on their age, gender, disability (dyslexia, ASD, ADHD, or other social communication disorder) at the start of the study. Two students self-declared as ASD. One student was diagnosed with ASD and ADHD. The majority of the students were between 18 and 20 years old, which is typical of any first-year engineering cohort, and were considered as suitable participants as most of them would be considered as not having the skills and attitudes under investigation in this study. One student who was 52 years old, was returning to education and had not studied electronics in a long time. It is not uncommon to have mature students to join engineering programmes and often they bring skills with them that can be shared with other students but this was not thought to have played any part here.

Case Study	Male	Female	Age range	ASD	ADHD
FC case with COGLE	5	1	18-52	1	0
PjBL case with COGLE	7	3	18-20	1	2
PjBL case without COGLE	6	1	18-26	1	0

Table 1 Participant details in each case study.

3.52 Research sites: COLT and SOLT environments

PjBL and FC are commonly used within EE. The choice of topics used in the 2 COLT and the SOLT cases are very commonly used in first year engineering curriculum across several disciplines. The diversity in terms of age, sex and neuro-typical and atypical (Colorosa & Makela, 2014, HESA, 2021), is representative of the student population within engineering education settings. The research sites chosen and the sample of student participants therefore, are representative of the population of first year students.

Using replication logic, two purposefully sampled naturalistic settings represent the unusual cases of providing scaffolding during a learning together phase, using COGLE, a teacher-less COLT environment to prepare teammate for FC and PjBL phase in terms of skills and knowledge. Likewise, a third naturalistic setting chosen purposefully for comparison with a more common case of SOLT environment to prepare students for PjBL phase. All three cases had a final un-scaffolded working together SOWT phase that involved FC activities or PjBL project to work on. This allowed the investigation of the development and transfer of the constructs of interest within computer orchestrated (COLT and un-scaffolded SOWT) and student orchestrated (SOLT and SOWT) settings.

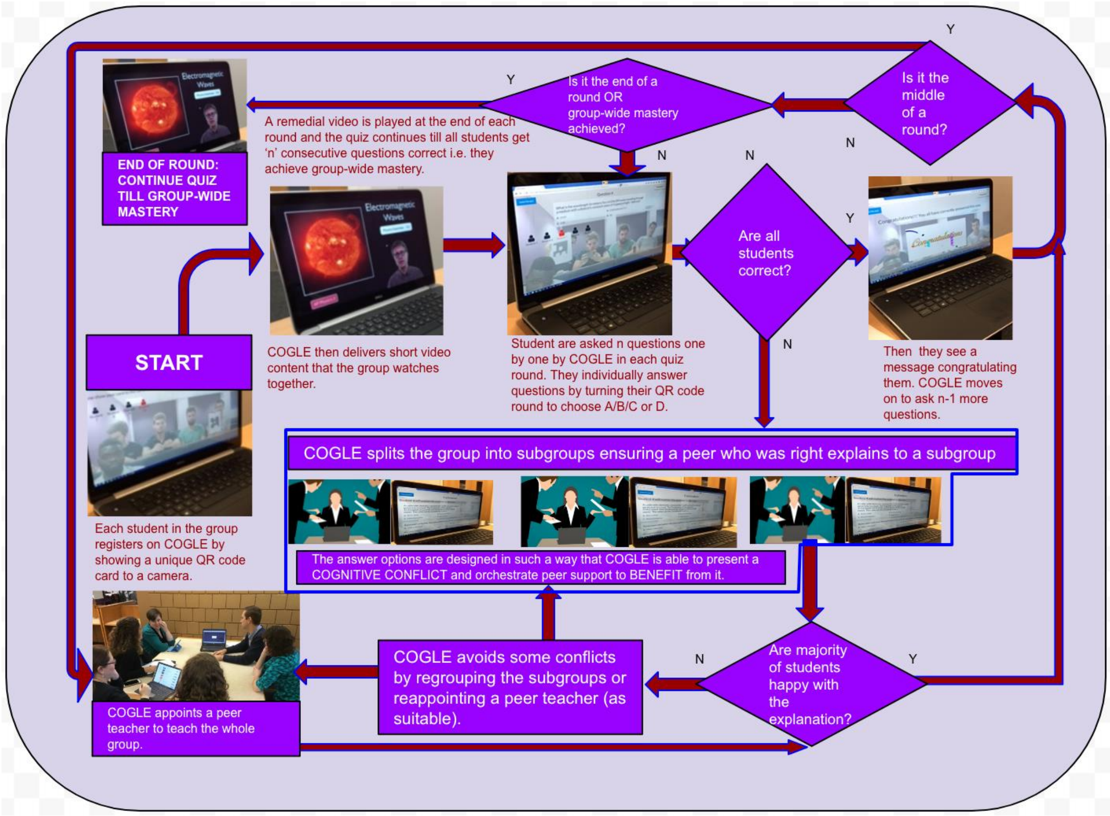

Figure 6 How COGLE works.

As shown in **Figure 1**, a learning session starts as COGLE plays relevant short videos, on a shared PC, and then orchestrates: the assessment by asking a set number of multiple-choice questions; support by play remedial videos based on student answers; and interactions between the teammates, until GWM is achieved.

The questions are designed so that they create *cognitive-conflicts* between two or more learners by including conflicting and plausible options in each question. Teammates first answer the same question individually by choosing an option on their own devices. After each question, COGLE summarises the response summary and their number of questions needed for GWM on the shared PC screen. After a set number of questions, it also shares a graph of their progress towards the GWM goal. It is hoped that this enhances the self and group-awareness of the knowledge and their progress towards the simple goal of GWM and increase engagement. After each question, where at least one student is wrong, COGLE uses its *peer instruction (PI)* macro-script to group relevant peers to resolve conflicts or simply help each other understand the content (Crouch & Mazur, 2001). The point of departure from PI is that COGLE shows the correct answer as immediate feedback to aid these discussions. If the conflict is not resolved, COGLE uses its *regrouping* micro-script which asks each student if they want to be regrouped with another peer for discussion. In case this too fails or is deferred/declined by the students, it plays a remedial video linked to the most incorrectly chosen option by tallying the mistakes made over several related questions, eventually covering most unresolved conflicts as GWM is reached. If any student makes a mistake before that, the target count to GMW is reset as a *penalty*, which makes the GWM script coercive and somewhat frustrating. However, the *peer-instruction* script is more flexible and it prompts with encouraging messages throughout and displays celebratory animations when the students attain mastery. Two recent pilot studies with engineering students have shown encouraging results of using COGLE to affect engagement and learning (Malik, 2016). The effect of COGLE as a contextual support in developing team skills and attitudes is the focus of this study.

The SOLT case on the other hand is a theoretical replication case, which represents how students may work together on their own, learning and working together with no or little interaction with the lecturer during PjBL, representing a practical reality within PjBL settings. Here, one or more students may emerge as the master orchestrators of the team depending on their skills and experiences. As will be described later, this case provided a comparison that helped discard some rival theory claims related to learning together over time and: trust, self-efficacy, and regulation skills development.

3.54 Measuring Conflict management style

Teamwork often involves conflicts. COGLE by design is likely to orchestrate cognitive conflicts and their resolution in order for teams to reach GWM. In non-scaffolded interactions too, cognitive and other conflicts may present themselves. At multiple points, I captured conflict resolution preferences of teammates quantitatively and later corroborated this with thematic analysis (Braun & Clarke, 2006) of the qualitative data to understand the relationship with other constructs such as trust and regulations skills.

Over time students may develop preferred approaches to managing and resolving conflicts such as: harmonising, avoiding, directing, compromising and cooperating, in different situations (Kraybill, 2005) as shown in **Figure 5**. Measuring someone's CM style indicates an objectivist approach, however CM styles are understood to be preferences that can change with time and situation. The 7-point Likert scale, Style Matters ®, Conflict Style Inventory was used multiple times during the study (Kraybill, 2005). e.g., "*So long as feeling as still under control, I push to bring our differences out into the open and try to find a solution that benefits both of us.*" and "*When the disagreement is still low key, I put as much effort into understanding the other side's views as I put into explaining my own.*" for cooperative style within calm conditions. This 20-item survey has been shown to be reasonably reliable (Cronbach's Alpha = 0.75 or greater on all items) (Braz & Lawton, 2010). The *Style Matters* ® survey thus provided a quick approach to capture these changes over time and the qualitative data also aided in understanding the influences that affected these preferences in students.

3.55 Measuring Regulation skills

For capturing the qualitative changes in regulation skills, a survey was adapted from (Splichal et al., 2018) to suit the COLT and SOLT environments. **Table 2** shows the timings and the modified questions in the SSRL survey. A two item free text questionnaire was used before the start of the study and after the working together session. An adapted 4-question questionnaire was administered after each learning together session.

Timings	**Questions asked**
Before start	Q1. Describe one team working event where things went well for you and your teammates and another where they did not go so well for you and your teammates. Q2. Also, describe how you or others in your team contributed to improving and worsening the situations you described as “did" and "did not go well” above respectively.
After each learning together session	**In cases 1 and 2 –** Q1. Describe what did and did not go well, when prompted by the system, *to teach* or explain to other student(s) a concept. (Say so, if this never happened). Q2. Also, describe how the system made you or others in your team contributed to improving or worsening the situations you described as “did" or "did not go well” above respectively. Q3. Describe what did and did not go well, when prompted by the system, *to learn from* other student(s), a concept. (Say so, if this never happened). Q4. Also, describe how the system made you or others in your team contributed to improving or worsening the situations you described as “did" or "did not go well” above respectively. **In case 3 –** Q1. Describe what did and did not go well, when teaching or explaining a concept to another student(s) (Say so, if this never happened). Q2. Also, describe how you or others in your team contributed to improving or worsening the situations you described as “did" or "did not go well” above respectively. Q3. Describe what did and did not go well, when you got to learn from other student(s), a concept. (Say so, if this never happened). Q4. Also, describe how you or others in your team contributed to improving or worsening the situations you described as “did" or "did not go well” above respectively.
After team working	**In all cases –** Q1 - Describe things that went really well for you and/or your teammates today and also things did not go so well for you and/or your teammates. **In case 1 and 2 -** Q2. Also, describe how the recent use of COGLE system, by you or others in your team, further improved the group interactions in situations you described as “did go well” above. Likewise, for things that did not go well, do you see any role that COGLE may have played in it not going so well today. **In case 3 –** Q2. Also, describe how the recent interactions went within your team during the learning sessions and how it further improved the group interactions in situations you described as “did go well” above. Likewise, for things that did not go so well, do you see any role in the way you worked together during the learning sessions in things not going so well today.

Table 2 The SSRL survey: different versions used at different points (adapted from (Splichal et al., 2018)).

The free text nature of this questionnaire suited the needs of this study to explore how and why students react to different situations as they interact in Self, Co and SSRL when learning and working in teams. Relevant themes from this survey and from the interview data were corroborated for triangulation purposes.

3.56 Measuring Pre and Post Test Scores

Subject knowledge test scores for each student were recorded, before and after the learning together sessions for all cases. The questions included multiple choice and/or open text questions on the content that had been covered during the learning together sessions. Using the pre and posttest scores, learning gains were calculated for individual participants. The interview themes were used to understand the role GWM played in enhancing self-efficacy.

3.53 Measuring Trust

As this study focusses on the development of trust, it was measured using quantitative instruments at multiple points and later corroborated with qualitative data through a thematic analysis (Braun & Clarke, 2006) of the qualitative data to understand the relationship with other constructs such as conflict and regulations skills. To enable quick snapshots of well-established core concepts like trust (Costa & Anderson, 2011; Mayer et al., 1995) existing Likert scale items with known reliability measures were used with minimal modifications.

Trust is conceptualised as a latent variable resulting from two related formative indicators (Mayer et al., 1995; Söllner & Leimeister, 2013). The first indicator is the propensity, or a general willingness to trust others. To measure this a 6-item pre-dispositional trust questionnaire was adapted from (Costa & Anderson, 2011). The original survey is reasonably reliable (Cronback's alpha=0.78) (ibid). Examples of the 7-

point Likert scale items in the modified survey are "*A typical student is sincerely concerned about the problems of other students.*" and "*Students usually tell the truth, even when they know they will be better off by lying.*"

The second indicator is the *specific trust* an individual places in their teammates, also known as trustworthiness (Mayer et al., 1995). To measure this a 5-item instrument for measuring team trust was adapted from (Costa & Anderson, 2011; Mayer et al., 1995; McAllister, 1995) to capture the three formative facets of specific trust, namely benevolence (affective), ability (cognitive) and integrity (conative) trust (Aiken & Boush, 2006) at multiple points in the study. The items were modified to make them formative based on foundations provided by Costa & Anderson (2011) & Mayer et al. (1995). The original survey is reasonably reliable (Cronbach's alpha for cognitive and conative items is above 0.88 and affective item is above 0.72) (McAllister, 1995; Webber, 2008). Examples of the 7-point Likert scale items, are: affective trust - "*My teammates help me when I need it.*"; cognitive trust - "*My teammates are knowledgeable in the topic area we are studying together*." and conative trust "*My teammates can be counted on.*"

3.57 Role of Semi-structured Interview

For each case, the survey data was used to formulate follow-up questions for the interviews to improve understanding and triangulation. The interview was audio-recorded (at least 60-70 minutes each and up to 120 minutes for ADHD and ASD participants) and the questions helped tease out perceived satisfaction and effectiveness of the learning and team activities. Interview questions were based on the links and gaps identified in the theoretical framework, see **Figure 2**. The questions focused on three areas, starting with the SOWT activity, followed by the learning together phase and finally comparing any past and current teamwork experiences. Some sample questions used within the interview are presented in **Table 3**.

Phase	Question / Prompt
SOWT	Start by asking about their satisfaction with the team working? Was the task a success or failure?
COLT/SOLT	How did COGLE / Learning together support -Team building - How? or Why not? -Knowledge building - How? or Why not? -shape your CM style? How? or Why not?
Comparing past and current experiences	How do you compare past experience of team working with COGLE/learning together experience in terms of: -Collaboration levels and cohesion? -Success / Failure of the task itself - one each? -explore why success /fail - skills, goal, commitment, value, trust, risk/stake?

Table 3 Sample Interview Questions and Prompts.

3.6 Data Analysis

Different types of data sources and methods enabled *data and methodological triangulation* when answering the research questions. Summaries of each case include analysis of quantitative data and inductive development and analysis of *story-book* themes (first) followed by deductive identification of *bucket* themes related to trust, confidence, self-efficacy, conflict and its management and regulation. Appropriate statistical methods (see below) were used for the quantitative data analysis and for Qualitative data, i.e. the interview and SSRL survey, were both analysed using both inductive (first) and deductive (second) thematic analysis (Braun & Clarke, 2006).

The students may develop their knowledge, trust, regulation skills and attitudes towards conflict management through working in teams across the three cases. Therefore, the *unit of analysis* here is the individual student. However, to better understand the social dynamics within the teams, I also analysed at pair and group level as was needed for understanding co and socially shared regulation.

The *specific trust* survey results provided trends over time showing how teammates updated the different facets of trust as they spent time learning together. Data was used to see how many participants expressed trust in their teammates at or above the value of 5 on the 7-point Likert scale. During the interview member checking was used to confirm the meanings attached to these values.

Likewise, the *Style Matters* ® survey provided trends over time showing how the preferences of participants varied as they spent time learning together. Here, the counts for the most and least preferred styles were extracted at every stage of measurement. The main intention was to see if participants maintained and/or enhanced their preference for the *cooperative style* as their top preference and likewise reduced their preference for the selfish *directing and avoiding styles* or for the more relation-oriented *harmonising style*.

Another set of quantitative data was the pre and post test scores and learning gain was calculated in each case study. As the sample sizes were small, the nonparametric Wilcoxon Signed Rank test was used to test for significance and non-parametric two series correlation effect sizes r was computed based on the Wilcoxon Signed Rank test z-values. The intention was to assess the effect of learning together on learning gain of participants and to corroborate with related qualitative themes.

The uniqueness of COGLE as an intervention, helped develop existing theory through interrogation of qualitative data from the interviews and the SSRL survey. I transcribed the data from the first six interviews verbatim. A professional transcriber transcribed the remaining ones. I checked the transcriptions and completed inaudible transcription process. The SSRL survey data presented opportunities and challenges alike. This data set helped with understanding the processes involved in changes to constructs over time. Although there were missing responses from some participants for some of the data collection points, collecting data at start/end of each session helped to overcome this challenge.

Using the 6 steps outlined by (Braun & Clarke, 2006), I first coded line by line the utterances inductively and iteratively and in parallel at semantic code level and latent level. Coding at semantic level allowed me to keep true to how participants label events described in the qualitative data. For example, one participant responded as below when talking about cognitive conflicts used in COGLE:

"Yeah… it [COGLE] did remind you… to be really open with what could be the correct answer… and… why, you got it wrong as well. Why [COGLE is]... getting you to talk to each other."

Semantically, I coded this as "*made us more open"* and at a latent level, I coded it as "*together we improved our knowledge"* i.e. they were more confident about their knowledge and "*encouraged a cooperative style"* of conflict management when cognitive conflicts presented.

At the same time, coding at the latent level parallelly allowed me to become aware of my interpretations and my own bias. In the above quote, I can see that I am interpreting being more open as being cooperative and linking it to enhancing learning and self-efficacy. However, later in the interview, the same student reported the following:

> *"It [COGLE] showed you that you have to trust your team members… but you can trust but not to over trust them as well… to trust them but also… actually pick the one that you thought was right… not to follow anyone... It would identify somebody who's got it right and someone who's got the question wrong and would have them actually explain it to them and help them one-on-one to get to have done this... bring them round to the correct answer and understanding."*

Semantically, I coded this as having a *"balance between trust in others and your own confidence"* and the importance of developing self-confidence, using a *"team approach / learning from peers"* in resolving conflicts to *"work together and not just follow"* in reaching the group-wide mastery goal. This re-assured me that my interpretation (latent codes) reflected what the student also thought after using COGLE.

I looked for patterns and relationships as I coded different utterances from the participants. For example, in the above codes and sub-themes, *cognitive-conflicts* are linked with *improved learning* and *self-efficacy* but also *improved trust* between teammates. I used spreadsheets to keep track of the codes and also for organising example quotes for each code. In an iterative process, similar codes were re-grouped into sub-themes and similar sub-themes were grouped into more abstract global themes. At each re-grouping, I carefully checked the quotes to verify that the emerging *story-book* themes, the sub-themes and the codes are aligned and evoke a story for the reader. When all the themes and sub-themes were named, they were reviewed and renamed to make them more appealing and inviting for the readers.

After developing the sub and global themes inductively, I then deductively mapped the theoretical framework related *bucket* themes, which helped identify the new themes that emerged from the data, exposing and exploring the discursive gaps (Ashwin, 2012). This helped improve understanding of the constructs and their antecedents and outcomes. For example, there were many instances of students saying how COGLE helps develop trust and many of these statements mapped to the *bucket themes* from the theoretical framework such as *citizenship, interaction frequency and past-performance* but as the above example shows, resolving cognitive conflicts together also helped in building and or correcting trust in each other, revealing a *discursive-gap.* Use of *story-*

book themes alongside *bucket* themes evoked the key messages, which helped explain the cases. I also counted the number of respondents contributing to each sub and global theme. I linked the themes pictorially and named the themes iteratively.

After the within-case analysis a *cross-case pattern search* (see chapter 8) was done across the *literal* replication cases and the *theoretical* replication case. The cross-case analysis helped discover contrasts, similarities and patterns across the three cases and tested the findings to discover contributions to theory. For deeper understanding, I searched the interviews and SSRL data of individuals who were in the same team. To understand the social settings better, I recoded the data at team and pair levels.

After analysing all data, I attempted to answer the research questions by integrating the data from all sources, benefitting from triangulation between different methods and data types. In addition, this generated descriptions and explanations of how learning and team working is supported within COLT, SOLT and SOWT sessions through the use of case reports and vignettes.

Comparison between the literal replication cases led to contributing to theory on scripting and computer orchestration of regulated learning, team effectiveness and an inclusive framework for supporting NT, ASD and ADHD students through technology. Comparison with the theoretical replication case led to insights on how students normally learn and come together in groups. Crucially, I was able to explore if SOLT sessions are enough to enhance team effectiveness or if COLT had any specific advantages.

3.7 My role as a researcher and developer

This research was carried out with students from multiple schools. The participants joined voluntarily from School of Engineering (where I am based) and the School of Mathematics and Physics. Participants were not my students and therefore I am not so much of an insider, however, I led the development of COGLE, which does make this research open to criticism on the basis of confirmation and researcher bias. The use of mixed methods and triangulation does go a long way in countering these criticisms that are common within many qualitative research studies. The interview questions were often followed up by clarifications where I checked with the respondent in a neutral non-leading way to check my interpretations. When my interpretations were wrong, I gave preference to the respondent's viewpoint in order to maintain the integrity of the research. The parallel latent coding process really helped minimize the effect of my own bias.

3.8 Limitations

One of the limitations of this research is that there are few studies to compare the results with. This however has been addressed to some extent by piecing together relevant research in the discussion in chapter 9. Another limitation is the small number of participants. For this reason, the study cannot claim generalization to larger populations, however, due to the design chosen, i.e. a comparative multi-case study, the claims are strong enough to call for more research in this area using COGLE and other group orchestration systems. A limitation for adoption of COGLE by others is that it would require designing MCQs with options and linked remedial videos that represent cognitive conflicts and common mistakes in a field. This requires experienced authors and is time consuming. Likewise, for topics where MCQs are unsuitable, the results from this study may not be transferable directly and other ways should be investigated.

Chapter 4: COGLE for preparing first year foundation students for a FC activity: Findings

This chapter introduces the reader to the case, the participants, and the use of COGLE within this setting, the purpose and nature of data collected and finally the methodological approach and findings from the analysis of the quantitative and qualitative data collected.

4.1 Research questions

Integrating data from quantitative and qualitative sources, collected at multiple time points to enable *methodological and data triangulation*, the following research questions were addressed:

RQ 1. How does computer orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated flipped-classroom settings?

RQ 1.1 How does computer orchestrated learning together in small groups affects a learner's attitude to conflict management?

RQ 1.2 How does computer orchestrated learning together in small groups affects a learner's development of trust in their teammates?

4.2 The participants and the context

From the Foundation year, 9 of the 125 first year students (see **Table 1** for details) joined the study in three teams of three. One of three teams later dropped out midway as one of them was an exchange student who returned back to their country. Remaining 2 teams completed the study. One of them was a self-declared autistic person.

A real-world case of first year Electrical Engineering (EE) module on the foundation programme where FC is used was purposefully chosen for studying COGLE use. The module had the hallmark issues: lack of student engagement and lecturer having to flip back to teaching and reducing time for *peer-instruction* in class (Bishop & Verleger, 2013; J. Chen et al., 2020; Crouch & Mazur, 2001).

Over three weeks, inside a physical classroom and no lecturer (just the researcher), the teams engaged in 4 two-hour COLT sessions. They used COGLE to watch pre-set videos and master topics in their set teams. Later, the teams designed a filter in a two-hour Student Orchestrated Working Together (SOWT) session.

The EE module bridges the gap between content taught in A level and the Analogue electronics module that students do in the following year. The COGLE videos and question I put together for 4 two-hour COLT sessions and the SOWT FC activity (team project) were found relevant by the lecturer teaching it. The lecturer invited me to recruit participants for this study from their class.

The COLT and SOWT sessions were planned in the first three weeks of the year, ensuring there was no or little overlap between teaching on the EE module and content in COGLE. The next section describes how COGLE was used to prepare students for the FC mini project activity.

4.3 Use of COGLE within this setting

COGLE allows students to *learn together* with their teammates in a teacher-less environment before *working together* on a project within a FC context.

The teaching material chosen covered all topics students needed to know to develop an analogue audio filter as their team project. This included several short videos lasting up to 20-30 minutes in total each day. Several questions were designed to help mastery of the content through COGLE. The options for these questions were deliberately set to increase the chance of a *cognitive conflict* between students.

The GWM script in COGLE promoted its simple goal: i.e. all teammates to answer 10 consecutive questions correctly for mastery. Students were asked to achieve mastery within the 2-hour COLT session and were free to leave as soon as they achieved it. COGLE orchestrated the playing of the videos; the presentation of cognitive conflicts and the interactions between the participants (by grouping/pairing them) in order for them to resolve or temporarily defer these conflicts (using prompts/scripts to that effect); the playing of any remedial videos tailored to address the gaps identified during the attempts.

The researcher only provided technical support with COGLE if needed. The 4 COLT sessions helped prepare students in terms of content and team working skills needed in the SOWT session. The next section describes the data collection procedure.

4.4 Procedures and Data Collection timeline

Table 4-Table 6 shows timing and purpose of different instruments used to collect data.

AT THE START OF THE STUDY	
Data Collected	**Purpose**
Subject Pre-Test	Used in learning gain calculations
Trust Pre-Test	Captures different types of trust levels in their current teams Used as a base line
Style Matters Conflict Management (CM) Style survey) Pre-test	Captures CM style preferences they come in with Used as a base line
SSRL Questionnaire Pre-test	Captures the level of regulation students are familiar with already

Table 4 Data collected at the start of the study.

AFTER EVERY COGLE SESSION (1-3)		AFTER 4th COGLE SESSION	
Data Collected	**Purpose**	**Data Collected**	**Purpose**
Daily Survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data	Daily Survey	Same as session 1-3 (see left).
		Trust Post-Test	Captures different types of trust levels in their current teammates after 4 COGLE sessions.
		Style Matters (CM Style survey) Post-test	Captures CM style preference after 4 COGLE sessions

Table 5 Data collected after COGLE sessions.

The subject test, trust, Style Matters ® and the SSRL survey data collected at the start served as a baseline to compare against for all subsequent measurements.

FC ACTIVITY		
Data collected before	**Data collected after**	**Purpose**
Subject Post-test		Used in Learning Gain calculations
	Daily survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data
Trust Post-Test	Trust Post-Test	Captures different types of trust levels in their current teams before and after the FC activity
Style Matters (CM Style survey) Post-test	Style Matters (CM Style survey) Post-test	Captures CM style preference before and after FC activity
	SSRL Questionnaire	Captures the level of regulation students are familiar with after COGLE use
	Interview	Captures the level of regulation, trust, CM style preferences before, during and after COLT and SOWT session.

Table 6 Data collected before and after the FC activity.

A daily SSRL survey was administered at the end of each session, adapted from (Splichal et al., 2018), which captured qualitative (open ended question) data from students about their experiences of using COGLE and was used to analyse the development of and/or regulation skills in action. At the end of the final COGLE session, both trust survey based on (Costa & Anderson, 2011; Mayer et al., 1995; McAllister, 1995) and CM style survey based on (Kraybill, 2005) were administered. Learning gain was computed by using the subject pre and post test scores obtained from the start of COGLE and start of FC activity session respectively.

All 6 students were invited for an individual hour long interview a few days after their SOWT session. This provided qualitative data about their pre, during and post COLT and SOWT experiences.

4.5 Methodological approach and research questions

The overall design in this case study research is quantitative first mixed methods approach. Due to only 6 participants, the quantitative data was simply described. The SSRL daily survey and interview generated qualitative data and was analysed using the grounded theory based thematic analysis (Braun & Clarke, 2006) as well as deductively using the theoretical framework of **Figure 2**. See section 3.4 for details. The next section reports the several within-case findings.

4.6 Descriptive statistics and themes

4.6.1 Measuring levels of trust in teammates

Trust survey collected data on a 7 point Likert scale at multiple points. Inspired by the National Student Survey style reporting, counts representing high trust (responses at 5 or above) on the Likert scale were used. Member checking was carried out during the interview and students agreed with the meanings attached to their data.

4.6.1.1. Development of trust within the COGLE sessions.

The data in **Figure 7** shows how widespread different facets of trust: affective, cognitive and conative trust, were at the ‘start of study’ and ‘post COGLE’ use. Affective trust reflects how much a student thinks their teammates are likely to help them. Cognitive trust reflects their capabilities and subject knowledge. Conative trust represents their reliability. The counts represent responses at 5 or above on the Likert scale used.

Sometime before the end of the 4 COGLE sessions all students (N=6) developed trust in their teammates in all three facets. Scores increased and decreased showing enhanced awareness about teammates compared to at the start. Clearly all teammates *learning together* in each of the COGLE sessions makes a positive difference.

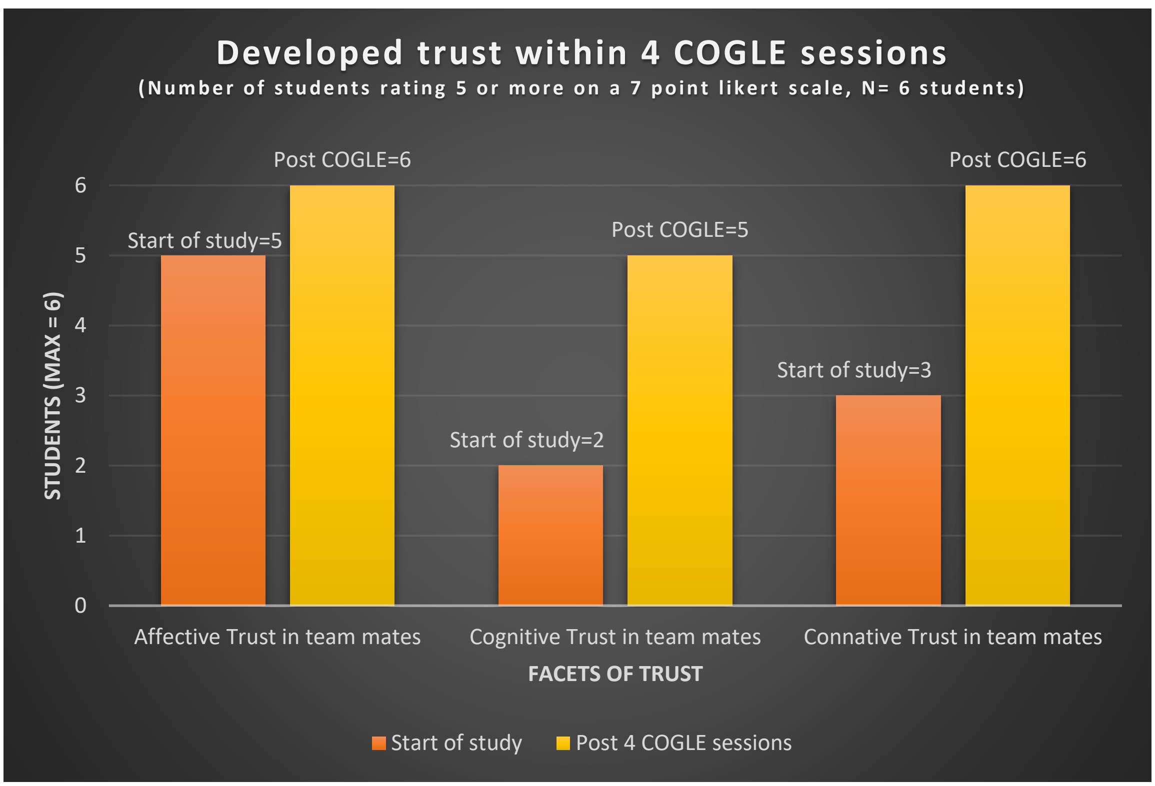

Figure 7 How trust changed Post COGLE use.

4.6.1.2. Widespread trust before the FC activity.

Few days after the last COLT session, the students were shown the details of the FC task. They were asked to decide how they will share a reward of £15 amongst team members if they designed the best solution during the SOWT FC session.

Figure 8 shows the trust levels before work started on the FC activity. Trust in teammates did not change much compared to **Figure 7**. Only one student reported a loss of conative trust in their teammates. I can verify from my field notes that one of their teammates had arrived late to the FC session, which may explain this. Their cognitive trust also dropped to 4 as a result. However, this is not visible in the graph due to the increase in the cognitive trust of a student who was previously below 5.

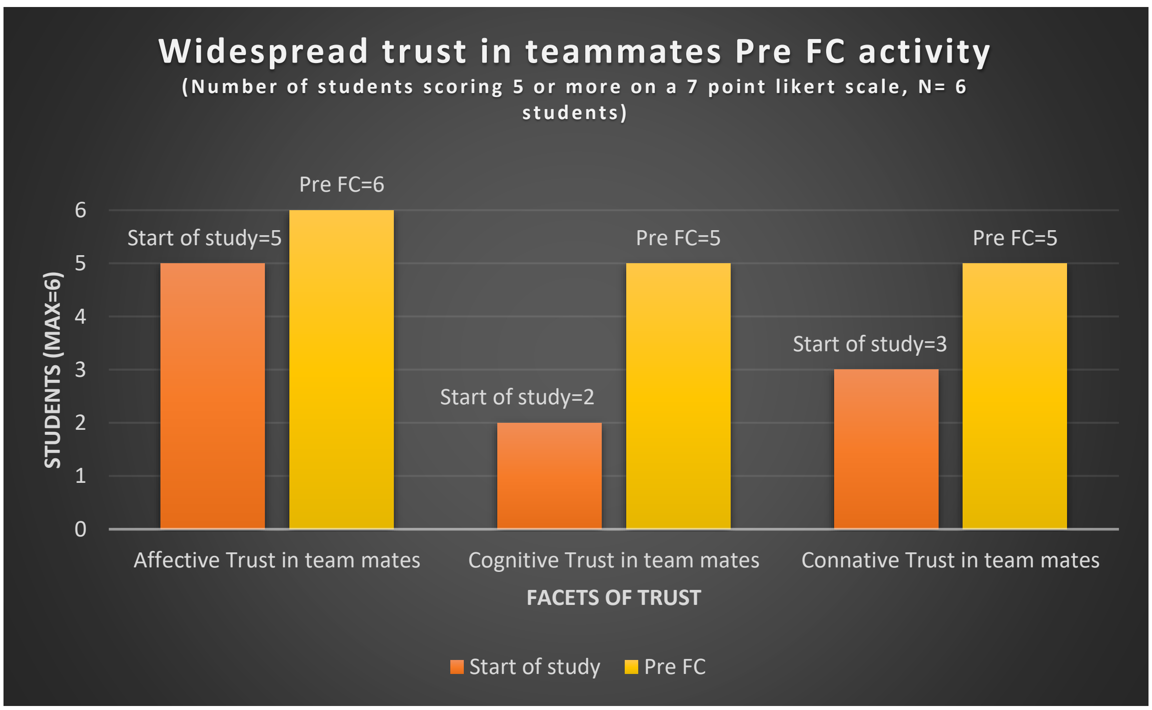

Figure 8 Number of students expressing trust in teammates before FC activity.

4.6.1.3. Trust after the FC activity.

Figure 7-Figure 9 show a more students trusting their teammates going into FC activity compared to start of the study. It also shows a drop after the FC activity. This is

the first sign of fragility and cyclic nature of development of trust in the face of challenges faced within the team. On closer inspection, the data shows fluctuations in the team where a student had arrived late to the SWOT session.

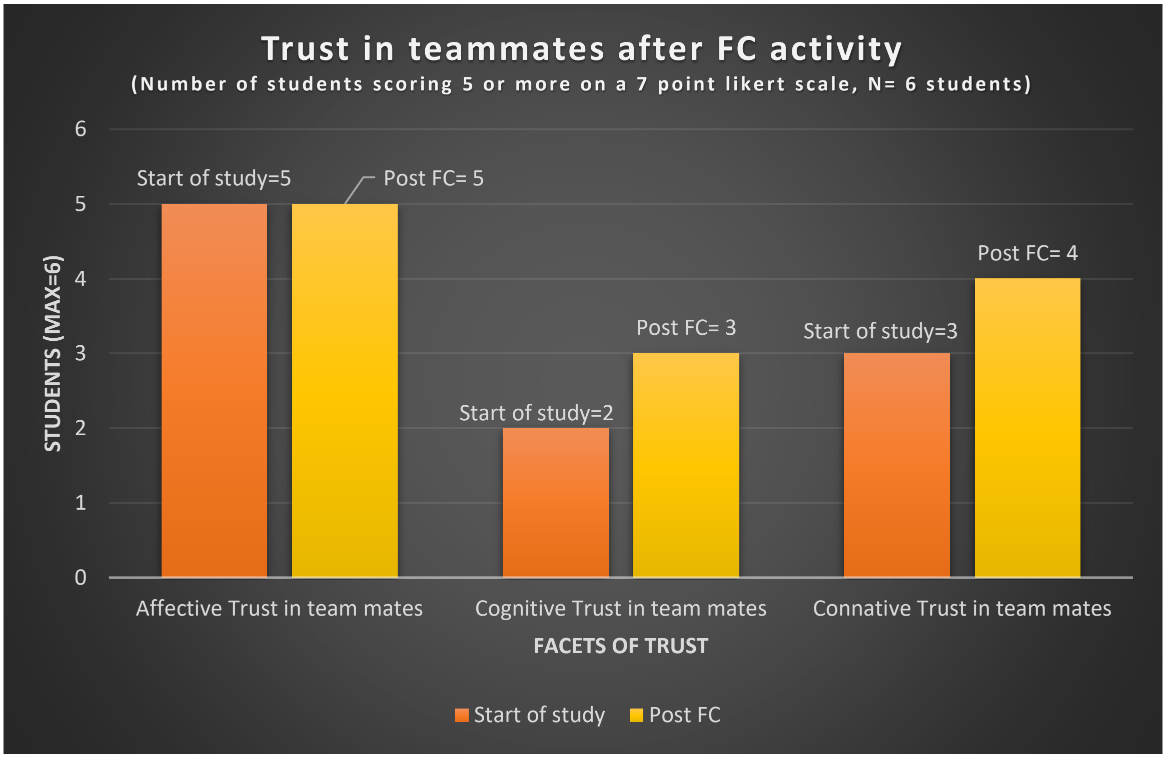

Figure 9 Number of students expressing trust in teammates after FC activity.

4.6.1.4. ASD student and trust

The data suggests that the presence of an autistic student did not impact the number of students expressing trust to be there in their teammates (all facets). This is an important result as it shows that trust was established and it did not drop at all in someone challenged with socio-communication skills in both their teammates.

Due to their socio-communication difficulties ASD students tend to be more trusting of others to avoid conflicts (Yang et al., 2017; Yi et al., 2013, 2014) This was certainly supported in the data. However, the cognitive trust this student reported in others updated from 6 at the start to 5, the most commonly reported level post COGLE and then dropped below 5 post FC, much like the other students. The ASD student was able to update their cognitive trust during COLT and SOWT sessions just as the others.

4.6.2. Measuring changes to Conflict Management Styles

Using the Styles Matters ® survey at the same four points as for measuring trust, I collected data on student preferences of the five CM styles. As shown in **Figure 5**, in chapter 2, a *cooperative style* means that task and relationship goals are both important. The *compromising style* can act as a *portal* for the *cooperative style* as people transition preferences to/from other selfish styles like *directing, avoiding* and *harmonising* where relations are more important over task goals.

a) COGLE encouraged cooperative and compromising as the top CM style.

After cleaning one response, which rated all CM styles equally and possibly not giving enough thought to individual items on the survey, the results of the *Style Matters* ® survey are shown in **Figure 10** and **Figure 11**. The *cooperative* style became the most preferred style for all students after 4 just COGLE sessions (from 2 to 5/5 student) and remained so before the SOWT FC activity.

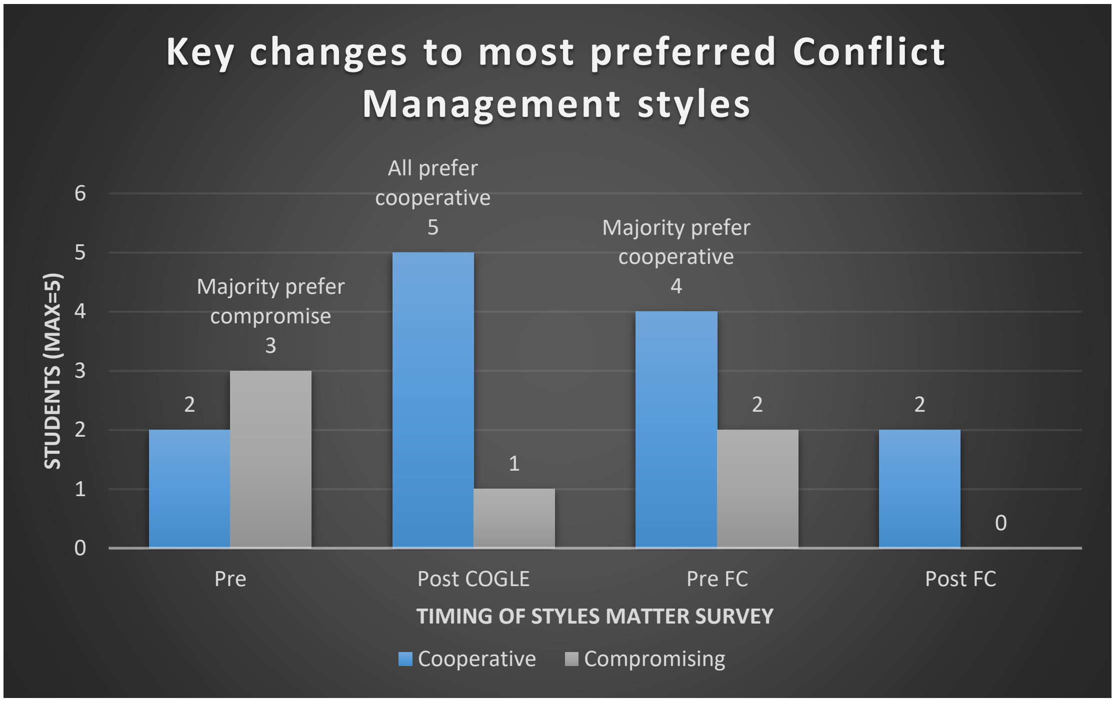

Figure 10 Most preferred styles at various stages of the study.

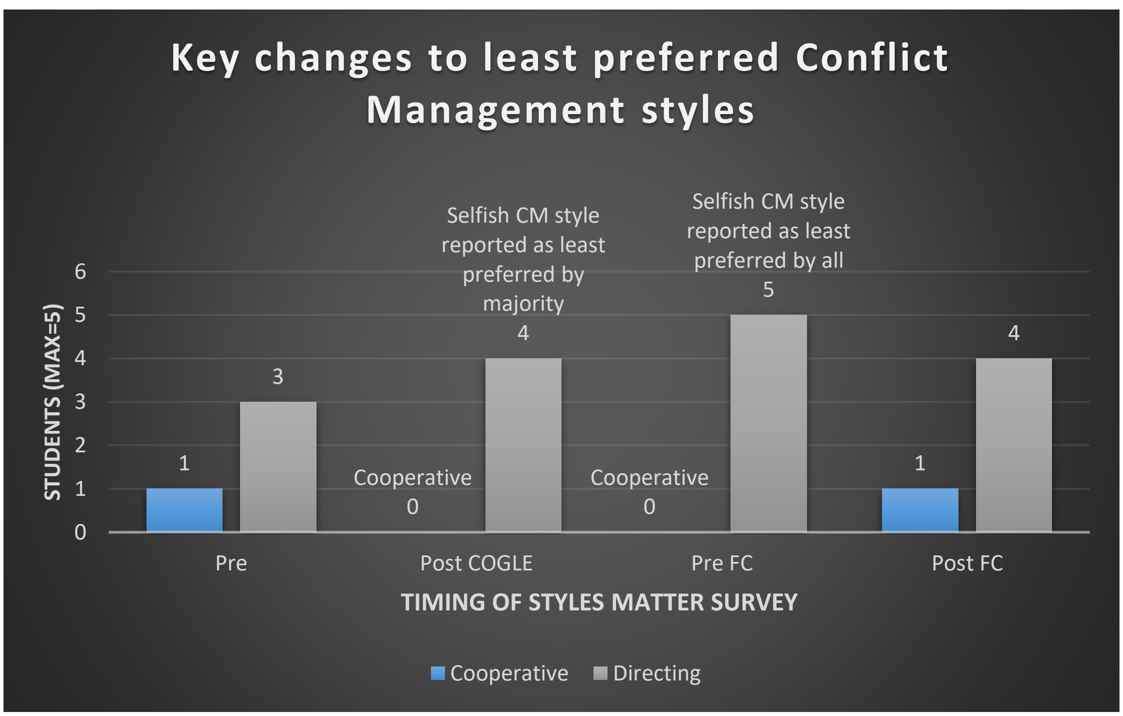

Figure 11 Least preferred styles at various stages of the study.

The post FC results indicate that the *cooperative* and the *compromising* style were no longer the top styles, the scores did not drop much and were only slightly below the *avoiding* or *harmonizing* scores. Noteworthy is that the ASD student preferred *cooperative style* throughout and managed to reduce their score for the *avoiding style.*

b) COGLE discouraged the directing CM style.

Figure 11 adds to the above trend as it shows COGLE increased the number of people reporting *directing* as their least preferred style (from 3/5 to 5/5) just before but also after the FC activity.

4.6.3 Pre and Posttest analysis of learning with COGLE

Student	Pre-test Score%	Post-test Score%
A0	17.39	60.87
A1	17.39	30.43
A2	43.48	60.87
A3	34.78	82.61
A4	43.48	73.91
A5	0	43.48

Table 7 Pre and posttest scores (Case 1).

Student	Absolute Gain	Normalised Gain
A0	*43.48*	*0.526*
A1	*13.04*	*0.159*
A2	*17.39*	*0.308*
A3	*47.83*	*0.733*
A4	*30.43*	*0.538*
A5	*43.48*	*0.435*

Table 8 Absolute and normalised learning gain for each student (Case 1).

A GWM approach orchestrated by COGLE, resulted in a noticeable *normalised learning gain* (NLG) as calculated using the equation (a). This equation requires data to be in percentages as the denominator has the 100 term in it, depicting the gain in scores normalized to the gain that they could have made. The approach should also bolster the student's *self-efficacy* as several self-assessment questions were used before achieving GWM (Panadero et al., 2012).

$$NLG = \frac{\%<Posttest> - \%<Pretest>}{100 - \%<Pretest>} \quad \text{(a).}$$

a) COGLE enhanced the normalised learning gain for all participants

The scores are presented in **Table 7** and **Table 8**, where 0 represents an actual percentage score, were used, due to small sample size, in the nonparametric Wilcoxon Signed Rank test, to compare the pre and the post scores from the same participants. A W-value, Wt =0, which is <= critical W-value, Wc=0 (at n=6), means the difference in scores is significant at (p<0.05). With a Z-value of -2.2014 (p value cannot be computed due to small sample size), this equates to a large and significant two series correlation coefficient effect size r = -0.6355 due to the intervention using equation (b) below.

$$Effect\ Size, r = \frac{Wilcoxon\ signed\ rank\ test\ \text{Z-value}}{\sqrt{(number\ of\ observations)}} \quad \text{(b).}$$

It is noteworthy here that all NLG values are also positive and only one value is between 0.15 < NLG < 0.3. NLG of the ASD student (A0) is within the range of scores achieved by their teammates in team 1, student A1 and A2. This suggests that in terms of enhancing NLG and self-efficacy, COGLE is an inclusive, efficient and effective way to run COLT sessions. In addition to this, both teams scored high in the FC design activity (Team 1: 85% and Team 2: 94%). Team 1 presented filter response with wrong axis, which lost them extra marks.

4.7 Qualitative analysis

This section first presents the themes from the SSRL survey, administered before start and after each COLT and the SOWT session. Next, it presents the themes from the post SOWT interview to provide alternate, sometimes more detailed, insights.

4.7.1 Measuring regulation of learning

Free text answers to SSRL survey questions were coded and analysed as described in Chapter 3. In the theme development stage of the thematic analysis (Braun & Clarke, 2006), the regulation of learning work by (Splichal et al., 2018) was used to deductively map activities like goal setting, making plans, monitoring and reviewing linked to SRL, CoRL and SSRL. Deductive coding was also done using the theoretical framework for antecedents of trust and identifying conflicts (**Figure 2**). Multiple theoretical lens used here allowed understanding regulation of learning in terms of the other constructs in this study that would otherwise have been missed if I only used the work of Splichal et al. (2018) to guide the analysis. In fact, other themes that emerged inductively were also preserved.

4.7.1.1 Importance of self-efficacy, early communication, trust, regulation, conflict management and cooperative skills (past experiences)

SSRL involves *working together* in a *shared* (planning, monitoring, and revising plans) way to meet *shared goals* of a team. **Table 9** summarises the themes and the frequencies at which they appeared in the responses.

CoRL, shared *monitoring* and *shared revision of plans* were not found in the responses, however, this may be a limitation of the questionnaire. *Working together* to meet a *shared goal* was an identifiable theme in 5 out of the 6 responses for a successful group-work. However, just one of the respondent chosen an example from educational settings. Most had experienced *delayed shared working*, after individually working on part of the overall task. Only 2 had experience working together throughout. As sample responses show this respectively:

Themes/ Sub-themes	Description	Count
Self-efficacy	Believing in own abilities to deliver the set goals.	4/6
Communications	Interacting with others in the team from the start and often.	4/6
Trust	Believing in others to deliver the set goals.	4/6
Conflict Management	Knowing when to resolve or defer conflicts.	3/6
Shared goals / SSRL	All working towards the same set goals.	5/6
Shared working	Working together throughout on all the tasks, supporting each other in the process.	1/6
Delayed Shared working	Working together only in the later presentation stages	4/6
Shared working as needed.	Working together as needed both individually and in a shared way.	1/6

Table 9 Themes & frequencies in SSRL survey - past experience of teamwork (Case 1).

"[Student] presentation where none of us knew any of the topic and *worked to individually research* different areas and *brought it all together*. We all *did our part* and *brought it together* nicely." (Bob)

"I realised that the key element to solving the problem is … *work over the problems together to reach the target* that you *are all striving for… I wasn't always correct* … but *knowing when to listen to the team* … is what allowed me to have a better quality of service to my customers." (Frank)

The above quotes recognises the role of *shared goals* that *all are striving for* as well as that of resolving *conflicting* opinions in achieving these goals.

The *autistic* student reported minimal exposure to CoRL or SSRL as seen below:

"Sometimes it goes right, sometimes it doesn't! … If it goes badly I will *let the other individual rant... Will usually wait until they leave and then make the corrections* (if needed)*."* (Alex)

The approach Alex used was to *avoid* resolving issues through discussions and finish the task themselves and without *shared working*. This could cause bigger *conflicts* later despite wanting to avoid conflicts in the first place. It may be seen as claiming superiority over others and Alex may end up losing their trust. These past experiences capture the diversity of experiences, which can be triggered through orchestration as well as highlights the need for new experiences to be orchestrated for successful teamwork. The next section reports on the themes that relate to the changes in skills and attitudes relevant to team working and how they were linked to the COGLE use.

4.7.1.2 Changes in skills and attitudes: the role of COGLE.

As described in Chapter 3, a thematic analysis of the free text comments was carried out inductively and deductively. The key themes that represent the SSRL data are tabulated along with their description and frequencies in **Table 10**.

Themes / Sub-themes	**Description**	**Count**
Orchestrate CoRL and GWM	COGLE paired students to teach and learn each other in order to achieve GWM.	6/6
Help reduce social awkwardness	Initial pairings may have felt forced or wired but soon it made them interact smoothly without the awkwardness.	5/6
Supports smooth cognitive conflict resolution.	COGLE paired students that had different answer, which were designed to create cognitive conflicts as the options represented plausible answers. There was support in the form of correct answer, remedial videos and deferral options.	4/6
Help build self-efficacy and trust	Repeatedly answering questions until ten questions are answered correctly in a row by all those in the team helped build both self-efficacy as well as trust in each other as they interacted and helped each other under the control of COGLE at first and then on their own too.	5/6
Students can overtake co-regulation with COGLE in the background	Initially triggered by the *positive frustration* caused by the *high penalty* associated with mistakes made during mastery cycle, CoRL changed hands several times between COGLE and teammates and eventually preferred doing it themselves.	5/6
SSRL can be internalised as trust and self-efficacy grows	Practicing CoRL under COGLE and own control help build the trust and self-efficacy, which in turn allowed them to internalise the correct SSRL scripts of chasing a simple goal of GWM via discussion and smooth cognitive conflicts resolution.	6/6

Table 10 Themes and frequencies in SSRL survey – role of COGLE.

a) COGLE can orchestrate CoRL and GWM that helps them interact early and often and supports smooth cognitive conflicts resolution

The pairing of students for *CoRL* by the PI script and the *high penalty* of the coercive *GWM* script had many effects on the students. See section 1.4 for more information on how COGLE works. For one it encouraged students to *interact early and often,* to learn/teach the topic from multiple viewpoints, allowing a reduction in *social awkwardness*:

"[Pairing] was *a bit weird* as explaining a topic. And *went well*. [Pairing] *allowed us to discuss* the topic." (Dan, *session 1*)

They were seen *helping others* learn or *resolving any cognitive conflicts peacefully* or using COGLE to *peacefully resolve* interpersonal conflicts:

"*Some debate* [sic] over answer *but worked together* to find *one we all* understood." (Bob, session 2)

"By *allowing us to vote* on who should explain the question… any *argument was* [sic] *quickly resolved*." (Cyrus, session 2)

b) Mastery can help build self-efficacy and trust between teammates

COGLE provided them with *numerous opportunities* to enhance *self-efficacy* and *trust:*

"*Allowed* people to *be more confident* when discussing questions and to *build on everyone's knowledge.*" (Cyrus, Session 2)

"As *we all talked* we got the input of *each of our strengths* of the subject applied before answering." (Frank, Session 1) *c) Students can overtake co-regulation with COGLE in the background*

They *co-regulated* the learning of their teammates *on their own* when they were more confident:

"*This* [COGLE led orchestration of CoRL] *didn't really happen* during the session. *But we all helped* to explain and understand concepts *when it was required*." (Bob, Session 2)

COGLE was always there to *back up* students if their attempts failed:

"[COGLE helped] by *giving an opportunity for others* to explain ... each one did it *differently* so [COGLE] helped with *improving my knowledge*." (Alex, Session 3)

d) SSRL internalised as trust and confidence grew

Mastery enhanced their *self-efficacy* and their *trust* in each other. They *joined forces* to *overtake* COGLE in *shared planning and working*, although these skills developed over the 4 sessions in a cyclic fashion:

"We was all tired today but *we all had something to contribute* when needed. I think it was *more of a team effort rather than the system* that helped us progress this time." (Frank, *Session 4*)

e) Coercive GWM script

Interestingly, if a student aligns to a different goal, than GWM, the coercive and repetitive nature of COGLE can correct this. On the first day, to *reduce time to mastery* (different goal) and *avoid arguments* (instead of resolving) one student regulated others to follow "majority wins" approach when answering:

"*We agreed to disagree* and learned that the *majority of the members answers were correct*, when one person wasn't correct, *they agreed to go with our answers* in order to avoid conflict." (Cyrus)

However, due to *high penalty* they had to do a lot more questions, as the majority were not correct all the time. This resulted in a *burnout* and *frustrations* in this group on the very first day. As COGLE overtakes when students fail to CoRL each other, it made them *correct their course* and achieved mastery eventually by working together.

"[We] *just worked together as a team* to complete the *ever increasing questions* (which was a bit frustrating)." (Alex)

This *backup support* from COGLE helps as the *teammates falter*, allowing flexibility in student control and COGLE control to practice CoRL and the coercive *GWM* script ensured practicing of SSRL skills.

f) Summary

During the 4 COLT sessions as *trust and self-efficacy* enhanced, the *PI scripts* and *GWM scripts* had been *internalised*. They were ready for the SOWT FC activity as demonstrated by content mastery and the ability to co-regulate teammates. Their SSRL skills grew over the sessions too. The next section shows how internalised scripts made it to the un-orchestrated FC activity.

4.7.1.3 *Shared regulation within the SOWT FC activity*

Themes/ Sub-themes	Description	Count
Shared goal and working together	Aiming to finish the task as a team by working together (except Frank all).	5/6
Delayed working together	Teammate worked individually and started working together late.	1/6
Unbalanced division of labour	Feeling that some teammates had more to do than others (Cyrus).	1/6
Satisfied with the outcome	Feeling that the design met its specifications (Alex and Frank).	4/6
Satisfied with the team working	Feeling that the teammates worked well together (except Cyrus and Frank).	4/6

Table 11 Themes and frequencies in SSRL survey – Shared regulation in FC activity.

Table 11 shows that they identified their *shared goals* and made *shared working plans* tackling challenges together from the start and *delayed shared working* in case of one student:

"*We* were very *quickly* able to *come up with* suitable *numbers and circuits between us*, when we were struggling *we were usually able to take a step back* and solve the problem…*we did struggle*… however *we worked well as a team through the issue*" (Bob, Team 1)

"Today *I* struggled to have any input *on this activity* as *I spent* most of the time *understanding how things work together* on the circuit and *once I figured* these parts out the work was *almost complete*" (Frank, Team 2)

Team 2 is where Dan arrived late for SOWT FC activity. A *drop in trust* was noticed in this team before the FC activity, which prevented interactions between Frank and the other two. In fact, Evan and Dan showed *shared working* and by the end they all came together. Evan summarised, the *delayed shared working* as:

"*We combined all our ideas together to get it all right* [before submitting]." (Evan)

The quote shows that they overcame the initial loss of *trust* in each other at the start of the SOWT session. They *valued each* other enough to *combine* their ideas and *worked together* (use of "we" vs "I") as opposed to avoid *conflicts* within the FC activity.

However, during the interview, despite being happy with working together during the SOWT activity, one student felt that they had to *help others a lot* creating a feeling of *unbalanced division of labour*:

"*I had to explain a lot to my teammates* who were less knowledgeable." (Cyrus)

4.7.1.4 Section summary

GWM and the PI script made students practice and master content and skills (such as *often and early communication*, *cognitive conflict resolution* and *helping each other*), which enhanced their *self-efficacy* and *trust* in each other. Orchestrating themselves at times with support from COGLE played a huge role in practicing and acquiring CoRL and SSRL skills. Most students knew the importance of *shared goal* and *working together* from before. During and after COGLE use, they showed triggering and transfer of the CoRL, shared planning and working elements of SSRL into the FC activity without the need for scripting all SSRL elements. Importantly, COGLE helped internalise shared working from the start, despite most having experienced *delayed shared working* in their past. The SSRL survey has its limitations but has managed to capture a lot of interesting dynamics.

4.7.2 Key dimensions, themes and sub-themes from the interview (SOWT part)

Team 1 and 2 had agreed to share the £15 reward equally if they won. From the field notes, I observed that only Frank chose to solve the task individually and showed *delayed shared working* while the others *worked together* throughout. Post SOWT each participant was interviewed and the transcripts were coded inductively coded and analysed, as described in Chapter 3, using the 6 stage thematic analysis approach (Braun & Clarke, 2006). As coding continued, constant comparison with new data and existing codes helped with improving the codes. At the theme development stage, deductive themes were merged with the inductive themes using the theoretical framework. In particular, themes related to antecedents of trust, conflict and its management, regulation of learning and the final themes are presented here.

Two key dimensions relating to team working emerged: ‘Effective team working’ and ‘Reflections on team working’. The themes and sub themes within each of these dimensions are shown in *italics* in the next section and quantification of the themes is presented in **Table 12**. The sample quotations are presented to elaborate the meanings further.

4.7.2.1 Key dimension 1: Effective team working

The following quote sum up this theme, the students were *confident* and *satisfied* with their team's work:

"I think *we did quite well…we were confident* on our numbers cause *we double check* them all." (Bob, Team 1)

Themes/ Sub-themes	Description	Count
Shared goals, planning and monitoring	Aiming to finish the task as a team and happy with shared planning and monitoring.	6/6
Shared Working	A team working together.	5/6
Delayed shared working	Worked on the whole solution individually and combined work with teammates when submitting.	1/6
Trusted each other	Teammates trusted each other due to COGLE interactions	6/6
Resolve conflicts in calm way	No tense or hostile moments and resolved all conflicts in calm way.	6/6
Team satisfaction	Feeling that the design met its specifications.	4/6

Table 12 Themes and frequencies in interview (FC activity) – effective team working.

The next few paragraphs detail the themes and sub-themes that emerged in more details.

a) Shared Goal, plans and monitoring:

All students, see **Table 12**, on the FC activity day had the *Shared goal* to *finish the entire task* as a team within the set time. They *shared* their *work* with others who *monitored* and *reviewed* the suitability to make sure their solution worked:

> "E*veryone felt* that they had a *really good grounding* in the subject area that *everyone is working* on in the project. *I worked on the values of the resistors capacitors…another person in our team was researching*... like the high pass and

low pass filters…*another person was Working out* how the circuit would work…everyone work together... *this is what I found…ok this is what I found* & then *we can put them together and find the outcome*" (Cyrus)

b) Trusted each other

Through COGLE sessions they realised that they are *stronger together* and *trusted each other* before and after the FC activity:

"As three parts *we formed a stronger whole* than single." (Alex)

"I think *3 Minds are better than one*." (Evan)

They *knew the strengths and weaknesses of each other* (cognitive trust) and they *cared for each other when stuck* (affective trust) during the COLT and SOWT phases:

"Dan'd shown that … *he knew quite a bit* beforehand …in what we did [in COGLE]…*he quite excelled it... so I trusted him* in a lot of stuff we got." (Frank)

This trust had actually developed between the teammates over a short period of COGLE use and is be explored in section 4.7.3.1e.

c) Calm

Over the 4 COGLE sessions they had become *comfortable working as a team* and *conflicts* were *resolved* peacefully.

"I think it was *nice* to see how *we'd come together as a team*. But... good little task to do." (Bob)

The *delayed shared working* in team 2 shows they were accommodating when Frank expressed *low self-efficacy* and they resolved this without compromising the outcome:

"I was *learning bits and pieces* about the circuit….but I was kinda [sic] struggling to put two bits of my part together... *I wasn't 100% sure... what we* *were... meant to do...* but *we kind of all talked...* and *figure that out in the end*…so.. I think it was… *a bit reserved* but *we weren't... hostile towards anyone [chuckles]*." (Frank)

Team working can be less than ideal experience for most. There are some things that do not surface during the actual team working as people are focused on making it a success. Such muted feelings are captured in the second dimension that emerged in this work.

4.7.2.2 Key dimension 2: Reflections on team working

The interview data captured muted feelings of *low self-efficacy* and that of *too much trust* in one student during the SOWT phase.

Themes	Description	Count
Low Self-Efficacy	Feeling not ready at the start of the activity (Alex and Frank)	2/6
Too much trust	Feeling others trusted them too much left them feeling short changed (Dan and Cyrus)	2/6

Table 13 Themes and frequencies in Interview (FC activity) - Reflections on team working.

a) Low self-efficacy

Students who had *low self-efficacy* at the start of the team working, showed this in various ways. Frank *delayed shared working* and became quiet during the bulk of the time and as he was working on the full solution on his own, joined in later.

> "*I was also trying to piece it together in my head* like how the system works….which I got there but *I didn't make a lot of contribution towards the actual team answer*… Well *I went over it [team answer] at the end...* and *I feel like we got the correct answers.*" (Frank)

The team did not let *delayed shared working* affect the *shared goal* of the team as they all *trusted each other*. They could not resolve a cognitive conflict around the value of a resistance which was no one's fault as they did not cover that topic in COGLE.

b) Too much trust

Cyrus, Bob and Alex were in the same team, and naturally on reflection, Cyrus felt that *too much trust* was put in him to finish the task. When asked hypothetically, how they felt about sharing the £15 reward equally, if they won, it left him *feeling shortchanged*.

"Maybe… *I felt that I did more* of the work than the rest of the team" (Cyrus)

Cyrus valued the newly formed relationship and did not want to ruin it by talking about an unequal split:

"*I kept it [the feeling of being shortchanged] to myself*... I didn't want... *ruin friendships and everything*." (Cyrus)

In both teams this did not impact the outcome of the work as they all checked the final solution and were satisfied with the solutions being submitted as a team.

4.7.2.3 Role of technology (COGLE) in effective team working

In pursuing why the team working experience was the way it was, links to various aspects of COGLE were mentioned.

Themes/ Sub-themes	Description	Count
Help build trust	COGLE seen as key in helping build trust in teammates.	6/6
Internalise scripts	COGLE seen key in helping internalise scripts used in the final day	4/6
Self-Efficacy	Mastering content made them feel more confident	4/6

Table 14 Themes and frequencies in Interview data (FC activity) - role of COGLE.

a) Self-efficacy

COGLE was also responsible for increasing *confidence* through GWM. This meant students could easily communicate reducing *social awkwardness*.

“I think because *we gained the background knowledge from* … from your website thing [COGLE]... and then there was this thing... what I would say *open and confident... it was easy to talk to one another.*” (Evan)

b) Internalise scripts

The repeated interactions help them *internalise* the *PI script*, which made them *rely more on each other* to succeed in the SOWT session. The impact of GWM script was similar, their enhanced *self-efficacy* made them more *goal oriented* and triggered SSRL in the FC activity:

“it's just *we were more confident* we could do it like that [*shared working*] because I've seen … when one person’s struggling *cause that's how COGLE works* as well as we know we will get through a lot easier that way” (Bob)

They even used the same *conflict resolution technique* as promoted in COGLE (*voting*) during the FC activity.

“I think they [Dan and Frank] had *two different values*…. they all came in like a specific range … so we were like … *which one do we go with*…. And so we just did a *group [vote]* and we went with Dan’s [values]” (Evan)

In other words scripts related to Co and SSRL were successfully internalised and used in the un-orchestrated FC.

4.7.3 Themes from the 4 COGLE sessions

Through repeated and balanced interactions between teammates, the *PI script* in COGLE promoted *citizenship* and *conflict resolution* and *provided arbitration* to resolve cognitive conflicts. The *GWM script* promoted goal orientedness in students.

4.7.3.1 Orchestration as a catalyst

As shown in **Table 15** from day one COGLE encouraged *natural communications to flow quickly* and took away the feeling of *social-awkwardness* common in any new group. The *PI script* made peers engage in CoRL and to develop *shared plans* and internalise *shared goal of GWM.* The coercive *GWM script* encouraged them to master the content and *enhance* their *self-efficacy*. The *high penalty* associated with mistakes *corrected over-confidence* and encouraged *cooperative behaviour*.

Themes/ Sub-themes	Description	Count
Encourage natural communications	Quickly overcome social awkwardness and make communications feel natural.	6/6
Overtake orchestration for mastery	Made students overtake COGLE in regulating each other and made them plan amongst themselves how they will achieve the shared goal.	6/6
Encourage internalisation of shared goal of GWM	Everyone aligned to the shared goal of working together to achieve GWM	6/6
Enhance learning	Help master content and learn the topics well.	4/6
Correct or Enhance self-efficacy	Felt more confident in the topics or got their over-confidence corrected.	3/6
Promote conflict resolution	Cognitive conflicts were not seen as conflicts but provided practice to hear each other's views to allow conflict resolution scripts being internalised.	4/6
Build trust through numerous opportunities	Interactions, frequency, helping each other, cognitive conflicts all helped in building different facets of trust between teammates.	6/6
Not taking shortcuts and working in tandem with COGLE	Internalising COGLE scripts and using COGLE as a fallback if their own scripts did not work or when they wanted COGLE to play its part.	4/6

Table 15 Themes and frequencies in interview (COLT part) - Orchestration as a catalyst.

The system was seen as *promoting conflict resolution* through cognitive conflicts presentation and prompts to help resolve these conflicts. The system provided *numerous opportunities* to build different *facets of trust* by helping each other and additionally resolving cognitive conflicts. The latter in particular was impactful in enhancing trust in teammates.

a) Build trust

Students felt that COGLE helped in increasing their knowledge of the *strengths and weaknesses of each other*. The GWM in COGLE helped build cognitive trust in teammates:

"*We knew...* umm… *all applied knowledge that we learn together* [in COGLE]... and worked well as a group." (Dan)

Learning together and in a predictable and regular way, working towards GWM may have also helped build *conative* trust. The affective trust maybe is linked to factors such as time spent together, multiple interactions and looking after each other when stuck, which also happened during COGLE sessions.

"To start off with *we don't know each other* [sic] and *COGLE also definitely helped* [in making us a team and trusting each other]." (Frank)

a) Encourage natural communications to flow quickly

In each COLT session, *PI script* creates *numerous opportunities* for interaction by *pairing relevant team members* in CoRL. Immediate feedback on the correct answer helps arbitrate cognitive conflict resolution and /or gives students enough confidence to help others when they are correct. This support makes them feel more comfortable, taking away the *social awkwardness*. This was a remarkable achievement of the system and it enabled *natural communications* quickly within the teams.

> "So it [COGLE] helps you, especially if work[ing] with the same people … it does help *get a level communication* with each other going …it *forces you* to *communicate* when you get questions wrong, in that *so when you do it wrong... elsewhere you are more happy to talk about it more*" (Bob)

If one student gets a question wrong, the whole group is pushed away from GWM. Such *high penalty* resulted in *positive frustrations* and made them want talk discuss from the first day.

"I see it [the frustrations] *more as a positive*….. it's [COGLE] *forcing you to converse with your teammates*... on your own accord more than is it's telling you to." (Dan)

b) Encourage having a shared goal and shared plans

Near GWM, it triggered cooperative behaviour in them, as otherwise the *high penalty* would force more work on them. It was surprising to see that they *overtake* COGLE and *discovered their own script* to achieve GWM. The *frustrations* of the *high penalty* triggered *shared planning and strategies* in order to achieve their *shared goal.*

> "That [*high penalty*] *could create conflict*... because of the knowledge gap... and *that would have created frustration*... *we were gaming the system*... otherwise we would of done 50 questions... *I think we wanted to get the questions right, so we worked collaboratively.*" (Alex)

In doing so, they moved from orchestrated CoRL to orchestrating CoRL on their own.

"*As we knew that it [penalty] was coming up* It's (sic) sort of *forced us to discuss it before* …It's where the system sort of also shined." (Dan) *c) Enhancing self-efficacy and learning from peers*

It was even more surprising to notice a feeling of *burnout* in the first session when one student tried to *overtake* COGLE to save time and quickly see him *review the approach with others* as they all became determined to get the GWM. Practicing the same thing several times gave their *self-efficacy* a boost, such that they *were able to discuss it more* and *regulate others*.

"To work out the resistance of a series circuit … *I have gone over the numbers like … three or 4 times* on adding it and *i think that I am right* then *obviously I am gonna push my idea forward.*" (Evan)

Their *self-efficacy* also got enhanced each time they were asked to explain their thinking to those who needed help or there were *cognitive conflicts* that needed resolving.

"I think as *it tells you to teach people if you've got right not wrong*, it *makes you feel quite good* …the system is more about developing the team work." (Bob)

d) Promoting conflict resolution skills through cognitive conflicts

Several times, in the sessions *cognitive conflicts* were presented. These needed to be *resolved* before *mastery* was achieved. It gave them practice of taking a *cooperating approach* to *cognitive conflicts.*

"[The cognitive conflicts made us] to work as a team... to *help each other* overcome those conflicts in knowledge and understand *Yeah…. understand ….why ….helping everybody else* and get the correct answer in the end." (Dan)

They reported that COGLE *enhanced their CM styles* increasing a more *cooperative approach* to conflicts.

"Oh... it *[COGLE] definitely aided* our like... *communication and teamwork* …because we have been *practicing* with the whole *explaining to each other idea*…I think that's what avoided conflict [resolved cooperatively] because … we were *more happy to chat* with each other about why your answer was wrong and *instead of arguing* about it." (Bob)

As the student overtook the system and discussed their answers on their own, this could leave an unresolved conflict in the group if there were *over-confident* students in the group. However, as COGLE *highlights the correct answer* this acted as *arbitration* between conflicting students. The conflict resolution process remained peaceful and students can all be on the same page in the end and it helped with *confidence correction.*

"That [immediate feedback] …helped with teamwork... you know…*stop arguments... can't really say it wasn't right when the system shows you it was*." (Cyrus)

By the end of the 4 sessions they had resolved *numerous* cognitive conflicts that they stopped seeing them as potential for a *heated conflict* and instead discuss things on their own showing signs of *cooperation* and internalising SSRL elements.

"We decide on maybe... so *we work out who's made a mistake* and where *without anything being heated*." (Bob)

e) Numerous opportunities and ways to build different facets of trust

Numerous interactions orchestrated by the *PI script* and the immediate feedback, increased the *knowledge of strengths and weaknesses* of teammates in real-time. Gaining access to *relevant past performance* information that informs the development of *cognitive* trust. It helped resolve conflicts together but also enhancing their trust even more in a cyclic way.

"Understanding your teammates thought processes to a degree is important to cause it'll *help you deal with conflict*…and *working with the team* … why they got a question *wrong* or why they got it *right*?" (Dan)

They all needed to *help* and *understand each other* several times in order to achieve the *GWM,* which helped increase their *affective trust* and *conative trust*.

"Just using the system... *getting to know each other*... we *didn't argue* when the system told us to [discuss]… *just builds a bit more confidence in each other*." (Bob)

"You know that they *are more reliable, if they're always getting it right* and *they're always helping... COGLE system it helps you to know who to trust.* " (Cyrus)

The speed at which this trust developed is also remarkable. In just *2-4 sessions* students developed trust in their teammates.

"I think [to] start building confidence... *2 or 3 [COGLE sessions] would be really good* to … start *getting into it properly as a team.*" (Bob)

Resolving *cognitive conflicts* can be seen to have multifold impact on building *self-efficacy*, *affective trust, cognitive trust* and even *conative trust* in the following two quotes:

> "I think it *[cognitive conflicts resolution] builds your trust for each other*, cause you know that *when things are going wrong*, …They're *not going like started [sic] being down* on you … *it's gonna be a healthy discussion ….it will give you trust* cause you know *you can afford to be wrong*, you've *got more confident*, cause if you wrong you don't wanna be just so shut down a bit. If they *answered differently* and *they were wrong*, they you would be like... like *where did you get that from*….but if they *answered differently* and *they got it right* then *you'll be like... OK*." (Evan)

This multifold impact on several antecedents of trust may be the reason why the trust developed quickly in COGLE sessions. The fact that they made *shared plans* to *overtake* COGLE in order to continue and achieve their *shared goal* of *GWM* is an indication of how trust and self-efficacy can trigger shared planning and working without directly scripting these.

4.7.3.2 Strategy that makes or breaks

Strategising to *overtake the system,* instead of having to do things under external control became evident very soon in the COGLE sessions. Some largely *aligning with the scripts* and *some discovering their own* happened when using COGLE. Where they internalised the right script (largely aligned or system) it helped them in *becoming a team*. While others who decided on *taking shortcuts* and focused on wrong goals and scripts had to later reflect on their choices as they experience *frustrations and burnout.* In either case this prepared them for the FC activity that was to follow.

a) Internalise the correct scripts to become a team

As seen before, orchestrations act as a catalyst for the students to internalise various good ways of working when working in teams. When students took the entire team with them and discuss in a *cooperative* way and aimed for all teammates to *master* the content, they have become a team. The *high penalty,* which meant having to do lot more questions, helped *maintain and/or enhance* certain *CM styles,* such as *cooperative,* whilst potentially *suppresses other CM styles* e.g., *directive*.

> "*GWM highlighted* the *need for collaboration cooperation over directing…* everybody *had to understand* it from the same viewpoint... and *if you directed and told everybody this is the answer*... they *weren't actually learning it* they were *just copying* whatever you were doing... *So it did reinforced it* [*cooperation*]." (Dan)

The more *confident* they were about themselves and their teammates the more *cooperative* they became. As shown before COGLE did help increase the confidence of students through its mastery cycles.

"Because *[I] didn't seem to know much* of the knowledge at first... *I was more compromising* to… the people who have more info… [Once] I had a little bit of grounding... you *became more confident and more cooperative.*" (Cyrus)

It is like a *positive spiral of success and internalisation* where you build trust and confidence as you keep on resolving the cognitive conflicts within COGLE and finally achieve *GWM.* The same spiral may also be followed by regulation skills.

b) Taking shortcuts and burnout

If, however, a student (or the team) *games* the system and *overtakes GWM* orchestration, without *cooperation* or without first developing their own confidence and gaining the trust of their teammates, they can take their team on a negative spiral and *burnout* as the *high penalty* makes their team do many more questions.

Cyrus wanted to *save time* by telling others just *follow the majority* when choosing answers and quickly gain mastery. *Saving time* was a *wrong goal* and "*follow majority"* was a *wrong plan* to have. On the first day, it seemed to work initially:

"We didn't really seem to get that [many discussions] … because we didn't… really seem to differ." (Cyrus)

Very soon they realised that they were on a negative spiral which led to *burnout* from doing more questions. They clearly had not interacted enough for trust to have developed by then. Others did not always listened to Cyrus. Even when they did, the majority were not always correct. The *high penalty* ensured that *mastery* count was reset if even one of them was wrong. They got exhausted and very frustrated and lessons were learnt on the first day itself.

> “we just *got really tired* from keep doing it …most people just got a bit halfhearted with it and … *just wanted to end [the mastery chase]… it would be best if* … [I/we] *just take your (sic) time with it*… [and] *thinking we will get through this quickly* as possible *that's when we were making mistakes…I was making mistakes* in the calculations…and we *had to go back* to the beginning again.” (Cyrus)

4.8 Integration of quantitative and qualitative stages

Here I triangulate the evidence collected throughout the study in order to answer the research questions from this case.

RQ 1. How does computer orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated flipped-classroom settings?

As the trust and self-efficacy grew during the 4 COGLE sessions (sections 4.6, 4.7), the students were able to overtake the SSRL and CoRL themselves with varying levels of success (sections 4.7.1 and 4.7.3). They planned on their own (shared planning) how to achieve mastery and were happy with their teammates checking their work (shared monitoring) and supporting each other understand (shared working) to achieve GWM (shared goal). It was actually the positive frustrations resulting from having to do several cycles of GWM, due to high penalty associated with peers making mistakes that help trigger and internalise the CoRL and SSRL scripts. Increase in trust and self-efficacy also triggered SSRL skills during the SOWT FC activity (sections 4.7.1 and 4.7.2). An increased emphasis on the *shared goal* of the team in the FC activity meant they were effective and chose a *shared working or delayed shared working* approach. They worked collaboratively and completed the task well, not letting conflicts come in the way of progress.

Next, I present evidence for trust and CM skills development, which adds to the understanding of how students developed team working skills and attitudes.

RQ 1.1 How does computer orchestrated learning together in small groups affects a learner's attitude to conflict management?

COGLE created *numerous opportunities* for students to practice *citizenship activities (helping each other), conflict resolution, conflict deferral / temporary avoidance* and eventual resolution. These orchestrated interactions helped them trust and get used their new teammates and resolve cognitive conflicts in a timely and collective fashion. This was required of them to reach their *shared goal* of *GWM* during every COGLE sessions. As trust between teammates grew, they also internalised SSRL scripts promoted in COGLE and took a more cooperative approach to conflict management. The following paragraphs presents multiple chains of evidence for this increased *cooperativeness* and suppression of the *directive CM style*:

Looking at the results from the *Style Matters* survey (section 4.6.2), 5 students had become *cooperative* by the end of COGLE sessions from just 2 at the start. On re-testing, before going into the FC activity, just one student changed to *compromise* CM style but all became less selfish as they rated *directing* as their least preferred CM style going into the FC session. I interpret this as becoming more *shared goal oriented*, preferring *cooperative* over selfish CM style.

The themes from the *SSRL* survey data (section 4.7.1) also shows that indeed over the 4 COGLE sessions students became more accustomed to working in a shared or *cooperative* way: i.e. working towards *GWM* by *discussing together* and *resolving cognitive conflicts* in a calm way, *helping others* and also increasing their self-efficacy and trust in others in the process. In the FC session too, they worked to deliver the shared goal in a *shared way* from the start or by the end. COGLE provided a safe environment where their SSRL scripts were invoked or developed and practiced over multiple days, within a relevant education context and with the same teammates. It made them realise the importance of resolving conflicts and team working. This led to a more *cooperative* way of working within the un-orchestrated SOWT-FC session.

The qualitative analysis of the interview data from the FC activity (section 4.7.2) also points in this direction. Here too, the evidence suggests they all actually worked to achieve their *shared goal* and there were *no conflicts* that were left unresolved. They were *comfortable with each other* going into the FC activity and decided to support those who had *low self-efficacy* and involved them either from the start or by deciding to check and consider the work done by all at the end, giving everyone a chance to *contribute as much as* they could. They were actually able to work well together when COGLE was removed.

Further, the analysis of the qualitative interview data from the COGLE sessions (section 4.7.3) shows that COGLE promoted conflict resolution through orchestrating *cognitive conflicts* and its *GWM* goal. Numerous interactions and cognitive conflict resolution and group awareness features of COGLE together help build *trust* between teammates (see next sub question for how). It also helped them become more *confident* by enhancing their learning gain (see section 4.6.3). During the sessions they internalised SSRL scripts as they *overtake* GWM. They realised that only by working *cooperatively* they can achieve GWM quicker. Within COGLE they also learnt how to defer a conflict for resolving later. The *high penalty* ensured they remained *cooperative* and in this way *maintain/enhance cooperative* CM style. It help *suppress* the non-beneficial *directing* and *compromising* CM styles through the use of *high penalty* as seen in the case of *taking shortcuts and burnout*.

RQ 1.2 How does computer orchestrated learning together in small groups affects a learner's development of trust in their teammates?

Each *mastery* session created *numerous opportunities* for students to practice *citizenship, cognitive conflict resolution* and find out about the teammate's *relevant past performance* in this process of *learning together*. All this helped develop and correct trust between the participants and their self-efficacy, enabling students to *overtake orchestrations from* COGLE by the end of the 4 sessions. It is also evident in the way they approached the FC activity, resolving any conflicts that emerged and delivering successfully on the FC task. The following paragraphs presents multiple chains of evidence for this increased *trust* in teammates:

Results from the *Trust in teams* survey (section 4.6.1) show that for all facets of trust (affective, cognitive and conative) there was widespread trust in team by the end of COGLE sessions and this stayed like this going into the FC activity. This trust had developed very quickly in under 4 COGLE sessions.

The *SSRL* survey data (section 4.7.1) also shows that as early as session two trust building had started and completed by session 3. Mastering together and resolving cognitive conflicts orchestrated by COGLE helped them increase their own confidence and the trust in others.

The qualitative analysis of the interview data from the FC activity (section 4.7.2) suggests that they all were *committed* to completing the activity, *trusted each other* going into the activity and were *happy to share their reward equally*. They knew the strengths and weaknesses of each other and they cared for each other. There was evidence of an increase in cognitive trust, affective trust as well as conative trust when looking back at COGLE sessions. It was this trust that helped resolve or defer the conflicts they faced whilst working and delivering on their shared goal successfully. Students linked *learning together* using COGLE to the development of trust in their teammates.

Further, the analysis of the qualitative interview data from the COGLE sessions (section 4.7.3) shows that the *social awkwardness* was reduced from day one itself, it lend the rest of the time suitable for building trust between each other. It confirms that *learning together* in COGLE with the *shared goal* of *GWM* provided *numerous opportunities* for *helping each other* (citizenship) as well as for resolving *cognitive conflicts* that led to building cognitive, conative and affective trust in many ways. All this gave them enough *knowledge of the strengths and weaknesses* of their teammates allowing them to trust them better. They knew they all had *mastered* content together, which also gave them a reason to trust each other. They did so first under the control of COGLE and then later *overtake* orchestrations themselves, which also shows trust in each other.

The use of cognitive conflict resolution that was promoted in COGLE had an impact on all three facets of trust and also on self-efficacy, making it an important reason behind the quick increase in trust after use of COGLE over just 4 days.

4.9 Summary of findings

Building trust and self-efficacy

The theoretical framework of **Figure 2** shows several antecedents of trust. This case study confirms the already known positive impact that citizenship (helping each other) has on building affective trust between teammates as shown in **Figure 2**. This work adds to the existing understanding on developing trust in teams in multiple ways as it shows that trust can be developed far quicker (2-4 sessions) than what the literature suggests (8 sessions) (Webber, 2008) through effective and inclusive orchestrations.

Firstly, this case identifies new evidence that links *resolving cognitive conflicts* in building or maintaining affective and cognitive trust in teams. It shows the importance of this type of interactions over simply the *interaction frequency* of *citizenship* or *simple interactions* on building trust. It also shows the impact of resolving *cognitive conflicts* on improving *self-efficacy* and confirms its already known impact on *learning*.

Next this case gives a new dimension to the term *past performance* also used in the framework of **Figure 2**. For teams that have no past interactions, *learning together* the content needed in a FC activity, can give access to *relevant past performance* on their teammates in order to build or maintain cognitive and affective trust.

Finally, this case shows the impact of the *positive frustrations* that emerged when orchestrating a single and simple *shared goal* of achieving *GWM.* A *high penalty* when a teammate gets a question wrong caused these frustrations. The penalty forces the students to go through more opportunities to help each other (*citizenship)* and resolve more *cognitive conflicts* together to achieve *mastery.* This led to further strengthening of the relevant facets of trust in others.

Conflict resolution, SSRL and CoRL script internalisation

This *shared goal* orchestration and the *positive frustrations* within it also led to students being able to practice and *internalise* the scripts for CoRL and SSRL, as evidenced when students *overtake* GWM, teaching each other and collectively working towards mastery from very early on in the COGLE sessions. COGLE also helped students practice and internalise *calm* conflict resolution without losing sight of the shared goal.

The *internalising* is evidenced by the use of these scripts within an un-orchestrated session successfully, thanks to the trust that has also been built in the COGLE sessions.

Maintain or increase cooperativeness

COGLE worked like a catalyst to achieve the desired results very quickly. The COGLE sessions helped build trust and conflict resolution, deferral and SSRL scripts were internalised by the students. This helped in maintaining or enhancing *cooperativeness* in students as they learnt how to not let the conflicts come in the way of their shared goal. Evidence suggest that students did not behave in a selfish or directing way when it came to conflict resolution. Using COGLE and even themselves, they practiced calm conflict resolution through discussing with everyone and deferring conflicts when appropriate.

The FC activity was un-orchestrated and if there was a teacher orchestrating the session, their experience would not have been disappointing as students were ready with the team working skills as well as content knowledge.

Chapter 5: COGLE for preparing first year BEng Electronic Engineering students for a PjBL Project: Findings

This chapter introduces the reader to the literal replication (repeat) case, the participants, the use of COGLE within this setting, the purpose and nature of data collected and finally the methodological approach and findings from the analysis of the quantitative and qualitative data collected.

5.1 Research questions

Integrating data from quantitative and qualitative sources, collected at multiple time points to enable *methodological and data triangulation*, the following research questions were addressed:

RQ 1. How does computer orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated project-based settings?

RQ1.1 How does computer orchestrated learning together in small groups affects a learner's attitude to conflict management?

RQ1.2 How does computer orchestrated learning together in small groups affects a learner's development of trust in their teammates?

5.2 The participants and the context

Ten of the 85 students from first year Electronic Engineering degree (see **Table 1** for details) joined this study. This included an Autistic student with ADHD and another student with ADHD. They worked in three teams (of 3, 3 and 4) and all completed the study. A real world case where PjBL is used within the first year Analogue electronics module was purposefully chosen for this study.

Over five weeks (with one exception, see next paragraph), inside a physical classroom and no lecturer (just the researcher), the three teams engaged in 7 two-hour COLT sessions. Like in previous case, they used COGLE to watch videos and master topics in their set teams. Later, the teams designed a filter and an audio amplifier in a two hour SOWT session.

The content was more advanced but included the same 4 sessions as in the previous case with additional content needed to complete the PjBL project. The design of questions and selection of videos was similar to what was reported in case 1.

One group's timetable did not allow them to all come together to a session so their participation got extended over 11 weeks and unfortunately in that time the COGLE system also stopped working due to changes in Google App Engine, where the system was hosted. I had to use an earlier version of COGLE with this team to complete their study for the last three sessions. This version had some differences including interface issues, which caused registering wrong answers at times and the functionality of remedial videos did not work either. Furthermore, if no one knew the correct answer in a team, it also did not reveal it. This affected only one group.

The next section describes how COGLE was used to prepare students for the PjBL project activity.

5.3 Use of COGLE within this setting

The 7 COGLE sessions were designed to prepare the participants with the content knowledge and the team working skills needed for the PjBL project. Please see section 4.3 for more details. The next section describes the data collection plans and purpose.

5.4 Procedures and Data Collection timeline

Table 16 to **Table 18** shows timing and purpose of different instruments used to collect the data. To keep the pattern of data collection similar to case 1, data was also collected after session 4 was used using the same instruments used before.

AT THE START OF THE STUDY	
Data Collected	**Purpose**
Subject Pre-Test	Used in Learning Gain calculations
Trust Pre-Test	Captures different types of trust levels in their current teams Used as a base line
Style Matters - Conflict Management (CM) Style survey - Pre-test	Captures CM style preferences they come in with Used as a base line
SSRL Questionnaire Pre-test	Captures the level of regulation students are familiar with already

Table 16 Data collected at the start of the study (case 2).

AFTER COGLE SESSION 1-6		AFTER 4th and 7th COGLE SESSION	
Data Collected	**Purpose**	**Data Collected**	**Purpose**
Daily Survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data	Daily Survey	Same as session 1-6 (see left).
		Trust Post-Test	Captures different types of trust levels in their current teams after 4 COGLE sessions.
		Style Matters (CM Style survey) Post-test	Captures CM style preference after 4 COGLE sessions

Table 17 Data collected after each COGLE session (case 2).

All students were invited for an hour (2 hour for NAT students) long individual interview. Later it was decided to drop the very last student to be interviewed. This student was one of 4 in a team and data, inductive thematic and theoretical saturation were achieved (see **Table 15** and **Table 27**) (Bowen, 2008).

PjBL Activity		
Data collected before	**Data collected after**	**Purpose**
Subject Post-test		Used in Learning Gain calculations
	Daily survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulation related qualitative data
Trust Post-Test	Trust Post-Test	Captures different types of trust levels in their current teams before and after the PjBL activity
Style Matters (CM Style survey) Post-test	Style Matters (CM Style survey) Post-test	Captures CM style preference before and after PjBL activity
	SSRL Questionnaire	Captures the level of regulation students are familiar with after COGLE use
	Interview	Captures the level of regulation, trust, CM style preferences before, during and after COLT and SOWT session.

Table 18 Data collected before and after the PjBL activity (Case 2).

5.5 Methodological approach

The methodology used here was similar to that in the other cases in this study (Chapter 4 and 6) and is described in detail in chapter 3. Statistical analysis was used where warranted by the numbers.

5.6 Descriptive statistics, analysis and themes

5.6.1 Measuring levels of trust in teammates

Data was collected on different facets of trust at five points through the study: Pre, mid and post COGLE use and also Pre and post PjBL task. Member checking was carried out during the interview and students agreed with the meanings attached to their data. Next section describes the findings from this data set.

5.6.1.1. Development of trust within the COGLE sessions.

The data in **Figure 12** and **Figure 13** shows how widespread different facets of trust were at mid-point ('post 4 COGLE' sessions) and at end-point ('post 7 COGLE' sessions) respectively compared to the start. The counts represent responses at 5 or above on the Likert scale used.

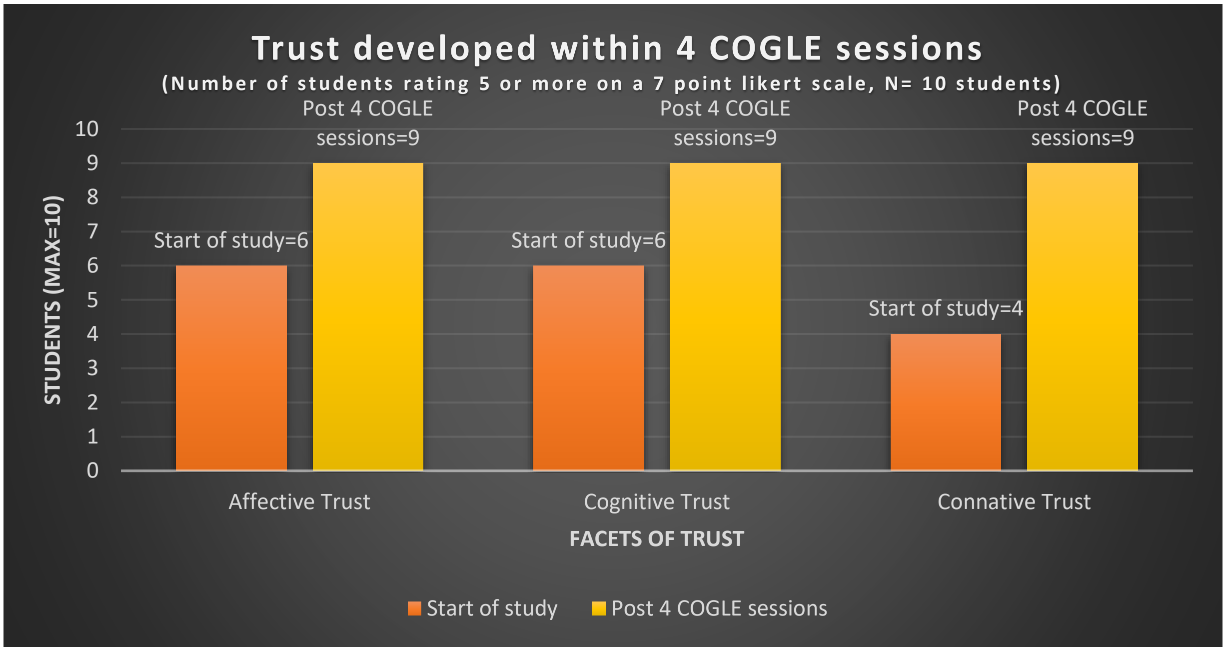

Figure 12 How trust changed Post 4 COGLE sessions.

Figure 12 shows that at some point before the 4th COGLE sessions nearly all students developed trust in their teammates (9/10) for all three facets of trust. This strengthens the findings from the previous case.

Likewise, as shown in **Figure 13**, compared to the start of the study the number of students trusting their teammates increased by the end of the 7 sessions. However, comparing with **Figure 12**, slight fluctuations are noticeable in the data.

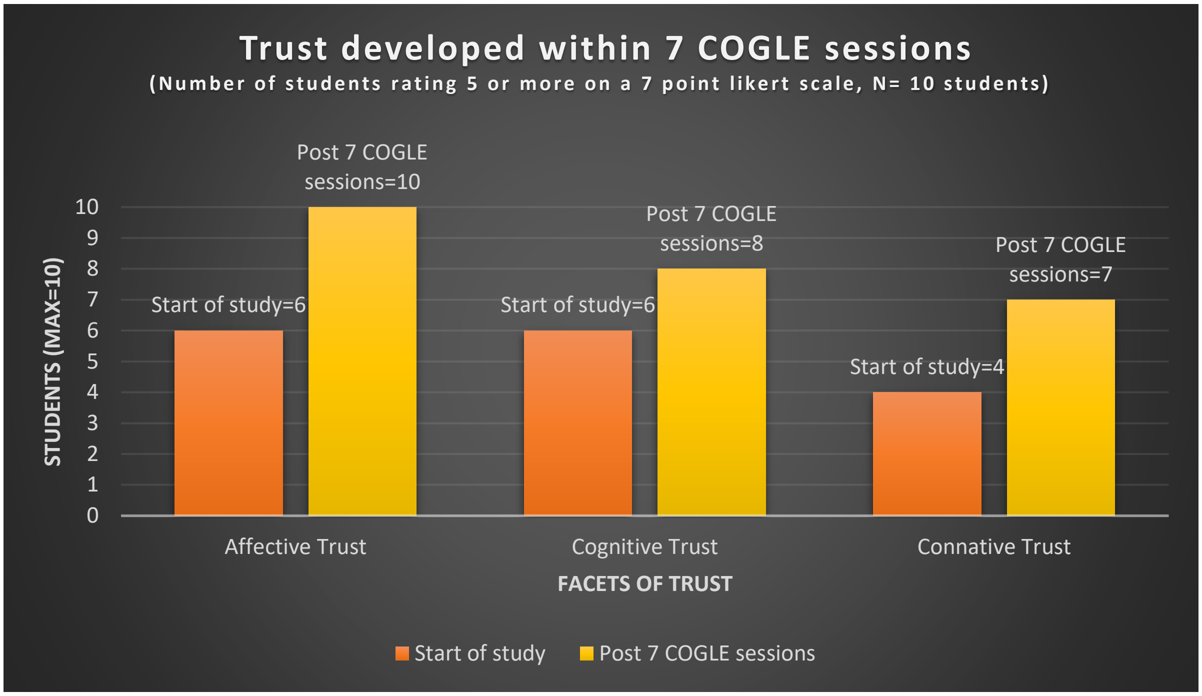

Figure 13 How trust changed Post 7 COGLE sessions.

Growth in affective trust can be explained by the time spent together helping and interacting through COGLE (10/10 reporting this trust). The drop in numbers at session 7 compared to 4, for Cognitive trust was due to increased difficulty of topics. With regards the conative trust numbers, on closer inspection of data and field notes some instances of late arrival which may explain the reduction in numbers.

Next subsection discusses another snapshot of the trust data collected just before the PjBL activity started.

5.6.1.2. Widespread trust before the PjBL activity.

Post COGLE session, students were shown the details of the PjBL task and were asked to decide how they will share a reward of £15 amongst three team members if their team came up with the best solution.

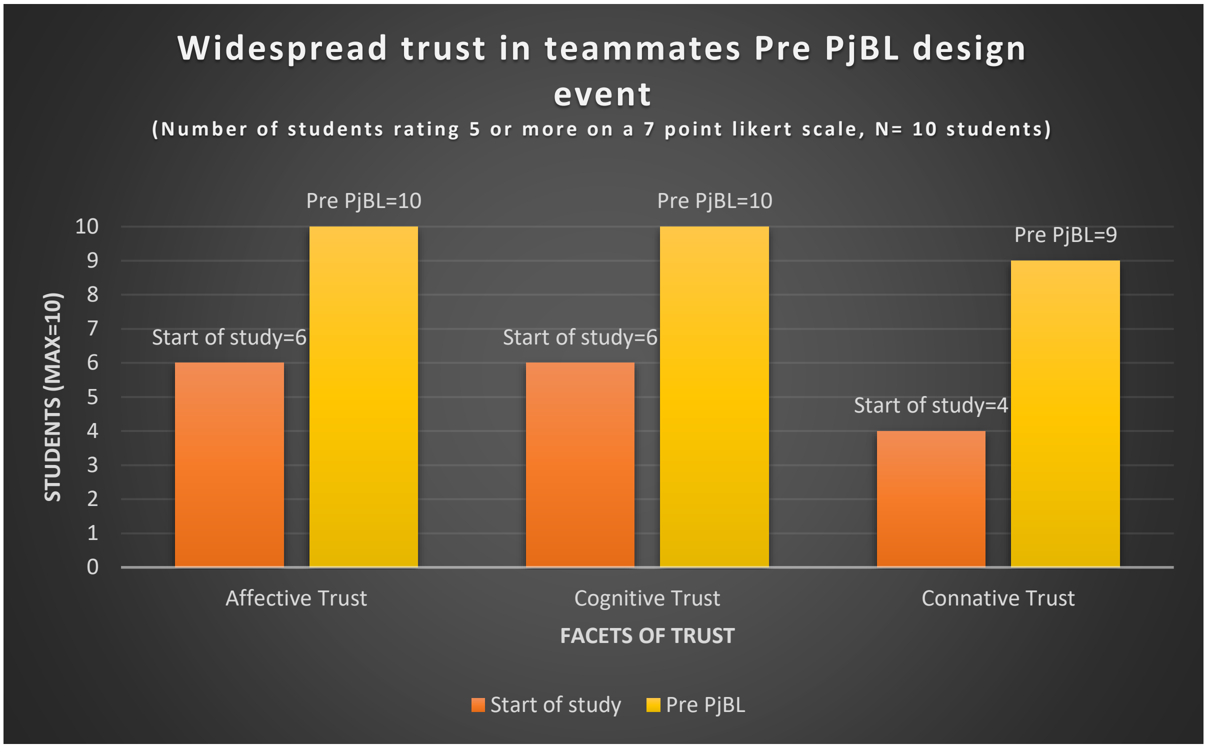

Figure 14 Number of students expressing trust in teammates before PjBL activity.

As can be seen from **Figure 12-Figure 14** the number of students trusting their teammates, after deciding equal split, was higher than at mid-point. This reflects that majority believed that as a team they would be successful.

5.6.1.3. Trust after the PjBL activity.

The post PjBL survey was only completed by 8 respondents. On closer inspection, the data suggests that changes within two out of three teams are responsible for drop in trust. These were the same teams where one student had arrived late to the SOWT session and one other reduced their scores.

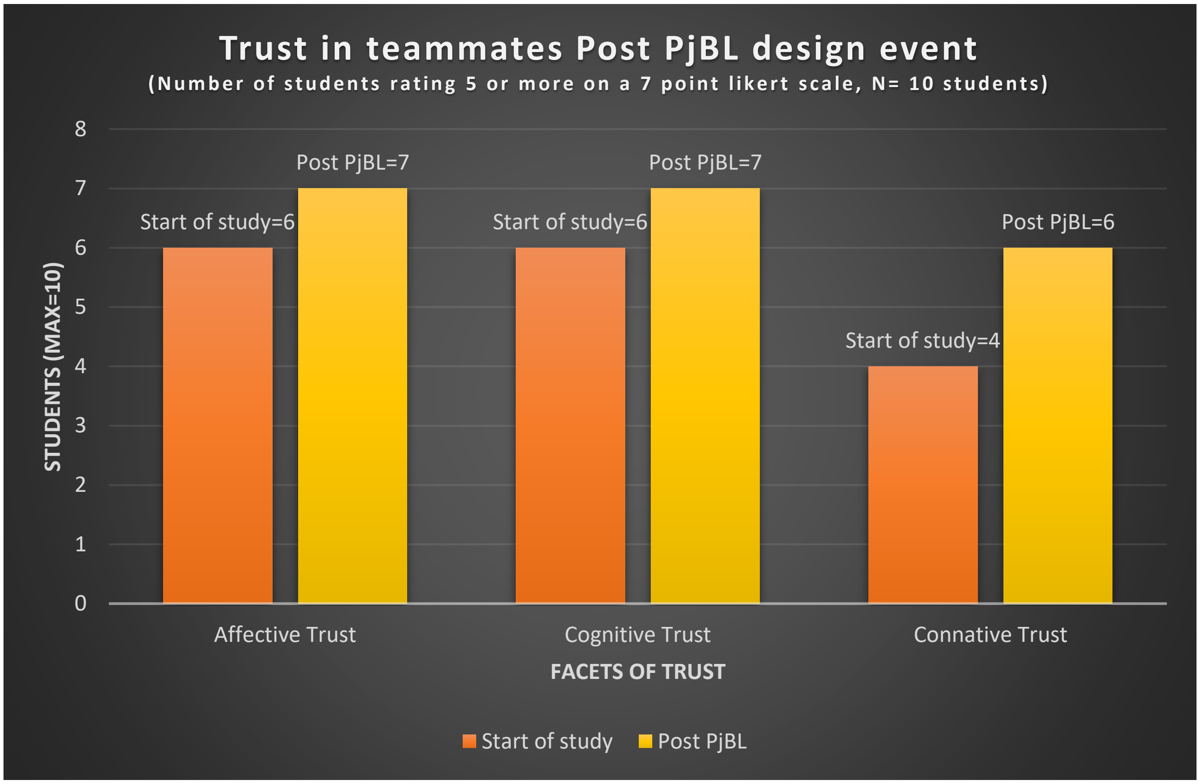

Figure 15 Number of students expressing trust in teammates after PjBL activity.

5.6.1.4. ASD and ADHD students and trust

Figure 14 suggests that the presence of an autistic and an ADHD student did not impact the number of students expressing trust to be there in their teammates (all facets) before the PjBL activity. This result is confirmed in both case studies. In contrast to previous case the ASD student here was not trusting of others at the start (reasons discussed in qualitative sections) but before the PjBL activity, they too reported good levels of trust. The trust survey shows that ADHD student was not trusting of others and their trust in others did fluctuate at each measurement point. By the time the student was to go into PjBL activity they reported good levels of trust in the others too. However, the ADHD student did loose trust in the ASD teammate during the SOWT session as per his survey data (also shown in qualitative data later).

5.6.2. Measuring changes to conflict management styles throughout the study

5.6.2.1. Exploring changes to conflict management style preferences

Using the Styles Matters ® survey at the same five points as for measuring trust, I collected data on student preferences of five CM styles. For details of each style, please see **Figure 5**, chapter 2. Below is a summary of the results from this case.

a) *Maintain and encourage cooperativeness and discourage other styles as top styles.*

One student did not complete the post PjBL survey whilst another student repeatedly rated all their scored in an identical way. The data for the latter student was removed before the analysis as it indicates lack of care in completing the survey. Note that there were times when the most and least preferred style was shared by up to three styles.

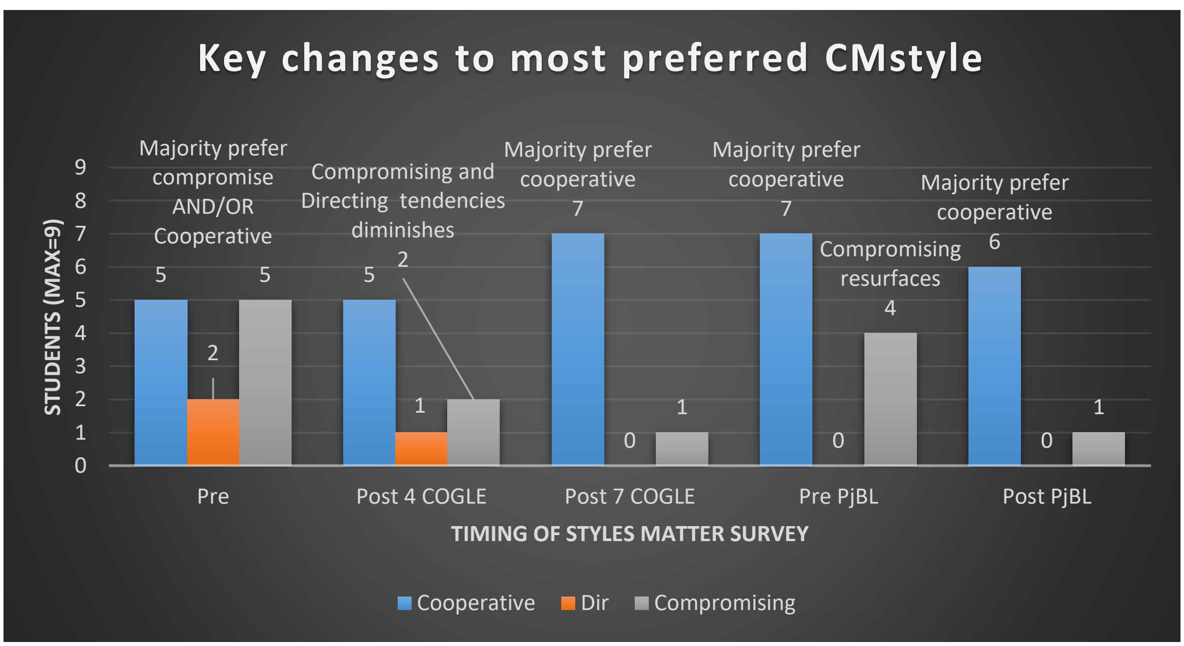

Figure 16 Most preferred styles at various stages of the study.

We can see in **Figure 16** that pre COGLE and after 4 sessions, 5 students show top preference for the *cooperative* CM style as well as for *compromising (portal)* style. Note that the decline in *compromising and directing (selfish)* styles starting just 4 sessions. After 7 COGLE sessions the top preference for *cooperative* style reaches majority (7 of 9). The trend is maintained in latter data collection points too.

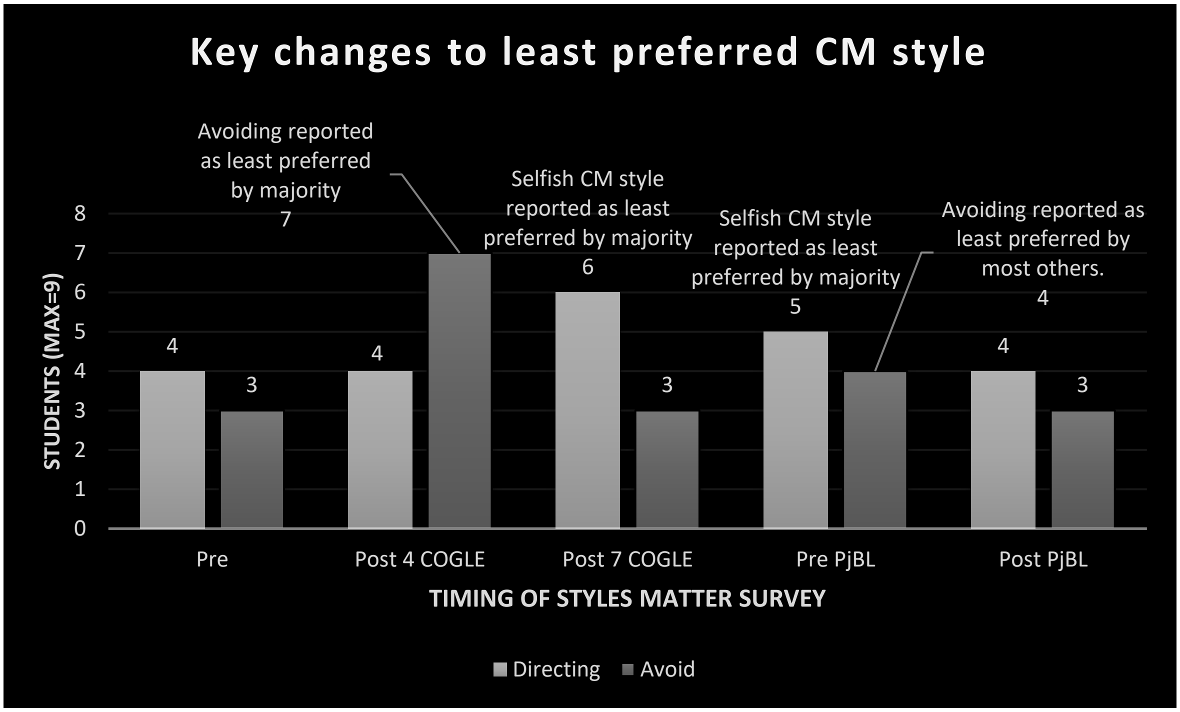

Figure 17 Least preferred styles at various stages of the study.

b) Discourage directing and discouraging avoiding CM styles.

Figure 17 shows how COGLE use reduces preference for *directing (selfish)* style (note, the figure plots least preferred styles). After 7 COGLE sessions, preference for both *avoiding* and *directing* styles was reduced, reflecting an alignment with the shared goal of GWM. Results from this and the previous case strengthens the case for *learning together with COGLE.*

5.6.3 Pre and posttest analysis

As discussed in section 4.6.3, percentage scores in **Table 19** represents the pre and posttest results for all participant before and after COGLE use. **Table 20** shows that the normalised learning gain values are all positive and large, with 9 out of 10 at more than 30%. The test questions consisted those used in the previous case alongside questions that cover the new content taught here.

Student	Pre-test Score%	Post-test Score%
A0	26.47	85.29
A1	23.53	44.12
A2	35.29	70.59
A3	29.41	52.94
A4	14.71	55.88
A5	26.47	55.88
A6	35.29	61.76
A7	26.47	55.88
A8	35.29	73.53
A9	38.24	70.59

Table 19 Pre and posttest scores (case 2).

a) COGLE enhanced the Normalised Learning Gain

Student	Absolute Gain	Normalised Gain
A0	*58.82*	*0.8*
A1	*20.59*	*0.269*
A2	*35.3*	*0.546*
A3	*23.53*	*0.333*
A4	*41.17*	*0.483*
A5	*29.41*	*0.4*
A6	*26.47*	*0.41*
A7	*29.41*	*0.4*
A8	*38.24*	*0.591*
A9	*32.35*	*0.524*

Table 20 Absolute and normalised learning gain for each student (case 2).

Due to small sample size, the nonparametric Wilcoxon Signed Rank test was performed on the test scores to compare the pre and the post scores from the same participants. A W-value, Wt =0, which is <= critical W-value, Wc=8 (at n=10), means the difference in scores is significant ($p<0.05$). With a Z-value of -2.8031 the result is significant at ($p<0.05$), this equates to a large and significant two series correlation coefficient effect size r = -0.627 due to the intervention using equation (b) in section 4.6.3. The COLT approach should also bolster the student's *self-efficacy* (Panadero et al., 2012).

It is noteworthy here that all NLG values are positive and only one value is between $0.26 < NLG < 0.3$. This suggests that using COGLE leads to an inclusive, efficient and effective way to run COLT sessions leading to large positive NLG and increased self-efficacy. This is also evident in the team scores in the SOWT activity: Team 1: 87%; Team 2: 55%; and Team 3: 77%.

5.7 Qualitative Analysis

This section first presents the themes from the SSRL survey, administered before start and after each COLT and the SOWT session. Next, it presents the themes from the post SOWT interview to provide alternate, sometimes more detailed, insights.

5.7.1 Measuring regulation of learning

In keeping with the previous case (see section 4.7.1), the free text responses in the SSRL survey were coded and analysed using inductive and deductive coding methods as described in Chapter 3. In addition to coding this data inductively, the regulation of learning work by (Splichal et al., 2018) and the theoretical framework of **Figure 2** guided the deductive coding used in the thematic analysis (Braun & Clarke, 2006).

5.7.1.1 Importance of self-efficacy, early communication, trust, regulation, conflict resolution and cooperative skills (past experiences)

SSRL involves *working together* in a *shared* (planning, monitoring, and revising plans) way to meet *shared goals* of a team. **Table 21** summarises the themes and the frequencies at which they appeared in the responses.

Like in the previous case, here too there were students who had experienced *working together* with others to achieve a *shared goal* within educational (N=5) and non-educational (N=4) settings. Majority (N=4) had experienced *delayed shared working,* where they worked on their assigned roles and came together in the end.

Themes/ Sub-themes	Description	Count
Self-efficacy	Believing in own abilities to deliver the set goals.	5/9
Communications	Interacting with others in the team from the start and often.	8/9
Trust	Believing in others to deliver the set goals.	5/9
Conflict Management	Knowing when to resolve or defer conflicts.	6/9
Shared goals / SSRL	All working towards the same set goals.	5/9
Shared working	Working together throughout on all the tasks, supporting each other in the process.	2/9
Delayed shared working	Working together only in the later presentation stages.	4/9
Shared working as needed.	Working together as needed both individually and in a shared way.	3/9

Table 21 Themes and frequencies in SSRL survey - past experience (case 2).

The importance of *early communication* in agreeing work distribution and *monitoring* progress in order to meet the shared goal as well as removing social awkwardness and *trust* building is shown in the responses below.

“Everyone *had each other's number* so they could contact each other to *check on their progress*. Once it was *made sure that everyone was doing their part*, the rest of the process *went smoothly*.” (Ben)

The autistic student reported exposure to SSRL and had no issues in working with others when they had established correctly a level of *trust* and familiarity with others:

"I was camping with my mate for scouts and was paired with people we never met before but *quickly got to knew* (sic) *everyone* and *performed well to the all the tasks given* and enjoyed our self (sic) at the same time" (ASD student)

The autistic student reported he was once *too quick to trust* a teammate, it did not end well for them. Despite their efforts in *re-connecting* and working with the other student, *they failed* due to lack of *trust* by the other in them:

"*At first I didn't help as I was ill … I tried to after but she wasn't communicating with me very well* to complete the task which *made me frustrated*" (ASD student)

As can be seen, this student (over) trusted that their teammate hoping they would understand that he was ill when he reached out. However, he was not trusted by his teammate, due to appearing unreliable (lack of conative trust) at the start. This resulted in *frustrations and loss of trust* and work being completed in a fragmented way. Due to poor understanding of someone else's mental states, known as *theory of mind,* autistic students are likely to assume trust in their teammates too quickly. This tendency to quickly trust others causes pain and frustrations when the quickly assumed trust is broken, as in this case, often causing self-isolation and working alone.

Students also understood the importance of *communication* in *conflict resolution* either by being part of a successful team or by virtue of it failing and reflecting on why they failed:

"Situations were *improved through good communication* and worsened by *people passing blame* around." (Finley)

These past experiences capture internalised experiences which can be triggered through orchestration as well as highlights the need for new experiences to be orchestrated for successful teamwork. The next section reports on the themes that relate to changes in skills and attitudes relevant for team working and how they were linked to COGLE use.

5.7.1.2 Changes in skills and attitudes: the role of COGLE.

As described in Chapter 3, a thematic analysis of the free text comments was carried out inductively and deductively. It resulted in the several themes as tabulated in **Table 22**, with their description and frequencies.

Themes / Sub-themes	Description	Count
COGLE orchestrates CoRL and GWM	COGLE paired students to teach and learn from each other in order to achieve GWM.	10/10
COGLE can help reduce social awkwardness (where present)	Initial pairings may have felt forced or weird but soon it made them interact smoothly without the awkwardness.	3/10
COGLE can orchestrate cognitive conflict resolution smoothly.	COGLE paired students that had different answer, which were designed to create cognitive conflicts as they represented plausible answers. It was done in a calm way as there was support in the form of correct answer as well as remedial videos in the situation where students did not agree.	8/10
Mastery helps build self-efficacy and trust	Repeatedly answering questions until ten questions are answered correctly in a row by all those in the team helped build both self-efficacy as well as trust in each other as they interacted and helped each other under the control of COGLE at first and then on their own too.	10/10
Students can start CoRL on their own with COGLE as back up.	Initially triggered by the frustrated caused by the high penalty associated with mistakes made during mastery cycle, students took CoRL into their own hands several times and eventually preferred doing it that way.	8/10
SSRL can be internalised as trust and self-efficacy grows	Practicing CoRL under COGLE and own control help build the trust and self-efficacy, which in turn allowed them to internalise the SSRL scripts of chasing the simple goal of GWM by doing discussing and resolving cognitive conflicts to achieve this.	8/10

Table 22 Themes and frequencies in daily survey - role of COGLE (case 2).

a) *COGLE can orchestrate CoRL and GWM that helps them interact early and often and resolve cognitive conflicts smoothly*

The *pairing* for CoRL by the *PI script* and the *high penalty* of the coercive *GWM* script encouraged students to *interact early and often* even when one of them got a question wrong in the mastery cycle. Students could see the benefits of this coercive nature of the *GWM* script.

"The system *prompted at correct times* which made the *session go well*" (Andy, session 2)

This helped remove *social awkwardness* from the start even for the autistic student and gave them the *confidence to interact* and *resolve cognitive conflicts* where present:

"It *prompted us* to compunicate (sic) with each other *which help get the ball moving* with our team work. What went well was that *we started to make better connections with each other* in the group, which *lead to us being more confident* to explain how we got an answer to our teammates." (Harry, session 2)

They were seen *helping others learn* and *resolving any cognitive conflicts peacefully*. On the one hand this helped increase their *confidence* in their answers (as in above quote) and on the other it helped correcting over-confidence in others (see below):

"They clearly explained the concept to me, and *I realised my error*." (Finley, session 4)

Additionally, there was *arbitration* help to resolve cognitive conflicts peacefully. COGLE *revealed the correct answer* and played *tailored video support* at the end of each round, this further helped with *confidence*:

"In the beginning when I was teaching I myself *didn't fully understand* how I got the answer *so I didn't give a detailed/understandable explanation* but *after watching the video* I was able to *give a good explanation*" (Ira, session 1)

These interactions, as shown in the next section, help improve self-efficacy and trust between teammates. However, when a student *guesses the correct answer* or is unable to explain well and is picked by the system to explain it to the group this can cause confusion, which is not resolved until they watch the tailored video or use the advanced feature of voting to choose another student to provide an explanation.

b) Mastery helps build self-efficacy and trust between teammates

Here is another quote that shows how working to achieve GWM together helped increase their *self-efficacy*:

“It was good because it *made me understand* what I had done wrong.” (Cathy, session 2)

The autistic student had also gained confidence. When selected by COGLE to explain an answer and they were not *worried about being seen as too eager* to explain:

“Well it gave me *more confidence* to properly explain something to my other teammates *due to an external force directing me* to explain the answer *instead of myself* which may *come across as too eager*”. (Harry, session 2)

In the past they had been too trusting of others and have been disappointed in them as a result. They were able to overcome their *fear of conflict* and successfully resolved cognitive conflicts in their team.

Aiming for mastery, COGLE orchestrations provided them with *numerous opportunities* and *information* to enhance their confidence as well as their *trust* in each other. PI script gave opportunities to resolve *cognitive conflicts* together, whilst the GWM script resets the target number of questions.

“When we someone got it wrong the *system prompted* the *person that got it right to explain* to the person that got it wrong.” (Ethan, session 7)

COGLE visualises these ups and downs in their progress towards GWM and shows the correct answers, making the group more aware of their strengths and weaknesses:

"The system *provided analytics*, more specifically a graph to showcase our group's rough *road to mastery*. The ups and downs and finally the straight line to our goal. Although, it makes me sad that we have *rough starts* in almost every session now, it also makes me happy that we're *experiencing them together* so the system helps us *build strong bonds amongst ourselves*. They may even surpass Hydrogen Bonds at this rate." (Ben, session 4)

However, as topics got more involved and no one knew the correct answer and the *banter* involving those who guessed wrongly continued, it had a *negative effect on their confidence and trust*. The tailored videos is what they relied on at that point:

"When the other student *tried to explain* the concept, it became apparent that *they did not fully understand* the question either. This meant that *very little was gained* from it being explained. When no one understands the question, having someone try to explain *it is not very helpful*" (Finley, session 6)

c) *Students can start co-regulation on their own (overtake), with COGLE as a back-up.*

The *high penalty* of the *GWM script* made them either *overtake* the CoRL for the remaining questions in *frustration* and/or cooperate with each other. They started discussing questions together before and on their own near the end of a mastery cycle and cooperated by teaching those who were wrong during COGLE orchestrated interactions.

"Having to explain the questions that a peer got incorrect due to them *guessing* was *frustrating* at times as I felt it *could have been avoided by discussing the question* *before submitting an answer*. When peers were a bit forceful/irritated during explaining a question, *I intervened* to change the tone of the conversation and *prompt proper explanations*.” (Andy, session 3)

SSRL was exhibited as they all contributed in order to achieve the simple goal of *GWM*:

“The system made us *all contribute* to improve the situation as we were *all working towards the same goal*.” (Rita, session 2)

Teammates stepped in themselves as shown before or the system would allow voting for another person to explain the topic when a guessing student was unable to. Here voting is used to encourage further discussion as opposed to create a divide in the group:

“*We* were able to *improve* the [guessing] situations by *voting on someone else* to explain the question as well as picking another question, allowing us to *extend the group discussion*.” (Don, session 3)

“The system is good at *prompting explanation* of a question within the group, *it picks a useful candidate* based on our individual results through the *mastery* process. Sometimes it was difficult for other students to explain a topic but *we would work together to help explain* that topic.” (Giles, session 2)

In this way control of CoRL switched flexibly between the teammates and the system several times during the sessions, sometimes difficulties and frustrations even triggered SSRL.

d) SSRL internalised as trust and confidence grew

GWM and *frustrations* linked to the *high penalty* made them focus on the *shared goal* from the start. Within the first two sessions of mastering topics together, their trust in each other grew and so did their *self-efficacy*. This made them used to working together towards a *shared goal* and achieving it each day, which helped them internalise SSRL skills:

"It (COGLE) helped us to *work as a team* to get *all the questions right*." (Ethan, session 1)

During the session there were clear signs of them *all* being able to work together several times. This *showed them* that they can *use SSRL in the face of any challenges* such as a guessing students and its consequences:

"The system tells who should be teaching who, and *if the explainer wasn't explaining well*, then the *other person would chip into* try and help, *usually it worked*." (Cathy, session 4)

From the 2nd session in some teams guessing had started to cause *frustrations,* which led some to *overtake* COGLE orchestrations. Students did the CoRL or even SSRL themselves or used the advanced features within COGLE, such as *tailored videos* and *alternate student teachers*, to help learn better and master together.

Sometimes such efforts worked and at other times they did not, causing fluctuations in either *self-efficacy* or *trust* or *both.* As a result the ability to demonstrate Co and SSRL skills also fluctuated as shown in section 'a' before. The *backup support* from COGLE helps as the *teammates falter*, allowing flexibility in student control and COGLE control to practice CoRL and the coercive *GWM* script ensured practicing of SSRL skills. Students had been exposed to CoRL and SSRL irrespective of their previous experience over several GWM sessions, which helped them internalise it, ready to use in the un-orchestrated PjBL session.

e) Summary

During the first 4 sessions, 9 out of the 10 students were confident in each other's ability (*cognitive trust)*, i.e. *a buildup of trust* was possible through COGLE use. For some *trust and self-efficacy* build up was possible within first two sessions. However, in team 2, teammates used banter as a regulatory tactic in the face of his guesses, the trust and confidence built up was delayed until the 5th session. *Self-efficacy* was also enhanced as a result of teaching others and mastering content together over the 7 sessions. By the 4th session the *scripts* related to having *early open communications* and *conflict resolution* had also been *internalised* by the students.

The later sessions gave students more opportunity for mastering new content and reinforcing calm *cognitive conflict* resolution or even deferring it using more features within COGLE as students became more confident in themselves, in each other and using COGLE features at the right time. Later sessions also posed problems with guessing as the topics got more difficult. Voting to extend discussion but with a different student who also got the answer correct or watching tailored videos were seen as helpful features here.

Their ability to use CoRL and SSRL with their teammates grew over the sessions as the *trust* and *self-efficacy* increased. Frustrations due to fluctuations in *trust* and *self-efficacy* caused by a guessing student's inability to explain to their group when selected by COGLE to do so, often triggered a positive response where a student or the entire team took the CoRL or SSRL in their hands and helped out. This was handled well by the existing features in COGLE and by the students having practiced CoRL and SSRL for up to 4 sessions already. After some fluctuations and practice rounds, most students had *internalised the SRL, CoRL and SSRL scripts* used in COGLE.

As COGLE is a repetitive program, it gave several opportunities where regulation changed hands from the system to the team and back to the system as difficulty increased. This was useful as COGLE served as a back-up at times when it needed to be, however it delayed the internalisation of the scripts in two teams by one session.

Likewise, for the third team the above experience was also similar until the start of 5th session. Before the start of the 5th session, for one team only, COGLE developed some problems and stopped working and the students had to use the older version of COGLE instead. In the older version, when it pairs students to talk, it *does not highlight the correct answer* if *only one person knew the correct answer* and also *when no one gets it right*. If no other student has the correct answer and cannot therefore chip in and the one picked cannot explain either as they have guessed, then it caused the trust and self-efficacy to drop.

"Did not show correct answer when we all got it wrong so we couldn't work it out." (Ira, Session 7)

Two other problems were there in the *older version*. Firstly, it made it very *difficult to complete mastery* as it used a camera system that was prone to errors in reading student responses using QR codes, causing them to restart the mastery loop even if they did not need to:

"It (the interface) was fine but we *weren't able to finish mastery*." (Ira, session 6)

Furthermore, in the older version the tailored video element did not work well and this caused frustrations to grow as often remedial action was limited:

"The video recommended did not cover what we did wrong so it was a waste watching it." (Ira, session 5)

These differences caused some difficulties during the last 3 sessions for one team, especially when someone guessed and no one else knew the answer to questions that were from more advanced topics.

The next section shows how internalised scripts made it to the un-orchestrated PjBL activity.

5.7.1.3 *Working together and shared regulation within the un-orchestrated PjBL activity*

As shown by the frequencies of the themes in **Table 23**, *learning together* to master the content had exposed students to work as a team together on a shared goal and prepared them, as far as the team skills are concerned, for effective teamwork in an un-orchestrated environment. However, the learning in the team that used the older version of COGLE in the content (Op Amps and amplifiers) for session 5-7 was not as good as other teams.

Themes/ Sub-themes	Description	Count
Shared goal and working together	Aiming to finish the task as a team by working together (except Giles).	7/8
Broken down communications	Feeling that the un-orchestrated team lacked communication (Giles)	1/8
Unbalanced division of labour	Feeling that some teammates had more to do than others (except Giles and Ben).	2/8
Some unresolved conflicts	Disagreements where voting was used and one person felt they lost in the voting or feedback not taken on board (Harry and Giles).	2/8
Satisfied with the outcome	Feeling that the design met its specifications (except for Finley).	7/8
Satisfied with the team working	Feeling that the teammates worked well together (except Giles, Ben and Finley).	5/8
Late arrival but worked together	One teammate arrived late, but was supported by others in the team (except Ben and Giles).	3/5

Table 23 Themes and frequencies in SSRL survey – Shared regulation in PjBL activity.

During the PjBL activity the first two team soon figured out their *shared goal* and were able to plan their *work together*, as is evident in the PjBL activity related responses:

"We *managed to get a lot done within a certain time limit* we had. Also we worked efficiently and as team to get a lot done. *Choosing resistor values cause a bit of a debate* but *we overcame this by agreeing to one value*." (Ethan)

However, the team that used the older version of the software for the last three sessions had to face challenges due to varying knowledge levels as a result of not completing *GWM* in some of the later topics. Furthermore, when they did do the PjBL session, it had to be split into two one hour sessions as one student was only free for one hour, which they realised after the session had started. There was a 4 week gap between their two PjBL sessions due to unavoidable timetable clashes. The room we had selected for the first session also had some of the machines faulty so the students could not sit close together. As a combined effect of all of this, they collaborated mainly for the first part of the task, the filter design, which was covered by the newer version of COGLE. For the later part, one of the students seemed to have completed most of the work and he sought the approval of the others, who agreed with the final solution to be submitted:

"*We produced a reasonable design*, and was *mostly happy* with the *outcome*. However, I felt that communication and *teamwork broke down as differences in knowledge and opinion arose*." (Giles)

There were some disagreements too between the Harry and Giles who divided the work, mainly due to lack of cognitive trust in others:

"*We didn't evenly share out the workload* as some of us *didn't have as much work to do* as others, resulting in some of *slacking when our tasks where complete*" (Harry)

5.7.1.4 Section summary

As shown here irrespective of past exposure to SSRL, using COGLE enhanced their *self-efficacy* as shown by their enhanced learning gain as well as *mastery* related themes in

Table 22 and help develop *trust* in their teammates. Although those that had experience regulation before, were able to regulate others better, sometimes by demanding to *trust them*. This shows that trust is needed before regulation can happen, even if it is *negotiated trust*:

"I *negotiated* with *my peers to trust my understanding* and explanation of the question *in order to proceed* with the *mastery* of the topic, which *proved to be successful*." (Andy, session 1)

GWM and PI script helped trigger and internalise the CoRL and SSRL scripts through practicing with their current teammates. The frustrations experienced by students actually triggered them to overtake CoRL, which exposed them to new scripts used or negotiated by their peers. Orchestrating GWM was simple enough to be internalised and in triggering regulation scripts student already had or new ones. This and the previous case are the only evidence of this kind supporting the successful triggering and internalisation of SSRL.

5.7.2 Key dimensions, Themes and sub-themes from the PjBL activity interview

All teams decided to share the reward equally if they were to win the task. Without any major mistakes all teams designed the required circuit. The task here was more involved than the previous case but it was an extension of it.

Post SOWT sessions, nine participants were interviewed and the transcripts were coded at first inductively and analysed, as described in Chapter 3, using the 6 stage thematic analysis approach (Braun & Clarke, 2006). At the theme development stage both data driven and deductive themes from the theoretical framework (see section 2.10) were identified and as the coding continued constant comparison with new data and existing codes helped with improving the codes and the final themes that are presented here.

The key dimensions that emerged were ‘Effective team working’ and ‘Reflections on team working’. The themes and sub themes within each of these dimensions are shown in *italics* in the next section and the quantification of these is shown in **Table 24** & **Table 25**. The themes are identical to the previous case, which gives strength to the findings. Some new codes were used due to the grounded nature of the coding process. New themes presented below are mainly in relation to the impact of a longer learning together phase and advanced topics being covered.

5.7.2.1 Key dimension 1: Effective team working

Adjusting for the difficulties experience by team 3 (room, system, delay and split session) all teams experienced *effective team working* as shown in the quote:

“Yeah. It was *very constructive*, what we were doing. We *were quite focused on the task*. … Yeah, and *when we were having the discussions*, I guess constructive is the word I would use for getting somewhere, sort of thing.” (Don, Team 2)

Themes/ Sub-themes	Description	Count
Shared goals, planning and monitoring	Aiming to finish the task as a team and happy with shared planning and monitoring. (except Cathy and Giles)	7/9
Working together	A team working together. (except Giles)	8/9
Trusted each other	Teammates trusted each other due to COGLE interactions	9/9
Resolve conflicts in calm way	No tense or hostile moments and resolved all conflicts in calm way. (except Giles and Harry)	7/9
Team satisfaction	Feeling that the design met its specifications. (Finley not, add some quotes and sentence for this)	8/9

Table 24 Themes and frequencies in interview (SOWT part) – effective team working (case 2).

The next few paragraphs detail the themes and sub-themes that emerged in this interesting case.

a) Shared goal, plans and monitoring:

Students on their PjBL activity day had a *Shared goal* in that they aimed to and *finished the entire task* as a team.

"*The goal* was to… hopefully *design the best system* and to beat the other team... *I feel like everyone was working together on that.*" (Finley, Team 2)

The 6 students in team 1 and team 2 made *shared plans* that put them in the best position to achieve their *shared goal* for the PjBL activity.

"I think *me and Don started* off by doing like the *first section of the task*, while *Finley* like *looked at the next bit*, I think, and then *we kind of just built on it*. And then, after we finished, it *went on to the next bit*. And kind of just, *just did that, to be honest,* just." (Ethan, Team 2)

Giles, from team 3, also made a shared Google document with a plan and structure but due to several issues the 3 others in his team did not see it as this.

> "Erm, I helped… *with him* to actually-, yes, I remember now [remembering], *to help calculate the Ap Omp-, Op Amp [correcting] values too*, with the resistor values. And then we were kind of like building it together…Yes, *Giles went over it and actually made sure they were correct*. He was doing write up mostly for, er, [inaudible], and I'd go and say, '*Hey, is this correct, do you think?*' and it'd be like, '*Yeah, yeah. Well, no, quite-, not, not this, but, yeah*.' " (Harry, team 3)

The approach chosen in all teams was some mix of *delayed shared working* or *shared working*, meaning they either planned the work on the sub tasks in twos or individually to contribute together later or they worked together on each sub-task, respectively. All 10 of them agreed with the solution before submitting.

Additionally, the teammates in the three teams were happy with *thorough checking or shared monitoring* of their work, which helps maintain the trust in each other:

"Yeah, exactly. Like it was a pretty nice and integrated. He could, like-, *he would see my calculations*, what I was doing. He would *double check those* calculations. He would like, 'Yeah, that's perfect.' *I would see his circuit* and be like, '*Yeah, that's fine as well*.'" (Ben, team 1)

Only team 2 had submitted their work within the first hour itself, without thorough checking. This left a *feeling in one of the members* of *lower satisfaction* with the outcome:

"Mmm [yes]. … It might be the calculations. *We might've messed up*." (Ethan, team 2)

Overall, the three teams exhibited good levels of SSRL by having shared goal, plans and shared monitoring.

b) Trusted each other

They were happy to share the reward equally as agreed at the start, which shows that they trusted each other by that point. Irrespective of their chosen approach of meeting their shared goal for the PjBL activity, the quotes below show that they realised that they are stronger together and trusted each other before and after the PjBL activity:

"*We trust each other's work* and based on previous (COGLE) sessions we could see who was good at what." (Andy, team 1)

The fact that they *trusted each other* stemmed from the fact that they *knew the strengths and weaknesses of each other* (cognitive trust)*;* they *cared for each other when stuck* (affective trust) and felt that *everyone was committed* (conative trust). The quotes below highlights their commitment and care for each other that they had developed during the learning together phase:

"Erm, yeah, yeah. If, if someone got stuck, then they would just help them out and tell them what they're doing wrong." (Ethan, team 2)

This trust had actually developed between the teammates over the short period of COGLE use and is explored in section 5.7.3.1e, but the quotes from the PjBL activity shows the link between the two:

"Er, *similar [trust]* by the end [of COGLE sessions, compared to other team experiences from the past]…'*cos COGLE like forced you to talk to people, erm, so it built up quicker than with other groups*." (Cathy, team 1)

c) Calm

Over the 7 COGLE sessions students had become *comfortable in working with their teammates* and there were *no conflicts* that were unresolved.

"If we do have a *disagreement*, *we're able to sort of solve it*…in a good way *without sort of falling out*." (Don, team 2)

Team working can be less than ideal experience for most and problems may not surface during the actual team working as people are focused on making it a success. Such muted feelings are captured in the second dimension that emerged in this work.

5.7.2.2 Key dimension 2: Reflections on team working

As mentioned earlier, one of the three teams in this case completed the PjBL task over much longer period due to *external factors* like *technical difficulties* in the system used. There were several other difficulties that this team had to face which may have affected their experience and team working, although the work submitted by them did not show this that much (a mark of 77%). This was also the team to start last and the two

NAT students who came forward to be part of this study were put into this team together. This group had two female and two male members. The interview data captured several other *external factors* that seem to have affected the team.

Themes/ Sub-themes	**Description**	**Count**
External factors	Factors beyond the control of the team or research design that caused some variations in the final day experience of the teammates (mainly team 3)	3/9
Low confidence in others	Low trust in some within the team to deliver on the PjBL task.	1/9
Lack of agreement on work share but no lack of will	Lack of agreement on how the workload is shared (division of labour)	1/9

Table 25 Themes and frequencies in interview (SOWT part) – reflections on team working (case 2).

a) External factors in the mix, with some low confidence in others

Older version of COGLE, seating arrangements due to faulty PCs, timetable issues, gender, and *low confidence in others* were all in the mix here and must have had an impact on their ability to work as a team:

> "I think there was *some issues with the computers*, and I think *they [girls]* just kind of-, they did, er, they got a bit… erm, *busy just having a conversation between themselves* for a bit. Erm, and that's why I kind of like really saw like *us being like broken down a little bit*. But, even, like, that *might have just even been the fact that we were sitting on opposite sides of the computer*, like." (Giles)

Different reasons were being contemplated for the less than ideal group-working that happened in this team. Despite all this, all the students came to both events and finished the task.

b) Lack of agreement on work share but no lack of will

There was *no clear agreement* in the way the work was distributed:

"*Nothing was really like clearly like agreed upon…eventually just kinda had to assume things*. Yeah…nothing was ever clear cut…*I think that was kind of an issue*." (Giles)

Giles wanted a clear cut decision agreed by all, but he was being passive deliberately and did not want to come across as controlling. However, Harry expected him lead in distributing the work fairly:

"*So long as I know what I'm doing* precisely, *the concentration's not always bad*. It's just when there's *a bit of...ambiguity*, I have a *tendency to go off on a tangent*." (Harry)

Harry had finished his calculations very early on in the second session. Giles took most of the work and was busy with it. In the absence of any guidance, Harry started to work on something on his own which *he thought would be useful* but in Giles's eyes this was not agreed or expected in relation to the PjBL task:

"I …said, 'Well, *if I've got to still be here, I might as well try and find something to do*.' …then *I decided*, 'Well, I could just draw out the… *work on Multisim,*' 'cos…to have a *layout*…it was *one of the tasks*, and I said *it would be quite useful*." (Harry)

Both contributed to the completion of the task to the best they could but they could not agree on work distribution and the value to each other's work.

5.7.2.3 Role of technology (COGLE) in effective team working

In pursuing why the team working experience was the way it was, links to various aspects of COGLE came to light. Several quotes already stated in the previous section have mentioned COGLE.

Themes/ Sub-themes	Description	Count
Help build trust	COGLE seen as key in helping build trust in teammates.	9/9
Internalise scripts	COGLE seen key in helping internalise scripts used in the final day	4/9

Table 26 Themes and frequencies in interview (SOWT part) - role of COGLE.

a) Build trust

Students felt that COGLE helped in increasing *awareness of the abilities and reliabilities* of their teammates (see quotes for themes *trusted each other* and *no conflict* earlier). The GWM in COGLE helped build *cognitive* trust *in teammates*:

“Andy is doing his best as well. So, it shows in the [COGLE] system what, you know, *what he knows and what he’s capable* of.” (Ben)

b) Acknowledging that they had internalised the scripts from COGLE

Over the 7 COGLE sessions, all had become more goal oriented and had internalised the scripts for CoRL and SSRL from COGLE or discovered by themselves. The repeated interactions within COGLE made them *rely more on each other* and be more *cooperative* to succeed in their *share goal*s:

“*Every week, I got more and more comfortable* with them, so it just felt like, ‘OK, we’re here, *let’s do what we need to do*…make the most out of the moment,…it’s nicer [to]…have like a *nice friendly environment whilst doing the work,* because it’s more…stimulating.” (Ira)

They arbitrated their conflicts *between two people*, just as COGLE would by telling the answer or showing a video, *a third source* was used to *regulate their behavior*:

“Normally it would be *two people disagreeing* and then *a third person would* sort of then go, ‘*Hang on, guys,’ [chuckles] … ‘get back into it here. We need to like focus up a bit*.’” (Don)

Overall, they were successfully able to regulate each other and work together towards a shared goal within the PjBL activity.

5.7.3 Themes from the 7 COGLE sessions

Compared to the previous case, students used COGLE here for an extended period of time. The themes from these sessions are shown in **Table 27** are identical from those in the previous case. Here too COGLE was seen as a *catalyst* for *enabling regulation* between teammates. Due to the extended exposure students had got used to COGLE being there within their teams, almost as a knowledgeable "teammate", which through its scripts handled some of the *dirty housekeeping or arbitrating difficult problems* needed to be resolved in team working.

5.7.3.1 COGLE Orchestration as catalyst for enabling regulation and as an arbitrator

Themes/ Sub-themes	Description	Count
Encourage natural communications	Quickly overcome social awkwardness and make communications feel natural.	9/9
Overtake orchestration for mastery	Made students overtake COGLE in regulating each other and made them plan amongst themselves how they can achieve the shared goal. (Cathy/Ethan)	7/9
Encourage internalisation of shared goal of GWM	Everyone aligned to the shared goal of working together to achieve GWM	9/9
Enhance learning	Help master content and learn the topics well.	7/9
Correct or Enhance self-efficacy	Felt more confident in the topics or got their over-confidence corrected.	9/9
Promote conflict resolution	Cognitive conflicts were not seen as conflicts but provided practice to hear each other's views to allow conflict resolution scripts being internalised.	9/9
Build trust through numerous opportunities	Interactions, frequency, helping each other, cognitive conflicts all helped in building different facets of trust between teammates.	9/9
Not taking shortcuts and working in tandem with COGLE	Internalising COGLE scripts and using COGLE as a fallback if their own scripts did not work or when they wanted COGLE to play its part.	6/9

Table 27 Themes and frequencies in interview (COLT part) – Orchestration as a catalyst.

a) *Encourage natural communications to flow quickly and overtake orchestration of mastery*

The advantage of engaging students from day one in interactions, in *encouraging natural communications to flow quickly* was maintained here too. The GWM means each teammate has to develop an understanding of the topics from the very first day:

"It's, it's because *the system puts you pretty much affront, right together*. You have *no other choice*. Either you do it together or you don't. And I think that's, er, like pretty good because *it means that everyone is taking part in it, and no one is, you know, slacking off.* " (Ben)

However, the extended use of COGLE and the predictability of the system introduced a new element of *banter* between the students, which was used to *regulate student behavior* to *come together* by one team.

"So, it, *it wasn't* as opposed to *like them completely just shunning me* and saying, 'You're not right. Just-,' It was kind of *like*, you know-, it, it was kind of like *a jokey thing that we did*." (Ethan)

Like in previous case, students had to *overtake regulation* from COGLE several times, which gave them a sense of control and allowed them to cope with the *frustrations* resulting from *guessing, answering in haste* or *repeated mistakes.* It also made them *communicate naturally* (instead of under COGLE's control) after just a few sessions.

> "I think *it [COGLE] prompts* discussion *not just when the system says...* let's say…one person had answered wrong, or something like that…we'd talk about why and possibly *get a little [chuckles] frustrated* every now and then… with *people not pressing the right button or something* [smiles]... *most of the time… it*

would prompt discussion… quite a lot of discussion…*we were always talking about the questions*, 'cos *we all wanted to master* …, the course." (Finley)

b) *Encourage having a shared goal and shared plans and overtake orchestration of mastery*

With the COGLE scripts in the background there to support them if needed, they took regulation in their own hands and discussed doing this in a *shared* way, *planning* to achieve the *shared goal* of *GWM* together:

"No. *Sometimes* we… kind of did it-, *we talked as a group before we voted*. So, it was just like, 'Oh, *which answer* are we going with *and why*?'" (Ira)

The scripts, such has having a shared goal and working together, had been internalised well by all those who did not have these and reinforced in those who had some experience of CoRL and SSRL before. This experience made them be *more cooperative* and *determined* to achieve the *higher* shared *goal* of mastery alongside *resolving* cognitive conflicts:

> "*I did peer mediating previously* so I've had some experience…but it [COGLE] has changed sort of my view trying to *achieve the goal even more*... I mean *in COGLE the objective was to achieve the goal as a group* and *if we didn't do that we wouldn't succeed...* so *just pushing a bit more* rather than *just resolving conflict... to try and to actually achieve the goal*." (Andy)

Learning together with COGLE reinforced the significance of working on a shared goal and they became used to working together as a team, ready for the SOWT session.

c) Correcting over-confidence and enhancing learning and self-efficacy

Self-efficacy of students was *corrected* where they were over-confident and likewise it was *enhanced* where it was the confidence was low:

"My knowledge of questions was proven to be wrong... that was *better* as I preferred to be questioned…& *show (sic) I was wrong & be corrected*….& the *second one was just learning from scratch*." (Andy)

These corrections in confidence also resulted in the *changing of hands* back to COGLE to regulate the student's learning when needed. This kept *over-confidence* in check and that COGLE was always there to help with such situations:

"*Somebody knew…we all decided to answer the wrong thing*…it [COGLE] would…probably make them…*would make them frustrated*, and *then they'd… [COGLE] would appoint them to explain it.*" (Finley)

Due to longer exposure to the system students discovered COGLE's role as a beneficial *third party* and used its advanced features too.

The students realised that when the selected one didn't knew the correct explanation, it was better to reflect and learn from a *remedial video* selected by the system than discussing with that teammate. This *arbitration or third party* effect, which is akin to *letting the software do their dirty work*, was much more noticeable in this case and it helped students overcome conflicting situations in a calm way (see next section):

> "*If someone wasn't sure… [And] guessed* and they… *get it right*, and then *they were prompted to explain*... we sort of discussed it for a bit… *we had a few disagreements*… 'cos no one knew the answer… *[We] go back and watch the [remedial] video*. And then, *from then on, when that situation arose... we'd just… watch the videos.*" (Don)

Over 7 sessions, the students got used to COGLE being there to help in such situations and the coercive script was no longer a source of frustration. They had started to rely on COGLE in difficult situations or use scripts they discovered themselves. They learnt to *cope with the frustrations* and became more confident not just with the content but also in dealing with the situations learning together presented.

d) Promoting conflict resolution through cognitive conflicts

Like the previous case, COGLE orchestrated several *cognitive conflicts,* which the students *resolved through discussions*. Over prolonged exposure of COGLE, they had discovered their own scripts when responding to frustrating situations. As the students had started to use the advanced *arbitration* features in COGLE more often in the later sessions, the *conflict resolution was noticeably calmer* and as intended by the script:

"*It [COGLE arbitration] does help*…it *tells you the right answer*, whereas…if…they were arguing…you know, no one knows who's actually right… if we *still don't understand, we can watch the video*, which then explains it…further. So, I feel like, yeah, it *helps resolve conflicts like that*." (Ethan)

e) Numerous opportunities to build different facets of trust

Like in the previous case, here too frequent interactions, which often involved helping each other and resolving cognitive conflicts in a calm way resulted in increasing trust between the teammates.

The later sessions had fewer questions in the question bank. This had a surprising and additional impact on how trust developed during a *cognitive conflict* when a question showed up for the first time. When a same or similar question came up again *it reminded them of the event* and *made teammates feel valued and trusted.* They all correctly answered the question *this time trusting the explanation* of someone who was *previously not been listened to*:

> "*If the question comes up again, a similar sort of question*, and we got it wrong previously because … *we were adamant our answer was right*, then we would go, 'Ah, OK [realising], *we should do it differently this time.*' So, you sort of…-, the person who was feeling less valued starts going, '*OK, they believe me now*,' [half laugh] after they got it wrong." (Don)

Also during the later topics, as the questions got harder, the graph shown by the system helped increase the *awareness of their common struggles* and how they were *progressing* in the face of these challenges together:

"The graph was very interesting to show us *how we were progressing [or not]…* and just to show *that how we were improving...* As we also saw a pattern that by the end we had pretty much aced the questions." (Ben)

As people got used to the COGLE over 7 sessions they were able to notice more of its features, like the graphs. Another impact of time was a stable *affective trust* that developed over time. COGLE also helped here by maintaining it as it did the *dirty work* of arbitrating between teammates. This was now seen as a valuable job that COGLE did and they almost treated COGLE as their non-emotional teammate and used it to stay nice to their teammates and let COGLE handle the tricky parts.

Like *self-efficacy, trust* also went through a cyclic correction process of enhancement and correction and those with very high or very low trust in others were able to update their trust in others in light of the evidence that was in front of them in using COGLE.

5.7.3.2 Not taking shortcuts and working in tandem with COGLE

Over time the coercive GWM script was internalised and students got used to *solving* questions *together* to achieve the GWM *goal.* They involved and *listened to each other*, as otherwise the *high penalty* would make them work even more:

"I guess it [the GWM script] would be…*share the answers with each other*, because *we have to know* for sure that *everyone understands that concept equally*." (Andy)

It made some realise that *they can be wrong* and not to always take a persuasive approach and *direct others* when they themselves are not confident about something. Instead, try and understand the viewpoints of others and learn from them *cooperatively*:

"So, if I, *I'd got it wrong* and they'd got it right, *I would think twice* before making [half laugh], well, not making [half laugh], *persuading, perhaps, everyone to follow my method, and try and understand their method,* and… yeah." (Finley)

COGLE offered the students several features which made them see it now as part of their team. Students realised that it can help with the *dirty work* and *support* in the form of *democratic voting* and *remedial videos* respectively.

> "*We knew…the format of the system*. So…'OK, we watch the videos, we answer the questions, we have the person explain it, *we have the [remedial] videos if we get it wrong*,' sort of thing, '*we have the midpoint part* [to vote for a teacher].' …*we knew what we were doing*." (Don)

5.8 Integration of quantitative and qualitative stages

Here I triangulate the evidence collected throughout the study in order to answer the research questions.

RQ 1. How does computer orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated project-based settings?

As the topics in the 7 sessions increased in difficulty the trust and self-efficacy went up and down to finally come to levels where all students felt they are a team, ready to work collaboratively on the PjBL challenge together (sections 5.6.1, 5.7.1 and 5.7.3). As stated in the answers to the sub question below, the students were able to *overtake* the orchestration and *regulation* from COGLE several times and also giving back control to COGLE when they faltered in the face of challenges. In the process they practiced and discovered regulation and collaboration scripts that worked and those that did not work, preparing them as a team. Similar to the previous case, multiple orchestration cycles of PI and GWM, encouraged shared planning and shared revision of plans to achieve mastery (section 5.7.3). They got used to each other and often checked and supported each other's work (shared monitoring) and understanding (shared working) to achieve *GWM* (shared goal). COGLE was seen as part of their team, which helped them achieve mastery through remedial videos and pairing teammates. They remained *positive* in the face of *frustrations* linked to the *high penalty* and mistakes within a *GWM* cycle. These challenges and the practice of shared planning, reviewing, goals and working helped them internalise the SSRL scripts (shared planning, monitoring and goals) that worked for them. Increased trust and self-efficacy allowed them to use these SSRL skills for completing the un-orchestrated PjBL activity (section 5.7.2). An increased emphasis on the *shared goal* of the team in the PjBL activity meant they chose to working in a shared way either from the start or by the end.

However, the team which used older version of COGLE, felt its absence during the un-orchestrated PjBL session and were not able to regulate each other in the PjBL settings. The levels of self-efficacy in this team were lower than those in other teams. Lack of immediate feedback had affected the confidence of the team members. This meant that cognitive conflicts sometimes remained unresolved, negatively affecting trust. Poor self-efficacy and trust affected their ability to regulate the others in the task ahead. Despite this, a shared sense prevailed and prevented selfish behaviour and they worked towards their shared goal even when faced with conflicts.

Like in previous case, the SOWT activity ended at a positive note, which kept relationships going in all teams. Next, I present the answers to the two sub research questions in order to further understand how attitudes to CM and trust between teammates developed in greater detail.

RQ 1.1 How does computer orchestrated learning together in small groups affects a learner's attitude to conflict management?

COGLE created *numerous opportunities* for students to practice *citizenship activities (helping each other), conflict resolution, arbitration* and eventual resolution (section 5.7.1 and 5.7.3). These orchestrated interactions helped them trust and get used their new teammates and resolve cognitive conflicts in a timely and collective fashion. This was required of them to reach their *shared goal* of *GWM* during every COGLE sessions. As trust between teammates grew, they also internalised SSRL scripts promoted in COGLE and took a more cooperative approach to conflict management. The following paragraphs present multiple chains of evidence for this increased *cooperativeness* but also the suppression of preference for non-cooperative and more selfish CM styles such as *directive* and other CM styles like *harmonising* and *avoiding*.

Looking at the results (section 5.6.2) from the *Style Matters* survey (n=10), before COGLE sessions the top preferred CM style were: *cooperative (n=5), harmonising (n=2), compromising (n=2)* and *directing (n=1)*. By the end of 4 COGLE sessions, one student changed their top preference from *cooperative* to *harmonising*, another from *harmonising* to *compromising,* one from *directing to compromising* and one from *compromising* to *cooperative*. These changes show more students moving towards the *cooperative* quadrant of **Figure 5**. Only one student went away, in terms of their preferences, from *cooperative* CM style. On re-testing, at after 7 sessions, 3 showed a change in their preference to *cooperative* and only one changed their top preference from *cooperative* to *harmonizing*. The *cooperative* CM style was now preferred by a majority (n=7). On re-testing, just before going into the PjBL task, there were very few changes and the most preferred CM style that emerged was *cooperative (n=7),* with one person moving to *compromising* and one changing from *harmonising*.

Just like the previous case, the most common least preferred CM style, just before going into PjBL sessions, was *directing (n=6)* followed by *avoiding (n=4),* both of which can be seen as *selfish* CM styles. I interpret this as students being more *shared goal oriented* where they prefer working together *cooperatively* and not selfishly when going into the PjBL activity.

The *SSRL* survey data (section 5.7.1) shows that 6 out of the 9 respondents reported knowing the importance of when to resolve and when to defer a conflict. By the end of the 7 sessions, 8 of the 10 respondents reported being exposed to resolving cognitive conflicts peacefully with their teammates. All students reported that COGLE paired them with others to resolve cognitive conflicts, and 8 acknowledged that they were supported by COGLE to defer conflict resolution to be resolved peacefully later. All students became more accustomed to working with each other in a shared or cooperative way, i.e. working towards *GWM* by *discussing together*. In the PjBL session, 1 out of the 8 respondents felt the group was *broken down* and 2 out of 8 respondents felt they *did not resolve some conflicts* that emerged during the group-work. Despite that *they worked to deliver the shared goal* and worked collaboratively either from the start or towards the end. Overall, COGLE provided them with a safe environment where they were exposed to COGLE led CoRL. They practiced CoRL and SSRL on their own too used COGLE as a backup in case they faltered. For some (n=5) their existing SSRL scripts were invoked, and for all others it gave enough practice over multiple days. This allowed practicing CoRL and SSRL and learning content together with the same teammates. All this made it easier for them to prefer *cooperativeness* in an un-orchestrated environment over selfish behaviour. Only one student was seen by one of his teammates as not being cooperative, despite this there was no lack of will to cooperate.

The qualitative analysis of the interview data (section 5.7.2) from the PjBL activity also points in this direction. Here too, the evidence suggests they all actually worked to achieve their *shared goal* and there was *only one team where conflicts* were left unresolved and despite this they all submitted their final work together. They were *comfortable with each other* going into the PjBL activity and decided to support those who had *low self-efficacy* and involved them by allocating them and supporting them in the work they did, even when they arrived late to the session. This shows they were actually able to work collaboratively even in un-orchestrated settings. Only the team that used older version of COGLE mentioned that they felt the absence of COGLE as their orchestrator may have affected the way their group during the PjBL activity.

Further, the analysis of the qualitative interview data (section 5.7.3) from the COGLE sessions confirms that COGLE promoted conflict resolution through orchestrating *cognitive conflicts* and *GWM.* Numerous interactions involving cognitive conflict resolutions and the group awareness features of COGLE, helped build *trust* between teammates (see next sub question for how). It also helped them become more *confident* by enhancing their learning (see section 5.6.3). During the sessions they internalised SSRL scripts as evident in multiple attempts to *overtake* regulation by students. They let COGLE *do the dirty work*, such as voting to select a new peer instructor, in their attempts to achieve *mastery* smoothly. Within COGLE they also learnt how to defer a conflict for resolving later. As they *overtake* the orchestrations to achieve GWM, the *high penalty* ensured they remained *cooperative* and in this way it help *maintain/enhance cooperative* CM styles. COGLE helped *suppress* the selfish *directing* CM style as the high penalty made them realise that they too can also be wrong at times.

RQ 1.2 How does computer orchestrated learning together in small groups affects a learner's development of trust in their teammates?

Each *mastery* session created *numerous opportunities* for students to practice *citizenship, cognitive conflict resolution* and find out about the teammate's *relevant past performance* in the *learning together* phase through COGLE. All of which enabled development and correction of trust between the participants (sections 5.6.1 and 5.7.1-3). This is evident also in students coming together to *overtake regulation* from COGLE many times during the 7 sessions as their trust and confidence increased. It is also evident in the way they approached the conflicts that emerged in the PjBL activity and delivered successful on their final shared goal. The following paragraphs present multiple chains of evidence for this increased *trust* in teammates.

Results from the *Trust in teams* survey (section 5.6.1) show that for all facets of trust (affective, cognitive and conative) there was widespread *trust* (N=9) in their teams by the end of 4 COGLE sessions and this improved (N=10) for *affective and cognitive trust* going into the PjBL activity. This trust had developed very quickly in under 4 COGLE sessions. However, challenges such as *guessing* of answers made the trust go down at times. COGLE supported the teams to enhance their trust in others again as is evident from the final measurements before the PjBL session.

The *SSRL* survey data (section 5.7.1) also shows trust building had started from the first session and trust was established for the majority by session 3. Only one student got delayed in developing trust in his teammates and this was due to the use of *banter* directed at him to regulate his *guessing.* Mastering together and resolving cognitive conflicts orchestrated by COGLE helped them increase their own confidence and their trust in others each time they completed mastery.

The qualitative analysis of the interview data from the PjBL activity (section 5.7.2) suggests that they all were *committed* to completing the activity, *trusted each other* going into the activity and were *happy to share their reward equally*. They knew the strengths and weaknesses of each other and they cared for each other. There was evidence of an increase in cognitive trust, affective trust as well as conative trust when looking back at COGLE sessions. It was this trust that helped resolve or defer the conflicts they faced whilst working and delivering on their shared goal successfully. Students linked *learning together* using COGLE to the development of trust in their teammates. The exceptions here were Giles and Ben. Giles realised that his team was not pulling their weight and his trust in them plummeted during the PjBL session and only recovered in the female members of his team. Ben on the other hand felt Cathy was not contributing as she came late to the session, however Andy regulated the situation and they were all working together after that.

Further, the analysis of the qualitative interview data (section 5.7.3) from the COGLE sessions shows that the *social awkwardness* was reduced from day one itself, it left the rest of the time available for building trust between each other. It confirms that *learning together* in COGLE with the *shared goal* of *GWM* provided *numerous opportunities* for *helping each other* (citizenship) as well as for resolving *cognitive conflicts* that led to building cognitive, conative and affective trust in many ways. All this gave them enough *knowledge of the strengths and weaknesses* of their teammates allowing them to trust them better. They knew they all had *mastered* content together, which also gave them a reason to trust each other. Control of CoRL *switched hands* several times between the students and COGLE in two teams as and when they faltered. Trust in teammates was also fluctuating with these *handovers* and by the time they went into the PjBL they expected all teammates to know how to deliver on the tasks set for them.

The use of cognitive conflict resolution that was promoted in COGLE had an impact on all three facets of trust and also on self-efficacy, making it an important reason behind the quick increase in trust.

Chapter 6: First year BSc Physics students preparing for a PjBL Project by learning together in SOLT sessions: Findings.

This chapter introduces the reader to the theoretical repetition case, the participants, the details of the learning activities and materials used, the purpose and nature of data collected and finally the methodological approach and findings from the analysis of the data collected.

6.1 Research Questions

The research question used here are slightly modified version of those seen in previous two cases as COGLE is not used here. Integrating data from quantitative and qualitative sources, collected at multiple time points to enable *methodological and data triangulation*, the following research questions were addressed:

RQ 1. How does student orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated project-based settings?

There were two further sub research questions as follows:

RQ 1.1 How does student orchestrated learning together in small groups affects a learner's attitude to conflict management?

RQ 1.2 How does student orchestrated learning together in small groups affects a learner's development of trust in their teammates?

6.2 The participants and the context

Seven of the 104 students from the first year of the BSc Physics degree joined this study (see **Table 1** for details). This included one autistic student. They worked in two teams (of 3 and 4) and all completed the study.

Content taught within the BSc Physics goes over the basics of electronics and does not go deep into the application and design aspects common in engineering courses. Most of the Physics students may already know, from their A levels, basic electronics. The context chosen for the study represents a real world case where PjBL is used within the first year analogue electronic module but the students were from the first year of BSc Physics course instead.

Over five weeks, inside a physical classroom and no lecturer (just the researcher), two teams engaged in 7 two-hour SOLT sessions. They watched the same videos and answered the same questions as used in the previous case. A Google form to be submitted individually was used to collect their answers. As feedback, student were individually sent a score at the end of the session. However, instead of COGLE orchestrating interactions, they learned together, orchestrating interactions themselves. Later, like case 2, they designed a filter and an audio amplifier in a two hour PjBL SOWT session. This is similar to what happens practically in the existing PjBL module where the lecturer only teaches in the lectures (here they have the videos) and even though a team of staff are around in the lab to facilitate students, majority of the time students orchestrate working together on their own.

It can be argued that the benefits seen in previous two cases could be the effect of the groups learning together. Therefore this case aims to investigate learning together using the same content but where orchestration is student led making this case a theoretical replication based on the rival explanation linked to *learning together*. The next section describes the data collection plans and purpose.

5.9 Summary of findings

Building trust and self-efficacy

The theoretical framework of **Figure 2** shows several antecedents of trust. This case study also confirms the positive impact that citizenship (helping each other) has on building affective trust between teammates as shown in the framework. In addition, this case also shows that trust can be developed far quicker (2-5 sessions) than the literature suggests (8 sessions) (Webber, 2008) through orchestration. Over longer COGLE sessions, new challenges may cause students to reduce their trust or even their self-efficacy, but the coercive role COGLE scripts played. This meant COGLE was seen as a trusted teammate, which brought the teams back on track by increasing their trust again and also their self-efficacy as they continued to learning together and achieved GWM.

Firstly, this case too identifies the link between *resolving cognitive conflicts* and building or maintaining affective and cognitive trust in teams. It shows the importance of this type of interaction over simply the *interaction frequency* of *citizenship* or *simple interactions* on building trust. It also shows the impact of resolving *cognitive conflicts* on improving *self-efficacy* and confirms its already known impact on *learning*. It highlights the fragility of the trust thus developed and new challenges and difficulties if not resolved can cause the trust to decrease. COGLE provide effective and inclusive support in overcoming these challenges and difficulties. The older version did this somewhat inefficiently.

Next, this case also gives a new dimension to the term *past performance* also used in the framework of **Figure 2**. For teams that have no past interactions, *learning together,* the content needed in a PjBL activity, can give access to *relevant past performance* on their teammates in order to build or maintain cognitive and affective trust.

Finally, this case also shows the impact of the *positive frustrations* that emerge when orchestrating a single and simple *shared goal* of achieving *GWM*. A *high penalty* when a teammate gets a question wrong caused these frustrations. The penalty forces the students to go through more opportunities to help each other (*citizenship)* and resolve more *cognitive conflicts* together before *mastery* is awarded. This led to further strengthening of the relevant facets of trust in others.

Conflict resolution, SSRL and CoRL script internalisation

This *shared goal* orchestration and the *positive frustrations* within it also led to students being able to practice and *internalise* the scripts for CoRL and SSRL, as they overtake GWM, teaching each other and collectively working towards mastery from very early on in the COGLE sessions. COGLE also helped students practice and internalise *calm* conflict resolution without losing sight of the shared goal. Where it was needed, additional features in COGLE were used by students to let it do the *dirty work* allowing them to defer the resolution of the conflicts to a suitable time and providing *arbitration support* in the shape of *correct answers and remedial videos*.

The *internalising* is evidenced by the successful use of these scripts within the SOWT session, thanks to the trust built within the COGLE sessions.

Maintain or increase cooperativeness

COGLE worked like a catalyst to achieve the desired results very quickly. The COGLE sessions helped build trust and conflict resolution, deferral and SSRL scripts were internalised by the students. This helped in maintaining or enhancing *cooperativeness* in students as they learnt how to not let the conflicts come in the way of their shared goal. Evidence suggest that students did not behave in a selfish or directing way when it came to conflict resolution. They practiced calm conflict resolution through discussing with everyone and deferring conflicts when appropriate.

6.3 Procedures and Data Collection timeline

Table 28 to **Table 30** shows timing and purpose of different instruments used to collect data. No new instrument was used compared to previous cases. All students were then invited for an individual one hour (NAT student interviews were up to 2 hour long) interview.

AT THE START OF THE STUDY	
Data Collected	**Purpose**
Subject Pre-Test	Used in Learning Gain calculations
Trust Pre-Test	Captures different types of trust levels in their current teams Used as a base line
Style Matters ® (Conflict Management (CM) Style survey) Pre-test	Captures CM style preferences they come in with Used as a base line
SSRL Questionnaire Pre-test	Captures the level of regulation students are familiar with already

Table 28 Data collected at the start of the study (case 3).

AFTER SESSION 1-6		AFTER SESSION 4 & SESSION 7	
Data Collected	**Purpose**	**Data Collected**	**Purpose**
Daily Survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data	Daily Survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data
		Trust Post-Test	Captures different types of trust levels in their current teams after 4 & 7 sessions.
		Style Matters (CM Style survey) Post-test	Captures CM style preference after 4 & 7 sessions
Daily Quiz	Self-assessment of topics.		

Table 29 Data collected after each session (Case 3).

PjBL Activity		
Data collected before	**Data collected after**	**Purpose**
Subject Post-test		Used in Learning Gain calculations
	Daily survey	Capture student experience of the session and any critical incidents to use within the interview Also capture regulations related qualitative data
Trust Post-Test	Trust Post-Test	Captures different types of trust levels in their current teams before and after the PjBL activity
Style Matters (CM Style survey) Post-test	Style Matters (CM Style survey) Post-test	Captures CM style preference before and after PjBL activity
	SSRL Questionnaire	Captures the level of regulation students are familiar with after the session.
	Interview	Captures the level of regulation students are familiar with after the session.

Table 30 Data collected before and after the PjBL activity (Case 3).

6.4 Methodological approach

The methodology used here was similar to that in the other cases in this study (Chapter 4 and 5) and is described in detail in chapter 3. As there were not enough participants here statistical tests were not used to analyse the data.

6.5 Descriptive statistics

6.5.1 Measuring levels of trust in teammates

Data was collected on different facets of trust at five points through the study: Pre, mid and post COGLE use and also Pre and post PjBL task. Member checking was carried out during the interview and students agreed with the meanings attached to their data. Next section describe the findings from this data set.

6.5.1.1. Changes in trust within the 7 un-orchestrated learning sessions.

All participants completed the surveys (N=7). The data in **Figure 18** shows a drop in the number of students who trusted (response 5 or above) their teammates in two facets, whereas **Figure 19** shows that only the number of those having conative trust in their teammates increased when comparing the data at the ‘start of study’ vs ‘post 7 sessions’. The overall number of students expressing affective trust was maintained at high levels throughout.

This contrasting finding (reduction in how widespread cognitive and conative trust is) after the first 4 sessions suggest that in the un-orchestrated learning sessions students were unable to get to know each other’s strengths that well. From observation of the first 4-5 sessions, they did not interact much as a team cognitively, rather they did the questions individually and only checked with each other on limited occasions. Over the last three sessions they did try to work together on the questions more as they find the content increasingly harder, by then they has also realised that they were all struggling with the content. However, even after 7 sessions, the cognitive trust did not become more widespread.

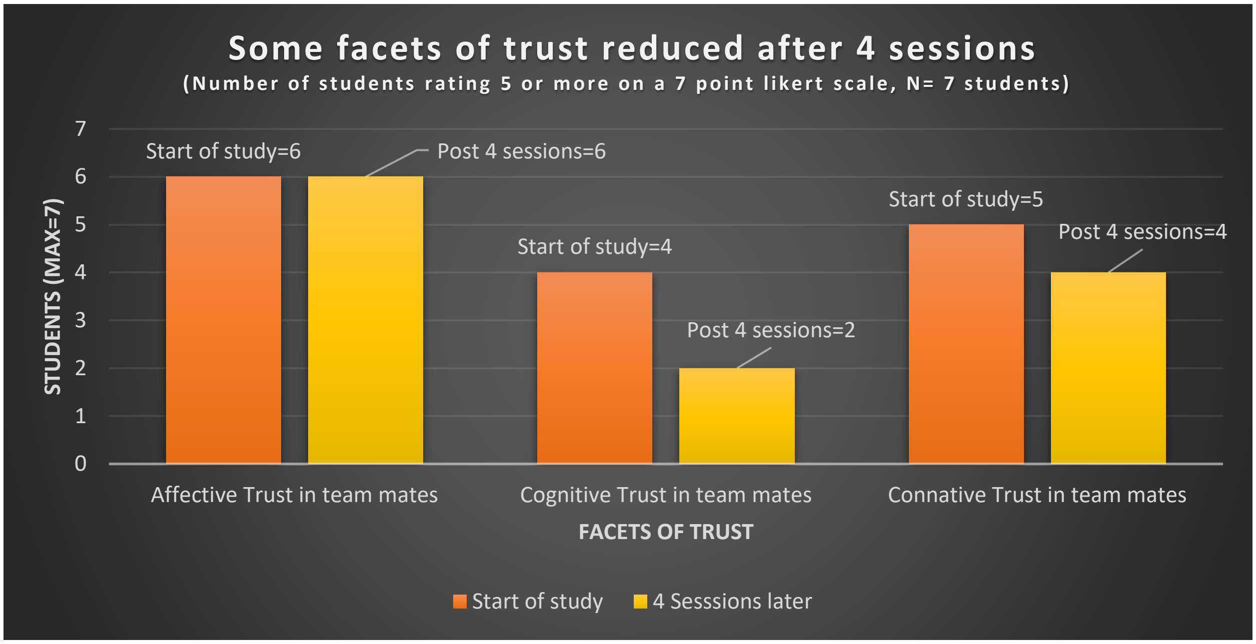

Figure 18 How trust changed post 4 un-orchestrated learning sessions.

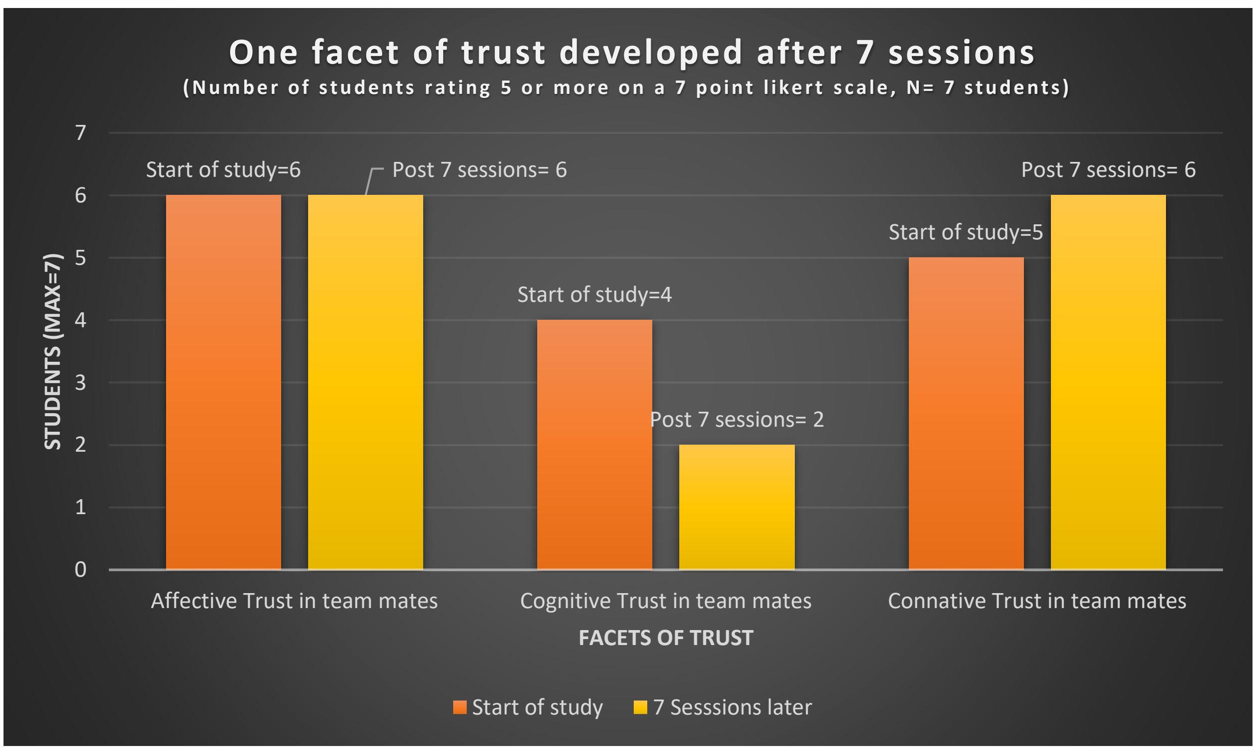

Figure 19 How trust changed Post 7 un-orchestrated learning sessions.

Next subsection discusses another snapshot of the trust data collected just before the PjBL activity started.

6.6.1.2. Trust less widespread pre-PjBL activity.

Before the PjBL session and completing the survey, the students were asked to decide how they will share a reward of £15 amongst three team members if their team came up with the best solution. As can be seen from **Figure 18-Figure 20** the number of students trusting their teammates after deciding on the way they split the reward did go to levels below the start of the study. Overall, this reflects the limited trust individuals had in their teammates to be able to finish the task at hand and that SOLT did not change this positively. Only the ASD student had increased their cognitive trust in their team.

6.6.1.3. Trust post-PjBL activity.

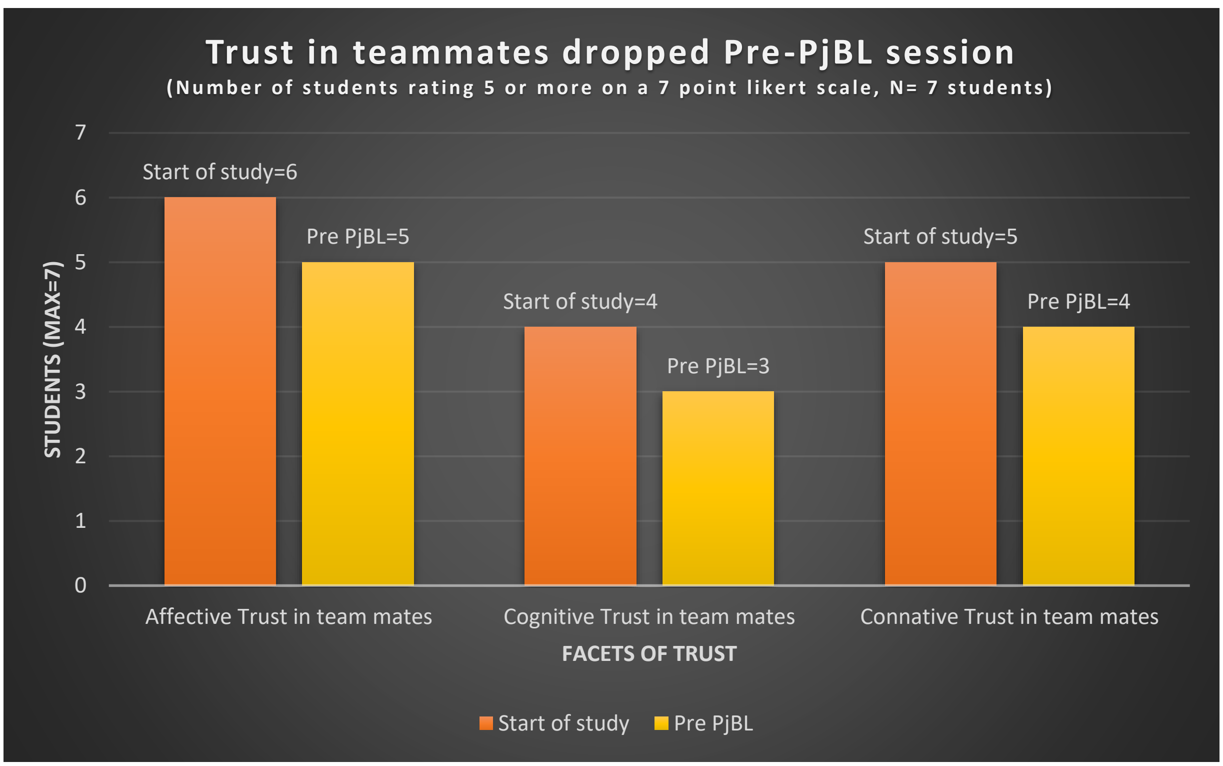

Figure 20 Number of students expressing trust in teammates, pre PjBL activity.

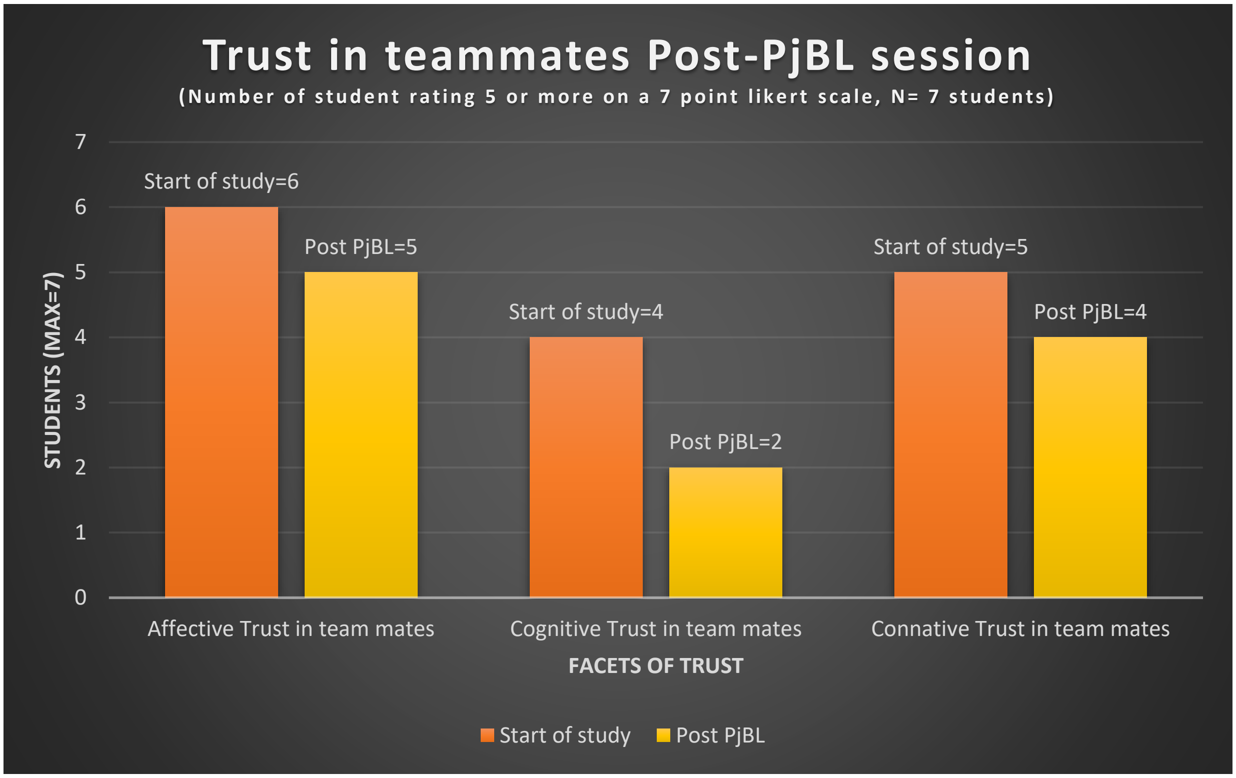

Figure 21 Number of students expressing trust in teammates after PjBL activity.

The post PjBL survey was completed by all students (N=7). Clearly, the **Figure 18** to **Figure 21** show that none of the different facets of trust benefitted here when compared to the start of the study. Overall, the number of students reporting to have cognitive and affective trust in their teammates before the start of the sessions have dropped. More is explored in the thematic analysis.

6.6.1.4. ASD student and trust

The cognitive trust the ASD student had in others seemed to have grown with time during the sessions. It is worth nothing that the ASD student, unlike the other students, has either maintained or increased their trust in others over this period. This over-trusting behavior is typical of ASD students (Yang et al., 2017; Yi et al., 2013, 2014). On closer inspection, trust of NT students in the ASD student had actually dropped.

6.5.2. Measuring changes to Conflict Management Styles throughout the study

6.5.2.1. Exploring Conflict Management styles changes

Using the Styles Matters ® survey I collected data at the same five points as in case 2: pre, post 4 and post 7 un-orchestrated sessions and also pre and post PjBL activity. This allowed me to arrange their CM styles in order of preference over the period of the study. For details of each style, please see **Figure 5** chapter 2.

a) Most maintain their most preferred CM styles (not much changed).

All students (n=7) completed the survey at all points. The results of the survey is shown in **Figure 22** and **Figure 23**. Note that there were times when the most and least preferred style places had up to two styles sharing each place.

Figure 22 shows that at the start of the study, 5 students show top preference for the *cooperative* CM style, one for the undesirable *directing* and *avoid* each and two for *compromising (portal)* styles. The number preferring *cooperating, directing* and *compromising* style remained constant after 4 un-orchestrated sessions. By the end of all 7 un-orchestrated sessions we can see a slight decrease in the popularity of *cooperating* and *avoiding* style but no overall change to the other two. At an individual level also there is no significant changes to be noted either after 4 sessions or after 7 sessions.

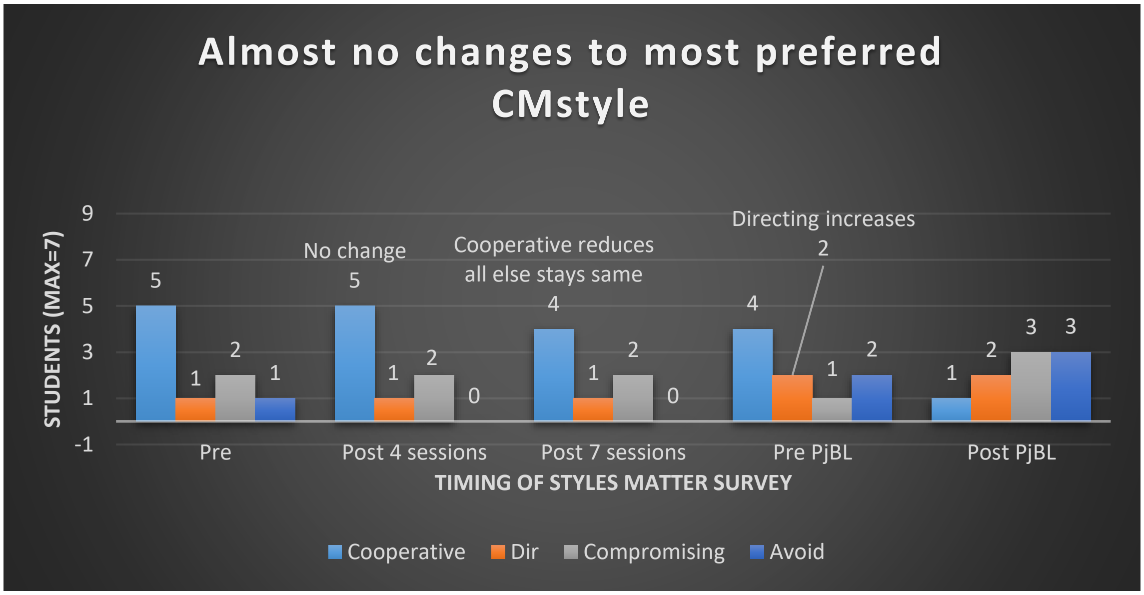

Figure 22 Most preferred styles at various stages of the study.

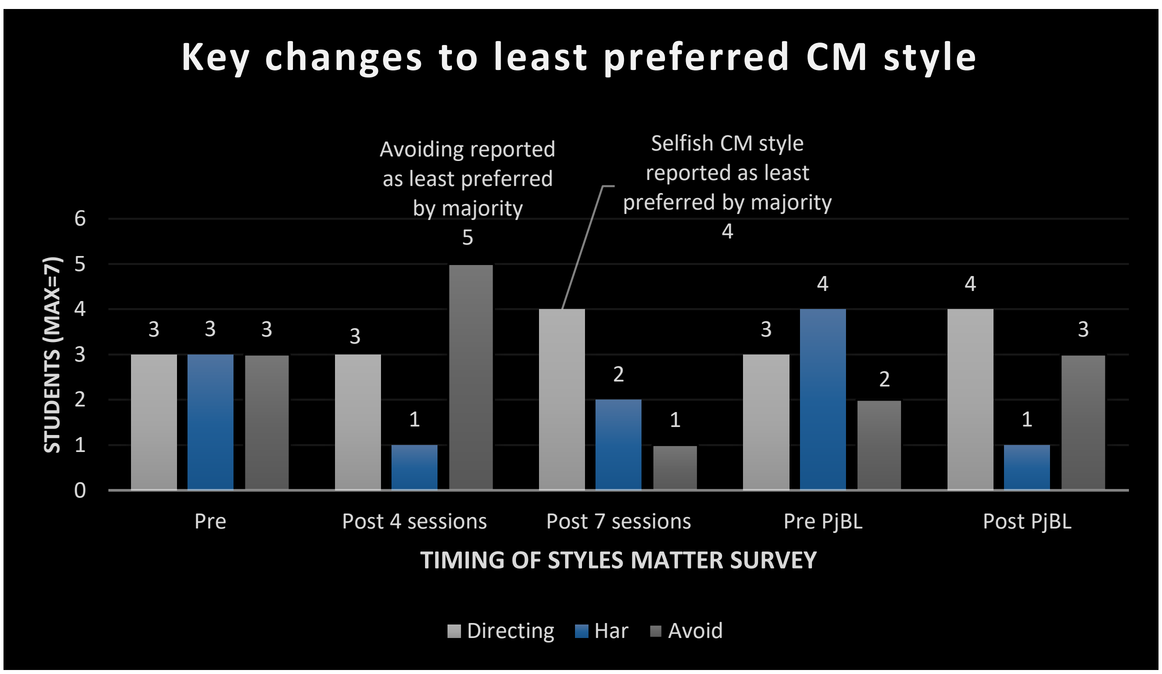

Figure 23 Least preferred styles at various stages of the study.

Just before the PjBL activity, *cooperative* style was less widespread but still majority style preferred by 4 students. So the un-orchestrated session seem to have *less of an impact* over CM styles of students and previous cases.

What is interesting to see, on closer inspection, is that after working in un-orchestrated teams, other than the changes shown in the **Figure 23**, Team 2 actually had 1 of 3 students not preferring *cooperative* style going into the PjBL activity, changing from all 3 preferring *cooperative* CM style at start. Team 1 saw 1 of 4 students change their top preference from *directing* to *cooperating* and another one *vice-versa.*

b) Discourage temporarily directing and avoiding CM styles.

The next set of results are interesting in that they show how the least preferred CM style changed in the same direction as the previous cases. **Figure 23** shows that, although temporarily, *avoiding* became the top least preferred style after the 4th un-orchestrated session. By the end of the 7 un-orchestrated sessions, the selfish CM style *directing* becomes the top least preferred style. However, going into the start of the PjBL activity the CM styles are not very different from where the students started. So overall, here too un-orchestrated sessions seems to have *less of an impact* on CM style preferences.

6.5.3 Pre and Posttest results

As discussed in section 4.6.3 percentage test scores and NLG scores are presented in **Table 31**. Same test questions were used as in case 2.

Student	Pre-test Score%	Post-test Score%
A0	41.18	41.18
A1	41.18	67.65
A2	32.35	50
A3	8.82	29.41
A4	41.18	52.94
A5	35.29	58.82
A6	38.24	35.29

Table 31 Pre and posttest results (Case 3).

a) SOLT not effective in enhancing Normalised Learning gain

Student	Absolute Gain	Normalised Gain
A0	0	0
A1	26.47	0.45
A2	17.65	0.261
A3	20.59	0.226
A4	11.76	0.2
A5	23.53	0.364
A6	-2.95	-0.05

Table 32 Absolute and normalised learning gain for each student (Case 3).

Here too, the Wilcoxon Signed-Rank test statistic was used to compare the pre and posttest score. The test was not significant at ($p<0.05$) with $W_t=1$ ($>W_c$ of 0 at $n=6$, removing 1 tie). Therefore, the null hypothesis cannot be rejected. Qualitatively too, 5 of the 7 NLG scores are below 0.30 unlike previous cases, including one negative NLG. Therefore, unlike COLT cases the impact of SOLT on NLG and *self-efficacy* of all students cannot be seen as effective, efficient or inclusive, this is explored further in later sections.

6.6 Qualitative analysis

This section first presents the themes from the SSRL survey, administered before start and after each SOLT and the SOWT session. Next, it presents the themes from the post SOWT interview to provide alternate, sometimes more detailed, insights.

6.6.1 Measuring regulation of learning

In keeping with the same process explained in sections 4.7.1 and 5.7.1, using inductive and deductive coding the SSRL survey data was coded and analysed. In addition to coding this data inductively, the regulation of learning work by (Splichal et al.,

2018) and the theoretical framework of **Figure 2** guided the deductive coding used in the thematic analysis (Braun & Clarke, 2006).

6.6.1.1 Importance of self-efficacy, early communication, trust, regulation, conflict resolution and cooperative skills (past experiences)

Here a greater proportion of the group-working examples described were from educational settings unlike in previous cases. One student had not provided an answer to all the survey questions and therefore responses from remaining 6 students are reported in **Table 33**. Students described a mix of when describing their past group-working experiences.

Themes/ Sub-themes	Description	Count
Self-efficacy	Believing in own abilities to deliver the set goals.	4/6
Communications	Interacting with others in the team from the start and often.	6/6
Trust	Believing in others to deliver the set goals.	2/6
Conflict Management	Knowing when to resolve or defer conflicts.	2/6
Shared goals / SSRL	All working towards the same set goals.	4/6
Shared working	Working together throughout on all the tasks, supporting each other in the process.	2/6
Delayed shared working	Working together in the presenting stages of the work, often individuals working on clearly identified tasks from the start and bringing it together at the end.	1/6
Shared working as needed	Working together as needed collaboratively from the start or as needed.	1/6

Table 33 Themes and frequencies in SSRL survey - past experiences (Case 3).

As shown in **Table 33** a majority of students described how *working together to a shared goal* and with a *shared plan* and engaging in *early and often communication* was seen critical to *success* and *team satisfaction.* Acknowledgment of the importance of regulation scripts (*shared goal, planning, communicating and organising)* is there just like in previous cases. Examples of shared working and shared monitoring were missing, this may be due to the limitations of using the questionnaire as before.

"I once had to build a bridge out of paper and tape that could support a fish tank, *we were the only team to succeed* and we achieved this through *planning and communication.*" (Erik)

Only two students acknowledged the importance of *conflict management skills* in *controlling the flow* of team working:

"When things *did not go well*, we started to *blame each* other for our minor shortcomings, which ruined the "flow" of the team, *resulting in many distractions*." (Adam)

However, not everyone in this case had experienced *success* in team working in the same way. One student reported an incident where they *did not trust* the others in their team and *did not communicate* with them at all. Instead worked on their own and were *confident* that they are *able to achieve the team goal.* However, this was *without the team's input* and is not really teamwork:

"Practical work and no one was doing anything. *I took matters into my own hands* and *did not ask them for help*, I did what is beneficial for me and the team without their help. Turned out good, but *I had to do all the work*." (Chi)

These quotes and examples show the nature of teamwork. Here too past experiences show a diversity of internalised experiences which can be triggered through orchestration as well as highlights the need for new experiences to be orchestrated for successful teamwork.

6.6.1.2 Changes in skills and attitudes: the role of learning together within an un-orchestrated setting.

As described in Chapter 3, a thematic analysis of the free text comments was carried out inductively and deductively. The key themes that represent the data from daily SOLT sessions are tabulated here in **Table 34** along with their description and frequencies. One student had not provided an answer to all the survey questions and therefore responses from remaining 6 students are reported in **Table 34**.

Themes / Sub-themes	**Description**	**Count**
Delayed and varying communication levels	Students worked on their own in learning the content and discussions were mainly around difficult questions or topics. This delayed interactions between the teammates.	4/6
Realising that they all knew little triggered open communications	They did not engage in open communications till late when they realised that no one knows more than them.	5/6
Successful attempts at co and shared regulation.	Students tried to pull together and self-orchestrated co and shared regulation attempts, which succeeded at times.	6/6
Failed attempts at co and shared regulation.	Students tried to pull together and self-orchestrated co and shared regulation attempts, which also failed at times.	4/6
No back up for recovering from failed or missing regulation in teams.	No external regulation source meant, regulation was dependent on students existing skills and attitudes to team work and naturally occurring triggers and if their attempt to self-orchestrate regulations failed, there was no back up either.	3/6
Useful regulation scripts not internalised by all.	Practicing CoRL and SSRL, goal orientedness under own control were not enough to internalise these useful scripts.	4/6
Useful conflict resolution scripts not internalised by all.	Practicing conflict resolution under own control were not enough to internalise these useful scripts.	3/6

Table 34 Themes and frequencies in SSRL survey– role of learning together.

a) *Realisation that they all knew little triggered and helped with open communications.*

As topics got harder the students started to *open up*. Over the first 3 to 5 sessions or so most of them had realised that they were *all in the same boat*.

"The video we were watching was not very engaging and so *my teammates and I were not fully concentrating* therefore, *we struggled with answering the question*. On the other hand, because we were *all confused and on the same boat*, we all *understood each other* and *relied on one another*" (Chi, Session 4)

Surprisingly, this had increased a sense of psychological safety between the teammates for the first time and this started to bring them together in a way that they started to be even more open after such realisation. However, the autistic student did never realised the reason behind the increased interactions in latter sessions.

b) Delayed and varying levels of communication between students

Earlier, they felt intimidated with the prospect of discussing things they did not fully understand with those they initially thought were more knowledgeable peers. Some did not want to look too clever, which also prevented them from opening up earlier. As a result there were fluctuations in the levels of communications on different days. Initially, both teams here found the first two sessions *easy enough* to finish by themselves. They *did not feel the need* to communicate and discuss over every question. They focused on the questions they think they knew and only *discussed with others harder topics* in latter sessions.

"*Everything went well*. All the questions *I* answered were *OK* the one that *I didn't know* how to answer *they explained to me*" (Bill, Session 2)

Thus, easier topics *delayed* and *minimised the interactions* between the teammates. For two students where interactions happened early, these interactions were *useful and satisfying*:

"*Learnt more* things *that I forgot* and was able to *understand where my teammate was coming from*" (Chi, Session 1)

As the topics *got harder* the students *discussed* these amongst themselves:

"*We discussed* the *topics that we did not understand* and *solved some of our doubts*." (Adam, Session 4)

Where students interacted like this, they *benefitted* from such interactions as it helped them learn from each other and also made them more of a team player than appear as socially loafing.

c) Co and shared regulation failed as well as went well

The students attempted to learn from the videos and questions on their own. In the face of difficult topics, in one team, a student came up with the idea like *looking up online* or going through the video *transcripts* to understand the content better.

These suggestions attempts were *accepted* by teammates, in blind trust, by students who had very recently realised that *they were all in the same boat* of not knowing much. If it helped them, this helped then convert their blind trust in the student who made the suggestions to more informed trust, as the team progressed:

"Google [searching] the topics helped us answer the questions" (Adam, Session 7)

However, there were very few such incidents. If on the other hand, they went along with someone's suggestion and they did not succeed, it led to *frustrations* from not finding the right information to be able to answer the questions. It reduced their trust further in the student who proposed it.

"A teammate *made it 'worse'* in my opinion by *suggesting that we didn't need to watch the videos* [and just read the transcripts], as when we followed that, *we still didn't understand*." (Chi, Session 5)

Whenever this co-regulation was successful, it *enhanced the trust in each other.* Whenever it was not successful, trust was lost and as there was no support for them to recover from this situation their trust in each other never developed fully. Feeling *less trusted* did not help with engaging in interactions:

"Today there wasn't too much communication as *all of us were confused* with the questions so we *didn't explain nothing to each other*. The problem is that the *concepts of the videos are too complex for our level*" (Bill, Session 5)

They *googled* and *discussed* things more, indicating that the *affective trust* played a bigger role than *cognitive or conative trust* in this situation where they were all low in self-efficacy.

“Being *kind and comprehensive* with each other and *admitting* that *no one of us are completely sure* about the concepts” (Bill, Session 6)

The autistic student was *unaware of the dislike for the videos* and *the google activity*, which the rest of the team engaged in. They did play their role by contributing to the discussion on their own as opposed to being fully aware of their team’s combined approach:

“We all contributed with the information *we gained through the videos*” (Dee, Session 6)

This shows that challenges can trigger orchestration of regulation, despite lack of trust and self-efficacy. However, trust between teammates is needed for successful transition from one off challenge triggered regulation to sustained shared regulation of learning throughout.

d) No back up when orchestrations were missing or they failed

As the teams faced either failed attempts to regulate each other or lack of orchestration of regulation, they *felt the need* of a teacher or some external input that would guide them or give them feedback *to help bring their team back on track*:

“*Not being able to ask* questions [of someone] made the situation worse and also the increased frustration *was not helping in the slightest*” (Adam, Session 5)

In the end, one of the student took a more leader like role, a *master orchestrator* to regulate everyone else in their group to analyse the questions together, but this happened in session 6, very late in the study and only in one team.

e) *Not enough practice of useful regulation or conflict resolution scripts to help internalise by all.*

Those who were working well together had formed bonds with each other, so much so that it manifested in the *formation of a clique* in one team. *Leaving behind two students in that team*, one of them being the ASD student, who actually did not notice this and the other who *felt ignored* and *left out* from the first session:

"We listened the ideas of each other in almost all the cases. I told an idea and *they ignore me*. … Sometimes *one member* of the group *did not let the others explain the ideas*" (Bill, Session 1)

The clique was also seen in the PjBL session. Whilst those in the clique were able to discuss with each other over session 6 and 7, Bill *struggled* with the content and *did not feel he could discuss the same with others*:

"As the whole group *didn't know* well about the topic *explaining* to another one something that you really don't understand well is *so difficult*." (Bill, Session 7)

Any type of *conflicts* (cognitive or otherwise) were *not being resolved.* Teams were not engaging in group wide discussions on every question:

"A question…*divided the group*…however, I changed my answer to …majority…*even though I didn't understand* why…I *would've liked it if they elaborated* why they chose that answer." (Chi, Session 3)

Their orchestration of regulation was patchy and levels of communications kept varying from one day to another. There really was no evidence of internalisation of any useful conflict resolution scripts in team members or for any of the teams having any shared plans or goals in the SOLT sessions.

6.6.1.3 Linking un-orchestrated sessions to un-orchestrated PjBL activity

The PjBL activity was attempted by both teams. One of the team members arrived late, and was not that well integrated in the team work. **Table 35** lists the themes from the *daily survey* data from the PjBL activity.

Themes/ Sub-themes	Description	Count
Partial knowledge	Feeling they did not learn enough to complete the task. (Adam, Bill, Erik)	3/7
Partial completion	Feeling they did not complete the full task. (Adam, Bill, Erik, Farhaad).	4/7
Clique formation	Unresolved conflicts during learning phase, resulting in less teamwork in PjBL activity and clique formation (Bill).	1/7
Partially satisfied	Feeling that they benefitted by the experience as it gave them the opportunity to learn more than they could have otherwise (Adam, Erik, Farhaad).	3/7

Table 35 Themes and frequencies in SSRL survey (SOWT part) - linking SOLT and SOWT.

To describe what went on in the PjBL activity, the word *partial* really goes well with *knowledge*, *task completion*, *and team-satisfaction*:

"We were able to *easily work out* how to work out the *low and high pass filter* but *not the amplifier"* (Adam, PjBL activity)

Whilst there were some who had *trust developed* in others, there were some others who did not feel the same way. C*lique formation* damaged the team working experience for the students. Two students in the clique worked well together:

"We decided on the strategy quickly and agreed with each other. I have *now developed a better friendship with my teammates* and understand them and can talk to them if I need academic help" (Chi, PjBL, activity)

Whereas, those outside the clique felt left out, similar to what happed in the learning sessions:

"Today *everything started OK*... but *later*, as we started to create the circuit, the *team work disappeared* and we didn't help each other with the issues because *we were more focused on completing our task than helping our mate*" (Bill, PjBL activity)

Others were partially satisfied with what they achieved:

"We were pushed to *go beyond what we are capable of* doing in electronics and *learned even more*. We *weren't able to complete* the task but I think it was *still a good learning experience*" (Farhaad, PjBL activity)

6.6.2 Key dimensions, Themes and sub-themes from the PjBL activity interview

Both teams actually decided to share the reward equally if they were to win the task. None of the teams (Team 1 and 2) fully completed their set tasks as shown in the marks they achieved.

The overall task here was similar to the previous PjBL case. The amount of details in the submitted work by each team was similar. The two teams got similarly poor marks (20% and 21%). The teams were not able to go past the filter design, which was 100% of the task for students in case 1. It was worth only 30% here and in case 2. Both teams had gaps in their knowledge, which they all knew by now and had given up on the amplifier design part.

All seven participants were interviewed and the transcripts were coded in the same way as described in chapter 3, similar to case 1 and 2.

Using the 6 stages of Thematic Analysis on the relevant part of the interview data from all participants, the key dimension that emerged was '*Ineffective team working*'. Another dimension that emerged was '*Need for orchestration*' in the learning sessions. The themes and sub themes within each of these dimensions is shown in *italics* in the next section. It is worth noting that these themes are either contrasting or partially same as in the previous cases. This theoretical replication study therefore gives further strength to the findings of this doctoral study.

The ASD student arrived late for the final activity and was not allocated any task by their teammates. He approached them and could not spot anything he could help with. Another member in the same team also felt left out due to the clique that was formed with the remaining two students in that team. The autistic student faced a lack of trust from others and was quick to trust others.

6.6.2.1 Ineffective team working overall

Themes/ Sub-themes	Description	Count
Ineffective team working overall	Students felt that their teams were ineffective in different ways in terms of the overall task (Dee, Guru)	5/7
Outcome dissatisfaction due to partial readiness	Students were disappointed in their partial completion of the PjBL task as they felt they were partially ready for it in terms of team working as well as knowledge (Adam, Bill, Chi, Erik and Farhaad).	5/7
Low self-efficacy	Students felt they did not learn enough to be able to finish the task (Adam, Bill, Chi, Dee, Erik and Farhaad).	6/7
Partial trust in teammates	They had realised that their teammates were also in the same boat and did not know enough to do the task. (Adam, Bill, Chi, Erik and Farhaad)	5/7
Passenger student	Student who benefited from the input of others (Guru, Chi).	2/7
Clique formation	A smaller group within a team that worked together ignoring the others (Bill).	1/7
Avoided conflicts	Conflicts were not resolved and were avoided.	5/7
Work well together when prepared	They were able to work well together when they were prepared for the task in terms of content.	4/7

Table 36 Themes and frequencies in interview (SOWT part) - ineffective team working.

Through the interview, the students shared their perceptions of how they worked together during the PjBL activity as a team. The themes within this dimension represent the different ways in which students see what *Ineffective team working* entails. In that there was *partial trust* between the teammates from the start of the task and the team members reported *outcome dissatisfaction* post PjBL task. One team developed a *clique.* The teams generally *avoided conflicts* but were also able to resolve some conflicts in a *calm* way. **Table 36** lists the themes and sub themes and their frequencies here. The next few paragraphs detail these themes and sub-themes within each theme.

a) Outcome dissatisfaction due to partial readiness

Students in both teams on the PjBL activity day were ineffective overall as they were only *partially ready* and could only manage *partial task completion*. They *worked well together* only for the first part of the task. The quotes below show that their *disappointments* with themselves in *not engaging with others* enough and also with the *content knowledge they lacked* to complete the entire task, respectively:

"Er, it was a little bit *disappointing* to *not be able to complete* the challenge. Erm, that (sic) would've been nice. But-, so, yeah, I think, *at least for the first stage we did, it was quite nice*." (Erik)

b) Partial self-efficacy and Partial trust in others

They felt they needed to build their *self-efficacy* fully. They also had *partial trust in others* to complete it.

"We knew that…*people understood about filters*…we also already knew that, as a group, *we didn't really understand Op Amps much*, so we didn't expect much progress on that end." (Adam)

c) Passenger student and Clique formation

Ineffective team working was evident in one team as they had a *passenger student*. This student even claimed their team was *successful* in delivering the task they were asked to deliver. Actually none of the other teammates claimed this as they knew what they had done and the *passenger student* did not really contribute anything to what was done:

"I'd say *successful*, yeah. Erm, 'cos I feel like we, erm, *were able to*, like… *do the stuff that was asked of us*." (Guru)

His own teammates were of the opinion that they had not completed the task:

"Well, I think *Erik and I*, *mostly*, erm, *worked on* the, the… *final activity*, with *Guru being a bit lost*" (Farhaad)

Ineffective team working was evident in the *clique* formation between two students.

"We started to do it together, but then *we started to* do it, *do it separately* … and that was the problem." (Bill)

Besides, the autistic student was not aware of this:

"Yeah, they-, all-, those *three* were *coming together really well*." (Dee)

Adam and Chi *did their own thing* and *lacked a shared approach* to working at the team level.

"If we were *all working on one part*, and then *that would take a while* to… catch up." (Adam)

d) Avoided conflicts

Over the 7 un-orchestrated sessions they became somewhat comfortable in working with their teammates. However, there were still *unresolved conflicts,* which impeded learning and affected team working on the PjBL tasks. No one had the passion to take on the issues head on during the learning together phase as they felt it was not worth the effort. They would *avoid the conflicts* altogether by submitting their own answers during the learning together phase. Sadly, this is what came through into the final day as well. They feared the worst and avoided any conflicts on the day. This was made worse as they only had *partial trust* in each other.

"*No one was that passionate about their answer…*if we had like *split answers*, then *we'd just do…our own* [submit own answers]…I don't think that [resolving conflicts] really happened [chuckles]… normally *one of us ended up agreeing with the other.*" (Farhaad)

6.2.2.2 Need for orchestration

In the learning phase, there was no teacher or automated remedial video or orchestrated peer interaction. This coupled with a lack *self-efficacy* due to *difficult topics* left the students *frustrated* and *helpless* throughout the study.

"*I don't think they* [videos] *taught us enough* about …Op Amps…'*cos we watched quite a few videos* [half laugh] each time, the *information can get a bit jumbled* and hard to follow along at points." (Farhaad)

They either *did not revisit the videos* themselves or found the information in them *too much* to find the relevant section to revisit. Having no one orchestrate these things was problematic and they *felt the absence of a teacher* during the learning phase.

"There was a point where we couldn't really…*unless we asked some… knowledgeable person.*" (Adam)

Greater degree of orchestration could have helped model the scripts needed for CoRL and SSRL as was the case in earlier cases. The next section probes further into the experiences students had in the learning together phase.

6.6.3 Themes from the 7 un-orchestrated learning sessions interview

The themes that emerged from this case were a revelation in how un-orchestrated teams come together and attempt orchestrating their teams. It shows an experience, that was all too familiar to the large first year PjBL cohort before this study and why it all was *too little too late*. This case highlights a real *need for orchestration* that is all-encompassing or group-wide. It shows what conflicts, regulation, trust, shared goals and early communication between teammates bring to teams of students who are unable to pull together on their own in good time. The themes and sub-themes that emerged from this case explains why and when the student teams were ineffective in achieving all the set tasks.

6.6.3.1 Too little too late

Themes/ Sub-themes	Description	Count
Lost time	Multiple reasons for delay in interaction between them. Pride and fear of appearing less knowledgeable. (Adam and Dee did not feel like this)	5/7
Delay in reduction of social awkwardness	It took them time to overcome social awkwardness and make communications feel natural. (Bill and Chi not awkward)	5/7
Pride in being a Physics student	This prevented them to discuss easy questions with each other as they thought they were too easy. (Chi)	6/7
Difficulty and low test scores triggered open communications eventually.	Difficult topics brought them together but it was later in the course which coincided with them getting low daily test scores. This made them feel that they are all in the same boat.	6/7
Self-orchestrated co-regulation initiatives partially successful.	Someone in the team launched an initiative which got everyone working together for a while. Sometimes it worked and sometimes it did not. (Adam, Bill and Erik, Guru: Google, transcript, screen watching and answering together)	4/7
Fear of conflict	Avoided conflicts as was afraid to discuss conflicts and resolve them. (Dee, Guru, Erik avoided)	3/7

Table 37 Themes and frequencies in interview (SOLT part) - too little too late.

Table 37 lists the theme and sub themes that emerged from the interview related to the 7 un-orchestrated sessions. During the first few learning together sessions, students watched the videos either individually or together but worked on most questions individually for various reasons. It was much later on in the study they realised that watching together and attempting the questions together can be beneficial for everyone's learning and also team working. They, therefore *lost time* as the *social awkwardness* between their teammates took time to disappear. Their *self-efficacy* and *trust building also suffered* as a result of the poor learning and interaction opportunities they managed between them by themselves.

a) Lost time

The team members expressed pride in their *identity* as *Physics students* and questions in early sessions were attempted on their own as they all liked a *bit of a challenge* for themselves. This meant during the early sessions they simply worked on their own and did not see the need to discuss every question with their teammates.

"Where *we're physics students* and *we enjoy finding out new stuff, we enjoy challenging* ourselves." (Erik)

They *did not feel the need to interact* with other students as *they found the early material (first two sessions) easy*. They believed in themselves and continued to do all the questions all by themselves. As a result they *lost time* that they could have used to learn about each other's strengths and weaknesses and bond as a team.

"When things were easy, *we didn't talk to each other*; we finished the task and *we go home*. And, *when things get more-*, as things get more *complex*, *we start to talk together.*" (Bill)

Only when the content was *perceived as difficult* by most it *triggered intra-group communications* and *ice-breaking* really happen but this was later into the sessions. This was around session 5 for most but it started around session 3.

"*After*, like … the fourth session." (Chi)

Before then, there was some interacting with each other throughout the study, but not everyone engaged in it. It is evident in the fall and rise in the daily average scores in **Table 38** that they started to come together around 6th session and that there was *limited learning*.

Day	1	2	3	4	5	6	7
Average (out of 10)	8.1	6	4	2.3	1.83	4.28	6.4

Table 38 Average of daily scores during the SOLT sessions.

As the feedback scores were emailed to them individually and not shared with the rest they did not realise what was happening and increasingly experienced *low self-efficacy.* For some this was a trigger to reach out to others:

"I… *got less confident* with my answers. And, *obviously,* [by] *asking questions*…would help and *I'd learn… more*." (Farhaad)

Feeling of psychological safety came late but when it did it *felt as a big relief* to them and they opened up after that:

"I think *all of us were feeling the same*, that… [We] *don't know properly how to solve it*. *So… you feel better*. You feel like, '*Well, I'm not the only one* that I [half laugh]…I'm lost in this.'" (Bill)

Time acted *as the ice-breaker* and the *frustrations* apparent on their faces helped them eventually get rid of the *social awkwardness* as they realised they were *all in the same boat*. When they realised this, they really pulled together and started watching together and answering questions together in a shared way.

"I feel like *I learnt the most on that day* [session 4], 'cos that involved the, erm… the… *n type and p type doping* thing, which was interesting [half laugh]… from then on *we all had to work together* to answer the questions." (Erik)

The ASD student still had a *fear of conflict* and was still operating at the edges of their group, unaware of the frustrations and the feeling of psychological safety.

b) What worked

One of the students acted as a *master orchestrator* (see next section) and was able to exercise *co-regulation,* which helped pull some of their team together. Even he felt the *lost time* despite all his efforts to regulate the behaviour and learning of the teammates and in the end he and one other *were perceived to be working in a clique* by Bill:

> "*Session 1*…I *didn't really know anyone*, so…I *didn't interact much*…Er, *Session 2* was more like, '*Hey, my name's Adam, how are you?*'…*Session 3* where *we started to really talk about the information*…*Session 4* or something, *we felt pretty confident with each other* as…we were considered *like acquaintances.*" (Adam)

Despite a growing feeling of a *clique* being formed, Adam tried again in the last two sessions where he helped his team with his *initiatives,* such as playing video on the projector and answering questions together and others found that helpful which gained him some *trust* of some of his teammates.

"His [Adam's] computer was *connected to the projector* so we could all see the questions and we could all… actually, that *made it easier for us to discuss the questions*." (Dee)

However, as shown in the final day, they worked in the *clique* and all this was *too little too late*.

The *free discussion* that did took place between some students also led to maintaining the affective *trust* between them.

"Just where *we'd had the natural discussions* over the course of the-, over the length of the course [helped build trust]." (Erik)

A couple of times *cognitive conflict* emerged naturally and if resolved it helped gain *trust* in the student who help resolve it. This did not happen between all teammates. This was perceived as *clique formation* between Adam and Chi as they enhanced trust in each other.

"[Adam] *led me towards the right direction*…I'd *build more confidence in them* and their answers, and *I'd definitely trust them more*, yeah [referring to a cognitive conflict resolution]." (Chi)

Left to happen organically, such interactions happened only few times within the 7 sessions. Furthermore, sometimes the cognitive conflicts were not resolved due to *fear of conflict*. This resulted in the *trust* within the two teams to be not widespread.

The next section talks about the triggers that were there which helped here, however, more such triggers would have helped the teams.

6.6.3.2 Need for Orchestration

As show in previous section, the students were able to regulate each other at times with varying success. They also lost time during at start for various reasons. Regulation was triggered by different events organically, such as difficulty or cognitive conflicts. However, the sharing, discovering and retention of the regulation scripts depends on individuals involved, opportunities available and sufficient practice. There were not that many of these opportunities around to discover and practice the shared approaches. Therefore, the retention was not a given and students felt the *need for orchestration* by some *neutral third party* that they *can trust* right *from the start* saving them the *lost time*.

A lack of orchestration of SSRL was also evident in all 7 participants not having *a shared goal* from the start.

Themes/ Sub-themes	Description	Count
Low-self confidence	Lack of knowledge of later topics left them feeling low in self-efficacy. (Dee and Guru high; weren't)	5/7
Some cognitive conflicts presented and were useful.	Occasional cognitive conflicts were presented naturally and were resolved. All this was impactful, but too little too late. (Chi, Bill, Dee not see any)	4/7
Shared regulation initiatives limited but preferred	Someone, leader like, emerged in the team & launched an initiative which got everyone working together for a while. This happened very late in the sessions and students wished these happened from the start. (Adam, Erik, Guru: Google, transcript, screen watching and answering together)	3/7
No explicitly shared goals or plans.	Individual goals, even similar ones, but not explicitly discussed or shared.	7/7
Practiced conflict resolution.	Some discovered that through discussions they can all come to the same answer and submitted these (Guru)	1/7
Need for orchestration	Need was evident in lack of shared goals and fear of conflict that led to avoiding cognitive conflict resolution as students were not enough or correct learning.	6/7

Table 39 Themes and frequencies in interview (SOLT part) - need for orchestration.

a) Triggers

Students may already possess team working scripts but this case shows that it takes something to trigger them. Here one such trigger was related to the progressive *difficulty in the topics* as perceived by the students.

> "The *true icebreaking moment*…would probably have been the *reactants* (sic)…where we actually really started to talk to each other about stuff … if *we were stuck* on a bit of information, we'd *ask the person next to you first*…and then… *just grow on that*." (Adam)

The un-orchestrated approach meant it took *time* for the *social awkwardness to fade*. It was the progressively *poor scores,* which encouraged them to do more *on task* discussions making them *aware of their common struggle*s and leading to the feeling of psychological safety.

> "In terms of *knowledge*, *it* [on task discussions] *didn't help* us that much, but *I think it just made… us more… comfortable* with just asking each other questions... Just knowing that … *they didn't know as well just made it more comfortable* that we were all on like a *level ground and on the same like base.*" (Chi)

This is how these *challenges united* them within an un-orchestrated setting and it even helped with ignoring the feeling of *low self-efficacy*.

"I'd say a mix of the *lowish marks*, er, *increasing difficulty* and the fact that we also *started to ask each other for help…a combination of those.*" (Guru)

The efforts of the self-appointed *master orchestrators* in each group were then directed in using their existing and useful scripts to pull together teammates to work together. However, the reach of this student was not exhaustive, some students did not accept them as the orchestrator or trusted them. A *third party,* something or someone, more neutral like a *teacher* to *orchestrate* the interactions in a balanced and in a shared way from the start would have helped the teams:

"It *would be better* if we had…*one big screen*…like *one answer sheet* that *we all just focused on*…'cos it would be *four heads thinking*, answering one question, rather than like *one head answering* one question by itself." (Chi)

A *teacher* or *a third party* would also have *sped up* the interactions by providing *arbitration* and encourage resolving the *cognitive conflicts* that were not resolved and they spent:

"*Ages* going over a *single* question just because *two people were having differing results*." (Guru)

b) Triggering, sharing, discovering and retaining scripts

There was no *group-wide sense* of preparing together as a team to be ready for their team task or their shared end goal:

"*I knew* we had the task…*I can't remember why*, but *I knew* we had like a task…I don't think we had any…thoughts about the *plan* before-, about *the whole team task*. I *don't think we kind of discussed it much*." (Chi)

They all seemed to have similar *individual goals* related to *learning electronics* and also improving their *team working skills* by taking part in the study, even these were never *shared*.

"*I wouldn't have said it was something that we discussed*…or even wrote down or said, 'OK, this is what we want to get out of this.'…but, you know, I definitely… like to think *that's something we were all working towards*, you know, even if *it wasn't explicitly stated*." (Erik)

This *remained dormant in these teams till much later*. On the other hand they did use their existing CoRL scripts when *triggered* by the need to resolve *cognitive conflicts.* At best they could just *hope that others used the scripts in return,* which sometimes they did:

"*I ask why … this is the answer*… And…*if* they explain it and *it still doesn't make sense* to me, *I suggest what mine is*, I guess. And, *I guess they'd do the same* towards me [half laugh]." (Farhaad)

The efforts of the *master orchestrators* started to have results, albeit much later on, e.g., when they shared their computer screen (see previous section) on the projector to *watch together* and *answer questions together.* By this time, the affective and conative trust at least was somewhat established in the master orchestrator. This allowed them to be seen as a leader and others followed their lead. This made the others in the team *discover* how important it was to *engage everyone,* both when consuming the content, as well as when *focusing* on working out the answers to the questions together one at a time. In following the *master orchestrator*, they *started to work in a shared way* but this was much later in the learning together phase. As they started interactions late, these were not as effective in learning and building team skills within the time they had for this study.

In summary, as expected they were introduced organically to some helpful ways of learning and working together in a team, during the learning together phase. However, like all things this experience was loss prone in an already *too little too late* situation.

6.7 Integration of quantitative and qualitative stages

This section collates the evidence from different instruments used within this case. It answers the following overarching research question:

RQ 1. How does student orchestrated learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated project-based settings?

Students in the un-orchestrated *learning together* sessions *lost valuable time* during the early sessions as they did not interact that much (sections 6.6.1 and 6.6.3). There were varied reasons for this lack of interaction. It *limited their ability* to navigate the challenges related with coming together as a *team* before going into the PjBL task. They were ineffective and partially satisfied with their outcomes. They all had *similar individual goals* for this study and through discussions they *could have developed* a shared understanding of their *unified/mutual goals* from the start to benefit from a more *cooperative* learning together phase. When they did, it was *too little too late*, which affected their learning, self-efficacy and also performance in the PjBL task.

Acquiring content *all by themselves* was a limiting factor. They felt a need for a neutral *third party,* like a teacher, to discuss answers with or get immediate feedback, especially around cognitive conflicts as they spent long time trying to discuss these, often without a resolution. They could not help each other either and had realised that they were all unable to learn this way. As a result, instead of increasing confidence over the 7 sessions, their self-efficacy and trust, in particular cognitive trust, in each other plummeted.

They responded well to challenges they faced during the learning together phase. The *frustration*, linked to not understanding the videos and questions, triggered by low daily scores as the topics got harder, were shared by the teammates. This resulted in a feeling of psychological safety, as they were all struggling and were *all in the same boat* together. They opened up to each other and reduced their *fear of conflict* and *social awkwardness*, but this happened quite late in the process. Some had given up on fully understanding each topic. This meant they went in underprepared into the PjBL task.

After some initial lost time, some students responded to these challenges and were able to *co-regulate* the learning and behaviour of others. They came up with strategies and initiatives for their teammates to try. In the absence of trust and self-efficacy it was hard for these *master orchestrators* to assume a leader like role without upsetting some in their teams. One person was left feeling ignored and a perception of clique formation was seeded, which sadly remained till the end of the PjBL activity and made them ineffective, inefficient and, in the team where an ASD student was present, not inclusive. In the other team, students were a bit more easy-going and were accommodating of each other's initiatives, but the lack of knowledge rendered them ineffective.

Both teams saw some attempts to exercise *shared working* towards a *shared goal* during the last two SOLT sessions. In the process, they discovered some SSRL and collaboration scripts that worked and some that did not work. Where these did not work, lack of immediate feedback and support meant they weren't able to recover from such situations. The limited successful instances did not give all of them enough practice to feel that they are ready as a team together.

The PjBL activity saw the clique emerging again in one team and witnessed passenger student behavior in the other. None of the teams completed the task linked to the harder topics. Conflicts remained unresolved, in varying degrees, in both teams as they avoided these. However, they did not enter into heated arguments over the unresolved matters.

Next, I present the answers to the two sub questions in order to further understand how their attitudes to CM and their trust in their teams developed in greater details.

RQ 1.1 How does student orchestrated learning together in small groups affect a learner's attitude to conflict management?

In this case, there were very few *opportunities* for students to practice *citizenship activities (helping each other), conflict resolution or deferral, arbitration support* and eventual resolution and develop useful CM skills. Students needed to *self-orchestrate* these activities in this case, but they lost time due to early *social awkwardness* and *individualistic* aims (sections 6.6.1and 6.6.3). Delay in having *shared goals* for each session meant *cooperative learning* was delayed. When students tried to resolve cognitive conflicts their knowledge failed them most of the time. There was no arbitration or remedial videos or immediate feedback to help resolve the cognitive conflicts. As noted in the following paragraphs and supported by multiple chains of evidence, students did not change their preferences in the desired or the undesired direction as a result of working in this way. Overall, they did not develop much *self-efficacy* and *trust* in each other over the sessions (see next section), they were unable to enhance or demonstrate much of their CM skills.

Style Matters ® survey

Looking at the results from the *Style Matters* survey (n=7), before the 7 sessions the top preferred CM style were: *cooperative (n=5), compromising (n=2), harmonising (n=1), Directing (n=1)* and *Avoiding (n=1)*. By the end of 4 sessions, members in both teams, did not change their top preference from *cooperative* or *directing* to something else, the preference for *avoiding style* became less common and there was an increase in preference for *compromising* and *harmonising* at the top position. These changes show some students moving towards and some away from the *cooperative* quadrant, see **Figure 5** (see page 51). However, *no change* is seen in those preferring *cooperative or directing styles.* On re-testing, at after 7 sessions, the movements were once again both towards and away from *cooperative* quadrant*.* One member from second team changed their top preference from *cooperative* to *harmonising*. The preference for *directing and avoiding* was *stable* compared to the start of the study. At this stage too, *no or little change* in preferences represents the situation. On re-testing, just before going into the PjBL task, three had moved away from the cooperative quadrant and two towards it. This meant that the preference for *cooperative (n=4)* and *compromising (n= 1)* decreased. The passenger student had moved from *cooperative* to *avoiding style*, which represents a strategic choice going into an activity with limited knowledge about the subject. The *directing and* *avoiding style* became more preferred at this stage. Overall, there was only a slight decrease in those who preferred *cooperative* at the start and an increase in preference for *avoiding (n=2)* in both teams and *directing (n=2)* in one team was observed. The master orchestrator had decided to prefer more *directing* style and so did the student who felt ignored, both wanting a greater say in their teams. A temporary suppression of preference for non-cooperative and more selfish CM styles such as *directive* and *avoiding* was noted before preferences for these styles returning back to levels before the start of the study or slightly higher when going into the PjBL session. A slight drop in preference for the desired *cooperative style* was also noted.

SSRL daily survey

The *SSRL daily* survey data shows that 2 out of the 7 respondents reported importance of trust in teammates and conflict management in previous team working. By the end of the 7 sessions, students in both teams reported being exposed to resolving cognitive conflicts successfully in a maximum of just 1 session. One team reported that conflicts were brushed aside and not resolved in 6 sessions. 4 reported that communications did not reach sufficient levels during the sessions. These factors affected their ability to trust each other cognitively (see next section). The opportunity to internalise good conflict resolution scripts by those who needed to was not enhanced in these sessions. In the PjBL session, 1 respondents felt the group had a *clique* as they were ignored and this was also seen in the learning together sessions. The ASD student, who was also in this team, avoided the conflict by staying out of the collaboration. In other team, the three students seem to have worked well without reporting any conflicts at all in this data set. Overall, un-orchestrated learning sessions provided them with limited exposure to conflict management and limited peer interactions to support any significant changes to the CM styles where these were needed. Furthermore, without any real-time support and feedback their success rate in the use of regulation and CM skills was low and this also affected their ability to practice and gain these skills.

PjBL activity interview

The qualitative analysis of the *interview* data from the *PjBL activity* also points in this direction. Here too, the evidence suggests 5 out of 7 left conflicts unresolved and worked together only on topics they had confidence in and with people they preferred. They did submit their final work together in the end. However, the themes here suggest that there were issues such as *Ineffective team working overall* due to presence of *Passenger student* and *Clique formation.* They *avoided conflicts* more than they resolved. In one team two students were *comfortable only working within a clique* in the PjBL activity. Dee was not involved, as they did not allocate him any task. Bill was left to do the harder task on his own. In the other team, two students worked well together where they could but there was a feeling of one student being a *passenger* student and they also *avoided* some conflicts. The formation of a *clique*, the presence of the *passenger* student negatively affected *trust* in the teams and along with this their lack of *self-efficacy* prevented any real demonstration of CM skills in the PjBL activity.

Un-orchestrated sessions interview

Further, the analysis of the qualitative *interview* data from the *un-orchestrated learning together sessions* confirms that conflict resolution was useful for 4 out of the 7 students and the others *avoided conflicts* due to their *fear of conflict,* which was not overcome during the session due to lack of interactions, need for support and lack of conflict resolution episodes. There was a need felt for orchestration and arbitration around cognitive conflicts and this was missing in these sessions. Besides very few interactions and cognitive conflict resolution meant the trust between the teammates did not develop (see next section). Limited learning meant they were less *confident* going into the PjBL activity (see also learning gain section). By the end of the 7 sessions, they had some exposure to conflict resolution, Co and SSRL scripts but it was all considered *too little too late* and not enough to allow internalisation of the correct scripts for CM skills.

RQ 1.2 How does student orchestrated learning together in small groups affect a learner's development of trust in group members?

Each *learning together* session could have provided several opportunities for students to show their *citizenship, cognitive conflict resolution* skills and find out about their teammates *relevant past performance*. This was not the case however. There was also a sense of losing time by not interacting more. They could have come together like they did in session 6 and 7, a lot earlier, but various factors prevented this. Besides, by session 5 they had realised that none of them knew more than the other and that the content delivered in the later sessions was harder. The students felt that the cognitive conflicts were not common and were sometimes avoided and left unresolved. This meant the *cognitive trust* suffered and never recovered during the sessions. However, the students were never in a heated argument about anything and were civil to each other throughout the learning together phase. This meant the *affective trust* was by and large maintained. The impact of time they spent together also helped maintain some *affective trust*. They all attended at least 6 out of the 7 sessions. This meant the *conative trust* developed somewhat. A new finding here links the co-regulation by a master orchestrator, which demands blind trust in them by those being regulated, can develop trust in them. These factors affected the maintenance, development and correction of different facets of trust between the participants. Overall, a drop was reported to how widespread the different facets of trust were comparing it before the learning sessions and just before the PjBL task. The fact that they did not always resolve conflicts that emerged in the PjBL tasks also show that the trust was less-widespread between teammates by that point. The following paragraphs presents multiple chains of evidence for this drop in *trust* in teammates.

'Trust in teams' survey

Cognitive trust between the teammates was not that widespread at the start (n=4) and just before the PjBL tasks was not widespread (n=3). *Affective trust* between the teammates was widespread consistently (n=6), which too dropped slightly (n=5) before the PjBL task. *Conative trust* was also less widespread going into the PjBL task (n=4) than at the start of the study (n=5).

SSRL daily survey

The *SSRL daily* survey data captured students past team working experiences and after each learning together session. Trust was seen as important by only two students given their past team working exposure. They all believed communication to be very important for team working but when it came to the learning sessions they actually worked mostly independently on the questions. This delayed the reduction in the *social awkwardness* and therefore in trust building interactions such as *citizenship, conflict resolution,* and a *greater frequency of interactions*. Lack of *self-efficacy* delayed such interactions further. In fact, when everyone realised that they were all in the same boat, in terms of not knowing more than the others, it helped trigger some attempts to co and SSRL. Later session saw these regulation attempts to be either successful, which help build the trust in the teammate attempting such regulation or unsuccessful and decreasing trust between the teammates. The formation of clique both during learning sessions and in the PjBL task shows trust was not that widespread as was needed for successful team working. Their satisfaction levels from the PjBL task they did together also suggest the same. So, overall there was not much positive evidence for trust being built in the SSRL survey data. In fact, the data points towards a drop in trust as there were not many occasions when the students successfully regulated others in a co or socially shared way. Besides, it was the low *self-efficacy* and *cognitive trust* in others that triggered these regulations in the first place.

PjBL activity interview

The qualitative analysis of the *interview* data from the *PjBL activity* suggests that there was a perception that there was a *clique formation* and a *passenger student* in the two teams respectively. The students were only partially satisfied with their output for the PjBL activity. This is linked to the partial trust they reported in their teammates. All this and the fact that they *avoided conflicts*, also points in the direction that *trust was less widespread* when going into the PjBL activity.

Un-orchestrated sessions interview

Further, the analysis of the qualitative *interview* data from the *learning together sessions* show that the students lost time and did not interact much in the early sessions. This meant that the *social awkwardness* was not reduced till later. This reduced the time left for building trust between each other through various interaction types that help build trust. As the students did not learn that well in the un-orchestrated sessions, their *self-efficacy* was low, which hindered open communications between them. These were times when the master orchestrator in each team attempted regulating their teams which helped in building trust in the orchestrator for some when such attempts were successful. Such attempts also lead to the feelings of being ignored and the presence of a clique, which prevented the trust build up for all. There were limited instances where cognitive conflicts presented. Sometimes, these were resolved and other times they took long and yet were left unresolved. Triggers like difficulty level helped with starting open communications but the lack of arbitration when any cognitive conflict emerged or help was needed to understand things, delayed any meaningful shared working. In session 6 and 7 when students finally worked in a shared way, it was almost the end of their learning together phase. These sessions were seen as beneficial by all but they were *too little too late.* This data therefore also confirms that *learning together* resulted in activities that were sometime useful but also sometimes detrimental in building cognitive, conative and affective trust. Such fluctuations are possibly natural in team working but the absence of a neutral orchestrator was felt by the students, which could have helped in increasing the trust between each other and support their various interactions from much early on.

6.8 Summary of findings

Trust and self-efficacy

This case study confirms the already known positive impact of time on affective trust between teammates. This work adds to the existing understanding on developing trust in teams as it shows that regulation has potential in the development of trust between people, even when there is no trust to start with. However, it takes time and skills to be able to regulate others and do it successfully. Support is therefore needed before new teams can acquire and demonstrate regulation skills. Self-efficacy is very important for someone to be able to regulate others. Unlike trust, which is also important for regulation, self-efficacy is a must before someone can regulate another person. Trust in this case became less widespread going into the PjBL task and self-efficacy dipped as topic became more difficult. Both trust and self-efficacy bounced back a little during the later sessions, confirming that it can take long before an un-orchestrated team develops trust in each other.

Conflict resolution, SSRL and CoRL script internalisation

The delay in reduction of social awkwardness, the absence of trust, self-efficacy and a *shared goal* and unsupported orchestration of regulations meant students worked on their individual goals and did not interact with others much. They needed something or someone to trigger these interactions. This came much later, in the shape of a feeling that they are *all in the same boat.* They could not, therefore, practice regulation or conflict resolution as much as needed to *internalise* the scripts for these. They were frustrated by the time they had to spend on resolving cognitive conflicts in the absence of immediate feedback which meant students started to avoid discussions and submitted their own answers instead. There was no help around that would help them recover from a failed attempt to co regulate others. The avoiding took place also within the PjBL task, indicating that they *internalised* unhelpful scripts. Presence of a *clique* and *a passenger student* suggests that SSRL was not present.

No significant changes to conflict management styles

Although students felt that their CM styles were no different from where they started, the CM style survey and their interview data suggest there were slight changes. Evidence from CM styles survey suggest that most students did not prefer selfish ways when it came to conflict resolution. However, there were conflicts that remained unresolved both during the learning together and PjBL sessions. The learning together sessions did not help build trust within all teammates. This impacted their ability to exercise their preferred *cooperative* style or to acquire the same where it was needed.

Chapter 7: ADHD and ASD

This chapter presents the analysis of data collected on the participants who declared as NAT (i.e. had Autism or ADHD). As autism is a spectrum of conditions, different individuals may have different aspects of it. I start by reporting the details of the conditions each participant reported. I also state their coping strategies and highlight where these were developed. I then present some key lessons learned from the cases and make some recommendations for practitioners going forward.

7.1 Case of Alex

7.1.1 Background on Alex (Case 1)

Alex, a mature student, self-declared as autistic based on a family member's diagnosis and her own reflections that she tends to *see the world in a different way*. She has developed coping mechanisms for her autism related challenges and says she *will* talk to people once the *social situation and the rules are clear* to her:

> "As I get (sic) older … I realise that I *view the world…differently* … so *tell me the rules* and … I *will* talk to people." (Alex)

Tendency to trust in others quickly and avoiding conflicts are a typical trait of someone with autism (Yi et al., 2013). The trust data and interview comments confirm that Alex is *fairly trusting of others*. She tends to avoid conflicts, as she rated high the avoiding style in the Styles Matter ® survey and as per a supporting interview comment:

> "I am just an *avoider*…..I will always *walk away from conflict*." (Alex)

7.1.2 Alex's experience of COGLE and the un-orchestrated activity

7.1.2.1 Alex's learning and self-efficacy after using COGLE

Alex felt that *for her level,* COGLE was *too fast* for her content needs. She did *not seem to retain* concepts taught *unless she practiced* the same again at home as well.

> "[For] someone like me *with zero knowledge* it went *too fast*... so if I had *repeated each session* [at home]… the next time... *it would have gone in*" (Alex)

She engaged in COGLE orchestrated interactions and understood the concepts enough to answer the question there and then, *but did not retain the knowledge* for long. Her confidence did not get the same boost as others experienced in the 4 sessions she participated in.

7.1.2.2 Helped reduce social anxiety and awkwardness

Alex noted that COGLE orchestrated interactions in a predictable manner. This made 'the *rules of engagement'* clear to her, making her *feel comfortable and safe* and *allowed natural communications to flow*:

> "*Comfortableness…*about *knowing what's gonna happen next*... it sort of *makes it more*... don't know safe's the right word... I'll use *safe…it* [COGLE] … *forced a conversation*... because *when people start* talking to each other, then *conversation naturally flows*." (Alex)

7.1.2.3 Helped reduce my fear of conflict and avoidance tendencies and reinforced my cooperative style.

Alex notes that at the start she was a *bit embarrassed* and the orchestrated *conversations felt a bit closed*:

> "In the *first one* it was, although it *initiated*…I think because there was no relation it was more *embarrassed conversation*…it was a much more *closed conversation.*" (Alex)

Alex shared her *struggles* with having *open conversations*, which explains the feeling of embarrassment at the start. Her *fear of conflict* noted earlier also frustrated her:

"I was *aware of his discomfort*... so obviously I did *not want to cause anyone discomfort but* umm…*his explanation did help* but it wasn't the best explanation." (Alex)

Frustrations resulting from these situations and the *high penalty* linked to GWM script in COGLE triggered open conversations later on and she *seems to have benefited* from repeated open interactions in COGLE. During the learning together phase she enhanced her *preference for cooperative over avoidance style* as indicated by the *Styles Matter* ® data. Her preference for *Avoidance* moved from *top two strategies* to *third position* before going into the FC activity. Despite her *initial struggles,* Alex did not perceive *cognitive conflicts as conflicts,* which meant she did *not avoid discussing* them:

"No… I did *not avoid it*... because *we discussed it*… umm I suppose *it wasn't really conflict*" (Alex)

Alex *always thought* highly of learning and working together, but it was her *use of COGLE,* which made this feeling *stronger* by enabling her to experience it within her team:

"I think… I have *always thought* that collaboration is a good thing... *but it's enhanced* [after using COGLE]... huh... *reinforced*... *both* of those words... *so it's a good thing*." (Alex)

7.1.2.4 Helped build trust and a stronger and closer team

Resolving *cognitive conflicts* in COGLE was perceived as useful by Alex for *learning* to some extent but more so for *team building*. It enabled her to establish a *more accurate trust* in her teammates and correct the *high initial trust* she reported in them before the study. Her *cognitive trust survey scores* reflected the knowledge based interaction (cognitive) in COGLE and not just affective trust that can develop over time:

"I thought I got one right... and they had got the opposite but... we both said our point of view and I was wrong... chuckles... but *I could see where my logic was incorrect*… that's for my learning... but... from the team side of things... it was good… it *increased the relationship... I don't know how*... somehow." (Alex)

Finally, others in her team never noticed anything different about her and the trust data shows an increased trust by the 4th session. She was never left feeling *undervalued* and *was supported* by her teammates:

"I *never felt not valued*. In our group... even if I was wrong... *they would say it was wrong* and *then say why it was wrong*." (Alex)

7.1.2.5 Self, Co and SSRL

Using COGLE teammates gained trust in each other. As trust and self-efficacy grew, they became more likely to respond to *challenges and frustrations*. At first PI and GWM were orchestrated by COGLE, then triggered by these challenges and frustrations, teammates overtook this role and used COGLE as back-up if they faltered. This gave them a taste of *CoRL and SSRL* and working together to achieve the *shared goal* of mastery. Alex was part of her team's shared plans to *game the system* to achieve GWM:

"Might be another *reason* why *we* were *gaming* the system... otherwise *we* would of (sic) *done 50 questions*" (Alex)

However, Alex still lacked self-efficacy as reported earlier. This meant that although exposed to SRL, Co and SSRL during COGLE sessions and there was trust between them, she did not feel as if she contributed as much as she could have in the FC activity. Practicing the topics for longer would have helped increase her self-efficacy and satisfaction.

7.2 Case of Harry

7.2.1 Background on Harry (Case 2)

Harry declared his diagnosis for ASD and ADHD when joining the study. As shown in the quote below, he believes he has *developed good coping mechanisms* for countering the effects of ASD on his *social skills* and *team working*.

> "I decided, 'Secondary school *I'm going to make friends*.' So, I've *learnt, over time*… that *certain things are acceptable*, *certain things are not*... I've *learnt how to…cope and deal with some of my problems and become better*… *Most of the time…working in teams is not a problem*." (Harry)

His approach includes being *respectful and helpful to others* when forming bonds. He avoids *upsetting people* by *cautiously* deciding when to use his style of dark *humour* with others. Consequently, he feels *more confident* in working *with known people* than with complete *strangers*:

> "I can often… understand a person quite quickly…talk to them in a *respectful manner* that they find… nice…it's a *little bit harder with new people*, 'cos *you don't know* what… erm, they *find acceptable or not*… especially when it comes to *humour*; that's a major thing *I try to watch out for*." (Harry)

He takes medication (for concentration) and is increasingly seeking support (despite his Autism) for his ADHD. *Relevant support officers* had already been helping him through his time at the University:

> "I'm trying now to actually get a lot more coping mechanisms [for ADHD]. I've gone… to…*study skills mentors*. When I'm *on my medication*, depending on the task, I can, at times… *any task for a while*, but that's the problem, *it has to engage with me*." (Harry)

Although he is *quick in problem solving and calculations*, it is his ADHD that can still cause him *difficulties in concentrating* on tasks:

> "I mean, *my main problem is concentration*…if I can concentrate, I can understand a task quickly, I can *solve problems very quickly*." (Harry)

With his developed coping strategies, he has overcome over-trusting nature that Alex and other ASD students report. The trust data and interview comments confirm that Harry does not start trusting someone until he has developed some understanding of them:

> "Yeah, *it takes time…I'm much more cautious*…I'm trying to like *make sure I make the right moves*." (Harry)

But in conflicting situations, he prefers to *compromise* between relations and outcome. Conflicts are avoided or resolved sub-optimally in his experience. When discussing his *Styles Matter* ® survey he said:

> "Yeah, I *try to compromise with people*. I always *steer away from conflict*, yeah, I guess." (Harry)

This highlights his fear of social exclusion. There is room for development in the way he approaches social interactions and conflicts, in particular with new people.

He explains that *taking longer* to actually trust someone fully is like having to wait in the *uncanny valley* (Mori et al., 2012) to acquire more evidence to become more familiar with others such that they become trustworthy. Uncanny valley is a debated concept, familiar to humanoid designers, virtual world developers and popular culture, where the valley represents a place where a design is considered very eerie yet very human like, much like "puppeteering a corpse" (Weschler, 2002; Yi et al., 2013) and can cause discomfort to humans. Even if he trusts someone he *still does not open up with* *them*, and waits longer, still fearful that he may make a move to disrupt his relationship with the person. It is when *he is certain* of what he can and cannot say or do and *when making mistakes* with them *becomes acceptable*, that he starts to really trust them and is ready to be *cooperative* with them.

> "So, it [familiarity/trust] goes *up*, then *drop*, then *up again*. Like have you ever heard of *uncanny valley* type scenario? So, as someone becomes *more human*, becomes *more cuter* [sic], but then there's a point where it just *looks creepy*… and then it *jumps back right up again*." (Harry)

Past experience of betrayal from peers and existing coping mechanisms related to his ASD makes Harry such. He longs and prefers for what he calls *proper personal discussions*, which he thinks can only happen between 2 people. He therefore, prefers teams of 2 or 4, as this way he can have a discussion with one other, free from anxiety of making others wait.

> "Chatting with *two … it's more laidback*; … you *can chat more personal things between two* people…when *someone else joins*, it's just like … '*How do I do this properly, then*?'" (Harry)

In summary, Harry prefers working in teams of two or four but may take longer to open up due to his ASD and current coping mechanisms. Furthermore, due to his ADHD he may *need more time to understand tasks*, which may be compensated by his speed of working. In team work situations his ADHD is *at odds with* his ASD coping mechanisms as he wants to make the right moves over time but he *struggles to concentrate on the work* for longer periods. If he is successful in having a proper discussion with his teammate, it still makes him anxious as he finds that he is likely to go off on a tangent and ignore others. He struggles to maintain his concentration needed to understand the task correctly. He is likely to give relationships and task goals equal weighting when in conflict and is likely to compromise task goals to save relationships. It may *delay progress* but also compromising relationships as others may not be experiencing the same anxiety.

7.2.2 Harry's experience of COGLE and the un-orchestrated activity

7.2.2.1 Harry's learning and confidence in self after using COGLE

As highlighted in chapter 5, Harry found that COGLE helped him learn in more than one way: through peers as well as through the animations within the videos. The final activity and what he achieved in it makes him feel that he learnt a lot more than what he would have if he did not take part in the study.

With regards his ADHD, COGLE was beneficial. He felt that COGLE *engaged* him and *planted the right information* he needed to *understand* and answer the questions.

> "Yeah, well, it [COGLE] *did plant some information* in my head …, it *helps me to engage* upon *the work …it helps me massively…* When I engage, I can…*understand a little bit better.*" (Harry)

The animations used within the videos were unplanned but these were helpful to Harry compared to lectures where the slides tend to be more static. This is again beneficial due to his ADHD.

> "Lecture rooms, they're more listen, listen, listen…[Whereas in COGLE] *medias do help…* you can just sit there and *listen and watch* at the same time... it [animations] was [sic] *constantly changing* and *often have information that accompanies it… diagrams*, for example." (Harry)

He also *engaged* well in the orchestrated *interactions*. This *enabled* him *to discuss with others* the topic, which is useful as *he normally takes time to open up* to others and can then go off on a tangent:

"It gave me a reason to chat-, *talk to someone about…mostly the work*." (Harry)

However, the new version of COGLE stopped working with his group after 4 sessions. The older version *did not have all the features*, including *feedback* on the *correct answer* or the *tailored video support*. This gave Harry the impression that this way of working is suitable for *easy and surface level topics*. His teammates also reported similar observations about the older version of COGLE. He thought COGLE *cannot continue to be helpful* for the entire course:

"Yes, *it* [COGLE] *does help*, actually… it, it's more-, I think it's better for the *initial engagement*…for the initial penetration of the like *surface level stuff*, then you can understand... and… expand upon it… *I don't think it would work after a while*." (Harry)

Both versions of COGLE kept changing his focus from watching, reading and solving questions to discussing results, during a mastery cycle. These short activities helped him concentrate and engage better given his ADHD:

"It's *not like monotone* sort of just chatting, *just talking, talking, talking*. It's…, 'OK, I have to do some calculations. OK,' and then…, 'Oh, I got it wrong. Why did I get it wrong? Oh, I got it wrong because of this reason.' Fair enough. So, *I'm changing from, like, from there to there to there to there to there,* like thinking" (Harry)

As there was no feedback or tailored video support, in the old version of COGLE, it made them *overtake* the discussions and *chat with each other more*. But in the absence of this support, they went *off on a tangent* and discussed irrelevant topics.

"Yeah, you can't like … *keep chatting and chatting*, 'cos you're gonna *get distracted* at that point…yeah, then you'll just *go off on a tangent*." (Harry)

In the posttest, Harry got most of the questions wrong for the topics taught by the older version of COGLE, and he did very well on the remaining topics as shown by the positive learning gain value.

7.2.2.2 Helped reduce social anxiety, awkwardness and made me comfortable

Harry also noted that repeated orchestrations in COGLE helped initiate conversations and this *allowed natural communications to flow from it*:

"In the core lectures, I *don't actually talk to anyone*. I *don't really like to*. Just sit there and do my work. COGLE, *it forced me to chat to someone.* I'm going to have to chat with this person. And, *through that*…you make …the *first step* towards… *properly* chatting to someone." (Harry)

He is normally *cautious* in interacting with new people as he *does not wish to come across as too eager* to socialise. COGLE *boosted his confidence* and reduced the *social anxiety and awkwardness* he experiences otherwise:

"Well it [COGLE] *gave me more confidence* to properly explain something to my other teammates due to an *external force directing me* to explain the answer instead of myself which may *come across as too eager.*" (Harry)

In his own words,

"I guess it [COGLE] helps … *cement the first steps*" (Harry)

During COGLE orchestrated discussions, he was initially *still cautious* and did not want to leave others out when discussing within the subgroup chosen by COGLE.

> "If two people are chatting and *two people are waiting*… so, *you don't want to also be the person who's keeping the whole group up*." (Harry)

He, therefore preferred the open and free communications, which happened closer to achieving GWM as they *overtake* orchestrations to avoid penalty. GWM and PI scripts orchestrated contributions from all and discussed and *no one was left out or waiting*. He made *silly mistakes* when doing the questions, as he was *unable to concentrate* on *every little step*. The *frustration* linked to this made them *overtake* orchestrations and discuss more, which *reduced his anxiety* linked to both his ASD (others left waiting) and ADHD (making silly mistakes).

7.2.2.3 Helped me become more cooperative by resolving cognitive conflicts within my team.

Using COGLE to repeatedly *resolve cognitive conflicts* helped build trust (*improved connections*) between teammates, *allowing Harry* and others to be *more cooperative*:

> "It [COGLE] allowed us to *discuss with each other* how to get the correct answer and as such *allowing us to cooperate better* due to our *improved connections* with each other" (Harry)

However, this change in Harry came *slower than for others*. After 4 sessions his trust in others had grown but his most preferred CM style was still *Avoidance* (as per his Styles Matter ® scores). It was replaced with *Cooperative style* only after 7 session, and remained there till after SOWT session.

7.2.2.4 Helped build trust in each other

Linked to his ASD and ADHD, Harry acknowledges that he has a tendency to get *engrossed* in calculations for very long periods of time and *not caring about talking to others* if he is doing this.

> "For me, personally … *when I get stuck into* something, I *don't really talk to anyone*… and I will do that thing for a long time straight" (Harry)

COGLE actually helped him *talk to others* due to it orchestrating the social interactions, which prevented him to work alone for too long:

> "Yeah, and [COGLE] forces the interaction… the *explanations*, then, yes, *it's useful to chat with someone*. That's where the COGLE comes into, 'cos, every time you make a mistake, it does-, gives you answers afterwards [new version only]" (Harry)

Due to these timely interactions, his teammates *never noticed anything different about him* and their trust for him increased by the 4th session just as it increased for others in the team.

He also eventually went past the *uncanny valley point* and actually started to trust his teammates after 4 sessions. Engaging into a *chat spiral* with his teammates in the last two sessions and also using *humor*, shows how he became *really comfortable* with his teammates:

> "Not initially… But …especially with the *last two sessions*, we did start chatting … *it start to spiral* and spiral and spiral… And then the last, like, session we had … *we were like making jokes… about loads of stuff*, actually." (Harry)

7.2.2.5 Self, Co and SSRL

Orchestration of interactions during the GWM cycle, exchanged hands from COGLE to teammates (triggered by frustrations linked to silly mistakes and penalty). This provided Harry and his teammates the opportunity to practice SSRL. As trust and confidence developed they were able to respond to these challenges and frustrations together. PI script, gave some exposure of CoRL as well.

However, when going into the un-orchestrated PjBL activity Harry and some of his teammates still lacked some knowledge and self-efficacy, due to the use of older COGLE version. As they had a lecture to attend, they only worked for 1 hour in the first SOWT session and that too with limited interactions. In the first session Harry wanted to figure out by himself what he was supposed to do. They reassembled again after a 4 week to finish the work. They had forgotten the details and had to spend time again on task understanding. Harry worked on the filter part as he felt he was confident with the filter design part that was covered in first 4 sessions. He assumed Giles would work with him and that the two girls will work together. However, Giles due to his ADHD related coping strategies, wanted to focus on his work and structured things in his way but he did not impose it on others. He initially stayed passive as he did not want come across as too controlling (see next section). However, Harry was relying on Giles to lead him and give him and the two girls more work.

This meant that although exposed to Co and SSRL during COGLE sessions and there was self-efficacy about some topics and trust between teammates going into the task, the transfer of CoRL and of all the elements (shared plan, do, monitor etc.) of the SSRL scripts did not happen in this team. There were limited attempts to make shared plans for completing the entire task or reviewing these. On completion of his filter part, Harry did share his work with Giles, who was trying to focus on his part. Harry was unable to take on board the critique from Giles due to gaps in their knowledge. Harry continued to work on his own initiative and kept himself engrossed with amplifier part despite his limited understanding of that topic (high SRL). He was resentful about the work not being divided to keep them all busy throughout the session (poor shared planning). Despite this his trust in Giles did not falter (he had gone past the *uncanny valley*).

In the end they submitted the final work to a decent standard. Harry demonstrated high cooperativeness and the emerging conflict between him and Giles did not stop him from contributing to the *shared goal* and keeping going till the end. Giles's trust in him however started to falter, as he found Harry's contributions as incorrect. His patience in Harry had also ran out. Having two NAT students in the same team increased the challenges. This affected both CoRL and SSRL (shared reviewing of their plans) in this team.

7.3 Case of Giles

7.3.1 Background on Giles (Case 2)

Giles faces problems with *concentrating*, in line with his ADHD diagnosis. He feels that his brain needs *engagement* for him *to stay on task* and he gets *easily distracted*.

> "*Distraction* is *a big thing* … all kind of part of the ADHD thing … and it's quite *hard to stay on task … if it's not stimulating enough*." (Giles)

As a coping mechanism, he tries to *put structure* around a task *to help him stay on task*, he also takes medication for this. However, when *in a team* this makes him feel that others aren't following his structure. He may then try to *engage everyone according to his structure*.

> "So…with ADHD, [I] *have to structure things… other people might not*, and… maybe that might play as to why *I feel that maybe they're not doing the work in the same way*" (Giles)

He was *aware* that this causes others to *feel being controlled*. As a *coping strategy* for this*,* he remains *polite and lets others contribute* and *tries not to overtake conversations* by *staying passive*:

> "*I'm aware of how that affects me at work* … I actively spend a lot of time trying to *keep that in check*. But it's…*so hard to try and do that…I let other people participate* and *I don't… overtake conversations*". (Giles)

In the next section, I look at how Giles experienced COGLE and if it helped Giles in learning and team working.

7.3.2 Giles's experience of COGLE and the un-orchestrated activity

7.3.2.1 Giles's ability to stay focused on task when using COGLE

Giles found the *repeating pattern* of *short activities* in COGLE very helpful for *him to stay on task.* It kept him *engaged* as the *mixed-media approach stimulated his brain* to be *productive* and *engaged*. This aided his well-developed *coping strategies* for ADHD related challenges:

> "*mixed media learning*, so like having the visuals and then having…audio and then text, like the *variation is really, really important*…I really, really like… it's *engagement* and …it's *stimulation*…when I'm not doing anything, I'll… *fiddle and things*" (Giles)

Initially, he thought that these *repeating patterns may turn boring* and he may get distracted. However, the *GWM goal* and PI script gave him a focus to use his well-developed coping strategies in the face of the perceived challenge of repeating activities:

"I was like, 'Ah, *I wonder if this is going to get really repetitive* or not?'… obviously *you note the repetition*, but *I wasn't really bothered by it* …the breakdown parts where… you're talking and you're trying to work it out, someone's trying to explain it to you…*I didn't find myself becoming particularly disengaged.*" (Giles)

Options in the mastery questions were there to test *cognitive conflicts* and also *mistakes students tend to make* in calculations. Like Harry, Giles too *made several silly mistakes* due to his ADHD.

"[COGLE] *stopped people* from going, 'Oh, that's the one that's like the most similar;'… *you actually have to go back and calculate it*… that actually was… *catching me out,*… most of the time… So, *it makes you*… *think about*… *things* that you were doing wrong" (Giles)

This frustrated him but he *overcame this frustration too*. The realisation made him do future questions with *greater care and focus* and this *was necessary* for achieving GWM:

"The *mastery* cycle… is *only frustrating, I think, if you let it be frustrating*." (Giles)

7.3.2.2 Giles's learning and self-efficacy after using COGLE

He found that the *insistent* manner in which the system made peers interact and the GWM goal can change the *frustration* into *positive frustration* encouraging them to *learn more*.

"That *insistence*… *eventually*, the frustration … of the repetition might… *engage them to finish it* [half laugh], if you know what I mean. So, *actually try and get it right*?" (Giles)

Giles normally finds *revision very disengaging*. However, Giles's *learning gain* was one of the best in the whole study. He found COGLE to be really good for his revision.

> "It was a *good revision* … and *I find revision really, really disengaging* … the *videos were clarifying* things… then doing those example questions [helped too]." (Giles)

COGLE pairing peers helped him *learn from others* but also that having to explain the concepts to others enhanced his knowledge and self-efficacy:

> "I've *grown up to, to learn* that it's actually *better* to let someone be like, 'No, *that's not how you do it*,' than…I was *trying to break down the ideas* as I had understood it *into a way that someone else can understand it*, it would then *improve my understanding* of it as well…and vice-versa." (Giles)

7.3.2.3 Giles's controlling tendencies in the face of others not pulling their weight in the final activity and COGLE use.

During the *learning together* phase, Giles felt that the new version of COGLE provided visual data to demonstrate to him and others well that *everyone was learning and contributing in a balanced way*. His trust in his teammates and his self-efficacy was up after 4 sessions. This external structure and *automated monitoring in COGLE* allowed him to overcome his *tendency to overtake tasks* as he was aware how everyone was doing and following the structure:

> "*We could see*... there was a bit of statistical data on the screen; … some quite good *visual feedback*… 'Done 10 out of 10 in a row… OK, well, if we've just done that, then they must understand it now'." (Giles)

He commented that COGLE made the team *more cohesive than he expected*, given the diverse make up:

"COGLE,… was… very good for *making… a group* that wouldn't necessarily work together very well,… and probably mitigates a lot of the problems." (Giles)

However, when they used the older version his teammates found the *topics difficult* and they could not complete mastery every time. It did not reveal the correct answer unless all teammates were correct or played remedial videos. This resulted in a drop in trust levels between the teammates and possibly made them less aware of each other's strengths and weaknesses.

"I think... the *mastery… times* for those sessions on operational amplifiers…*were quite long*… *a lot of wrong answers*… because they are *quite complex*… I think that might have been why… the [Trust] *numbers went down*." (Giles)

Differences in the two versions of COGLE affected the trust and the transfer of team working skills into the un-orchestrated PjBL activity:

> "*We were working quite well together* by that point… and *I kind of felt* that… *would've just passed over* [to the PjBL activity]… *better*… a lot of the *social aspects* of… COGLE I think are really, really good." (Giles)

When going into the PjBL activity they were not at a level where they were at after session 4 in terms of trust or knowledge. In addition, he *believes* that during the final PjBL task, the *lack of orchestration was noticeable* as no one was there to reinforce a structure:

> "Having that system then removed…I think… like a kind of…*lost kind of feeling*… that is the *hierarchy*… *there was no one to tell them*" (Giles)

He felt that the *teammates were not pulling their weight* at times during the SOWT session, so he felt compelled *to assume a more directing* role:

> "Some…*friendly encouragement needed*…*to get things done*…when I saw *everyone kind of losing their focus* and *just kind of dawdling*…I was like, 'Either, either they're really bored or they just don't know what to do, and…*they're looking for direction.*'" (Giles)

7.3.2.4 Self, Co and SSRL

Giles and his teammates practiced CoRL under the control of COGLE, which created the (external) structure he prefers. The automatic shared monitoring in COGLE and shared working allowed them to gain trust in each other in the first 4 sessions. They were at times able to *overtake SSRL* too in the COLT sessions. He was able to practice CoRL on others.

However, during last 3 sessions and particularly in the un-orchestrated activity Giles felt the loss of the controlling structure. Trust was down as a result. His coping strategies helped him keep his controlling tendencies in check on the first day of SOWT. Giles created a Google Document and shared it with the others as he tried to put some structure around the work. For the others this was something new and did not work as well. However, on the second day he led the redesign of the filter and was more controlling as he really wanted to finish the tasks. He expected the others to contribute to his Google document, which they still did not and this triggered him to take things in his own hands and complete the task. Ira was an exception to this and contributed to the document to finish the task with him.

Although exposed to Co and SSRL during COGLE sessions, fluctuations in trust, and differing knowledge levels meant there were limited attempts to make shared plans in this team during SOWT. In the absence of the orchestration, Giles expected others to join in with his structured approach, which did not work that well. He did eventually submit a working solution with support from Ira. He discounted both Harry and Rita's inputs as not valuable.

7.4 Case of Dee

7.4.1 Background on Dee (Case 3)

Dee also had developed *coping mechanisms* for working in teams, in relation to his ASD diagnosis. He would *seek clarifications* if given *vague instructions* by someone *in charge* of his team. However, this meant that *he may rely* on others to take a *lead within team settings*.

> "Maybe there's a group project … and *someone's taking charge* … if *I'm only given vague instructions*, I'd probably just be confused, *but I'd just ask* them *to be a bit more specific*." (Dee)

Throughout the interview he mentioned *he was a slow reader*, which made it difficult for him to fully engage with the final day's tasks. This may suggest that there are potentially co-morbid conditions like ADHD but nothing else was declared.

Later, in the interview he mentioned that he is *not the most social person* and has had little overall team working exposure and also reported *one broken down dyad* in his current course, and he presented the work himself alone. He also mentioned that he tends to make some *assumptions,* which can be *right or wrong* at times. He refers to these wrong assumptions as *sins* indicating past troubles. Once again, this is linked to autistic people being over-trusting of others and if the trust is broken, it feels like a sin to have trusted someone based on incorrect assumptions.

Next, I look at how Dee experienced the SOLT phase and how it prepared them to work as a team.

7.4.2 Dee's experience of SOLT and SOWT

Dee's team watched the videos together in a room and answered a set number of questions in each of the 7 sessions. Here, there was no repeating mastery cycle as seen within COGLE sessions nor any COGLE based orchestration of interactions, arbitration or remedial video support. There was no immediate feedback on the attempt and an email was sent out to each student, after each session, identifying their mistakes. None of the students ever mentioned using the feedback email to discuss between themselves the questions and their answers at any time during the study. The daily scores and averages for his team are show in the **Table 40**.

Name	1	2	3	4	5	6	7	Student Average
Chi	5	5.5	5.5	0.5	1.43	5.71	6	4.23
Adam	7	8.5	5.5	3	2.85	7.14	7	5.86
Bill	8	7	5.5	2.5	4.28	5.71	6	5.57
Dee	10	2	2.5	0.5	1.43	5.71	5	3.88
Daily Average	**7.5**	**5.75**	**4.75**	**1.63**	**2.50**	**6.07**	**6**	**4.88**

Table 40 Daily scores (out of 10) for each of Dee's teammates.

7.4.2.1 Dee's learning and Self-efficacy

It can be seen that his daily scores are below the daily average of his team for 6 out of the 7 sessions. His normalised learning gain of 0.22 also shows a *gap in overall knowledge*. His self-efficacy did not enhance before going into the PjBL task:

"I *remembered* [half laugh] *very little* from the…actual sessions themselves, so *I wasn't all that useful, to be honest*." (Dee)

Although there were others in the team who got more questions correct each day than him, there was little interaction between him and them. In session 1, he reported that *he discussed one* answer with the teammates and agreed on it, *but was unsure* if it was correct or not:

"We were able to *agree on a final answer*. We weren't sure if the answer was correct." (Dee)

In sessions 2 and 3 too, he got a confirmation from his team for one question when he shared his answer with them. This helped his confidence:

"They *confirmed* my understanding of a question. It made me *more confident* as we solved *the question together.*" (Dee)

However, in session 4 his attempt to *learn from others did not go too well*:

"When I *asked for help* with a question this *didn't go well as the answers* the group came up with *didn't match* what the video stated. In the end I *decided to make a guess and move on with the rest of the questions*." (Dee)

In session 5, *nothing happened* as all his teammates were unable to answer most of the questions. Dee, unlike others, was unable to sense this difficulty that everyone was facing.

In sessions 6 and 7, things changed as Adam acted as the *master orchestrator* and shared the questions on the projector and orchestrated discussion and collective solving, almost like in COGLE. This improved the marks, see **Table 40**, and their *interaction*, as this quote from session 6 shows:

"*We all contributed* with the information we gained through the videos." (Dee)

Due to the delay in them coming together and gaps in knowledge, he did not feel ready for the PjBL task.

7.4.2.2 Social anxiety and awkwardness

Dee mentions that it maybe did not *cross their minds to discuss* the answers for each of the question during each session like they did in last two sessions. On the first day the questions were *too easy* (he scored 10/10) and they *did not know each other that well.*

“I guess ‘cos we didn’t quite *know… each other that well* … maybe *it didn’t cross our minds or something*.” (Dee)

They discussed only one question per session for the first 4 sessions and did the rest in *private*:

> “[Earlier sessions] *weren’t public*. They were just on, like, everyone’s individual… screen and they were like, ‘What’s the answer to question 2?’ and it was like, ‘Hold on, I have to scroll up to that one.’…we were *going at separate, different rates*.” (Dee)

For Dee, it was *awkward* to ask the others when all were doing them at their *own separate pace,* he preferred the experience in sessions 6 and 7:

“But, if it was all upon the [shared screen]… and *we were all* going [discussing].” (Dee)

Dee was the only one who was unaware of the shared feeling of *psychological safety* in the team relating to no one knowing the answers. He thought they had *interacted enough to be comfortable* with each other by then and missed social cues relating to the feeling. During session 4, he tried to seek help but it did not go too well as the others did not know the answers.

Dee *liked the way Adam orchestrated* the team using the projector in the room and *sharing his screen* with the rest. It helped synchronise everyone’s efforts and focus on one question at a time, which did pay off in terms of learning and scores on days 6 and 7 for all students. This encouraged *cognitive conflicts* to play out and discussions to take place.

> "*Strongest example* of that [cognitive conflicts] was probably, er, *Session 6 or 7*…when *Adam was going* to (sic) *the questions*…his computer was connected to the projector so…*we could all* [discuss]… [It] *took the pressure off a bit… lot nicer.*" (Dee)

7.4.2.3 Conflict Management styles

It was only from session 6 onwards that the team really came together and started working on the questions in a *cooperative way*. This is also reflected in the Style Matters ® survey data. Dee *increased his preference* for *cooperative style* when approaching *cognitive conflicts* at the end of SOLT sessions. He did seem to have the *right script for dealing with diverse answers* and *did not see cognitive conflicts* as conflicts:

"*Our answers didn't agree with each other*. We just… *reacted maturely* and … *we compared the methods… saw the weaknesses in both*, tried to *find the best one.*" (Dee)

However, as there was *no immediate feedback*, this meant that they *could not know for sure* if their answers were right or wrong and could not really resolve the *cognitive conflicts* each time they were presented. This lack of *feedback* also impacted the learning, the self-efficacy as well as the trust development in the team.

7.4.2.4 Trust in Dee and his trust in others

Dee was the only one in this case study who experienced an increase in all three facets of trust in his teammates during the first 4 sessions. This is typical of ASD students (Yi et al., 2013) and is backed up also by the trust survey data. Dee was too trusting and *he trusted them more than* he even did *himself*.

> "Well…I *began*, *without a shadow*, began *to trust everyone…as we started to work a bit more…I trusted more…at one point, relying on their knowledge* of the subject because *I thought they just knew better than I did.*" (Dee)

On the other hand his teammates trust in others, as measured by the trust survey, showed a decrease by the end of 7 sessions. Over-trusting does not often end well and it did not in this case either. After arriving late, Dee took time reading the task whilst the *others had made a start without him*. As Dee still trusted the abilities of others more than his own, he let them get on with the task without much interaction on the final day to start with. He also *assumed* that the others were working well together and thought they *had it under control*.

> "Yeah … *those three were coming together really well*." (Dee)

In fact, they were all *struggling* with the task and also were *not working as one team*. Dee went up to them and *told them he did not know much*. This further reduced any chances of him being included in the work that they were already well into. Even though *he had good scripts for team working,* he could not use them on the final day. He stayed out of the team work. He referred to this as committing, in his own words, *the sin of assuming* they *had it in control* so his knowledge was not needed. He *realised this* when I told him that the *team actually agreed to share the reward equally with him* if their team was to win the final design challenge. He reflected also on his past experiences of making *assumptions* which had *caused him problems before*. Dee needed the coping strategy that Harry had developed when it came to trusting others.

> "I may have just *committed the sin* [of assuming] that *they* were the ones who *knew what they were doing*… I had, had this *weird* ven-, *vendetta against assuming things*, 'cos that *usually leads to just big problems*." (Dee)

7.4.2.5 Self, Co and SSRL

When Adam orchestrated the answering of the questions in a *more public way, it triggered the right scripts* within Dee and others who discussed the questions and scored higher for more difficult topics. However, they did not *practice* this enough to *internalise* and use in the SOWT session. CoRL and SSRL did not really happen on the final day.

Despite his high SRL, perhaps too high, Dee found it tricky to make himself part of the team on the final day. When he walked up to them to find out how they were getting on, he did not see a structure and an opportunity where he could fit in and *take the weight off* someone.

"So, I couldn't just *take the weight off someone else*." (Dee)

When going into the un-orchestrated activity Dee felt that he knew far less than the other three, which was not entirely true. As no one was clearly passing on instructions to Dee in terms of what he could help with, he was unable to make sense of the structure put in place to complete the tasks on the day. Overall, the SOWT session was non-inclusive, partially effective and inefficient.

7.5 Summary

Social Anxiety and Awkwardness

The two ASD students (Harry and Alex) show that COGLE was helpful in reducing *social anxiety and awkwardness* much earlier (within first 2-3 sessions) as the orchestrations encouraged interactions between teammates. In comparison, in case 3, the students *warmed up to each other* after the 5th session. They lost valuable time in overcoming social anxiety and awkwardness. It took them the realisation that no one knew the subject and one teammate acting as a master orchestrator to reach this stage.

a. Trust in others and in the ASD student

ASD students typically are over-trusting (Yi et al., 2013) but they can develop coping mechanisms, like Harry did and become over-cautious in trusting others. COGLE helped here as it allowed both Alex (who was over-trusting) and Harry (who was under-trusting) to be better informed when trusting others. In comparison, Dee trusted his team too quickly. Later, he reflected this may have been a mistake. This was like a *Deja vu* feeling for him.

Additionally, Alex and Harry enjoyed support and an enhanced trust of most of their teammates when going into the FC task and PjBL session respectively. However, during the un-orchestrated activities in these sessions the lack of self-efficacy for Alex and Harry's knowledge caused the trust in them from one of their teammates (Cyrus and Giles respectively), to go down. However, the two teams managed to complete the task. In contrast, Dee's teammates did not trust him or anyone else in the team for that matter, to complete the task fully and they did not. One of them did not trust specifically Dee and found him a bit odd as highlighted in chapter 6.

b. Changes in CM Styles as measured by Style Matters ® survey

Alex and Harry found that COGLE reinforced their preference for cooperation. Styles Matter ® survey responses showed this movement in their preference: from avoiding to cooperation in the case of Alex and from compromising to cooperation in the case of Harry. The frustrations and challenges, in COGLE's GWM script, actually triggered interactions that explains this shift. Dee on other had seemed to be cooperative as he had developed coping mechanism to counter his ASD. However, for cooperation, he needed others to trust him and some trigger for cooperation to happen. When Adam took charge of orchestrating the group, it triggered cooperation scripts Dee's team.

c. *Self-efficacy and learning*

Alex did not find COGLE to be as effective in helping her understand and retain knowledge for long. As she was returning to education after a long time, she wanted more time to learn in COGLE by herself.

Harry benefitted from using the new version of COGLE and thought he had learnt a lot from taking part in the study. His test results showed that he understood content from the first 4 sessions only. Giles learnt well all topics as COGLE supported his ADHD related needs and he spent more time on his own. Dee's learning and confidence did not improve over the sessions and it prevented him from contributing in the PjBL task.

d. *Regulation skills*

Regulation skills take time and practice to internalise but also significant is the trust and self-efficacy between teammates. Alex certainly felt this way and would have benefitted from a longer period of interaction and content mastery. Harry on the other hand did get the extended period of interactions (albeit with two different versions of COGLE). His confidence and trust in his teammates went up. He even demonstrated some elements of SSRL during the PjBL task but the team generally suffered due to a lack of knowledge and co-ordination. Giles's trust in Harry had dropped during the SOWT sessions, therefore Harry was unable to CoRL with him. Giles himself was hesitant at first but had to take control of the teamwork. Having two NAT students in one team turned out to be problematic.

Although Dee got some practice in regulation skills, when Adam orchestrated session 6 and 7 in a public manner. However, two sessions were not sufficient to internalise and these skills were not used well in the PjBL task.

e. Staying focused on task and structuring team work

Giles as well as Harry, both have ADHD, and they benefitted from COGLE as it orchestrated short videos, quizzes and interactions and remedial actions. This kept both of them sufficiently engaged to learn and stay focused. This enabled them to contribute to the PjBL task with whatever they had learnt.

Both Harry and Giles noted the absence of COGLE in the SOWT session. Giles prefers structure in team and individual work to help him stay focused. COGLE provided this through GWM, PI scripts and group progress visualisation graphs. Later on, in the PjBL task Giles even shared a structured Google document but things spiraled downwards as others saw that as restrictive and wanted more interactions, which Giles did not lead on. Harry also mentioned that although COGLE helped with interactions and learning, it did not teach him how to clearly divide the work between teammates. Their well-developed coping mechanisms related to their ADHD were hard to overwrite in just 7 COGLE sessions.

f. Limitations and disadvantages.

COGLE can lead to a premature feeling of cognitive trust in NAT students, as in the case of Harry and Alex. Building trust helps with feeling invested in each other. However, eventually when the trust breaks, it can make others feel awkward and/or that the NAT student was like a passenger student. To minimise the chances of this, NAT student should be given time to master content on COGLE so that they don’t really come across as a passenger, which clearly they are not. In addition, more than one NAT student should not be put in a team. Besides, for encouraging interactions from those with ADHD, question design should avoid catching people’s silly mistakes (due to their attention difficulties) and focus more on cognitive conflicts. Giles did not let this frustrate him, whilst Harry found resolving cognitive conflicts much more useful that being penalised for silly mistakes.

Chapter 8: Cross Case Analysis

This chapter presents and tests the theoretical propositions and those emerging from the three cases in this study by performing a cross-case analysis. The first of the three cases was an unusual case of COGLE, allowing investigation of understudied constructs linked to the development of team working skills and attitudes within COLT settings. The second was, a purposefully selected literal replication of the previous case allowing for corroboration of evidence and enhancing analytical generalisation in support of the extension to the theoretical framework used in this study. Finally, a third case that does not use COLT but uses SOLT, provided a contrast and further enhanced analytical generalisation. It allowed discarding of a rival explanation related to simply learning together in SOLT sessions.

In order to identify the important lessons from this study and answer the research questions, I first defined the criteria to extract and re-cod all the data at individual, at pair and at team levels. I felt that these additional levels were needed to support and extend the *necessary and sufficient conditions* linked to CoRL between any two teammates and SSRL within a team. The chain of evidence used to code is also presented in each table in the next section. I checked for *necessary and sufficient conditions* and present empirically supported patterns of similarities across the three cases. Furthermore, I highlight the lessons learned from comparing the literal replication (COLT) cases with the theoretical replication (SOLT) case.

A *necessary condition* is one where for a given value of a dependent variable that occurs more than once, the independent variable repeats. This condition is tested by selecting cases where the repeating value of an independent variable is absent and checking if the corresponding value for the dependent variable is also absent. Likewise, a *sufficient condition* is one, where for any given value of independent variable that repeats, the dependent variable also repeats. This condition is tested by selecting cases where a desired value of a dependent variable is absent and checking if the corresponding value of the independent variable is also absent.

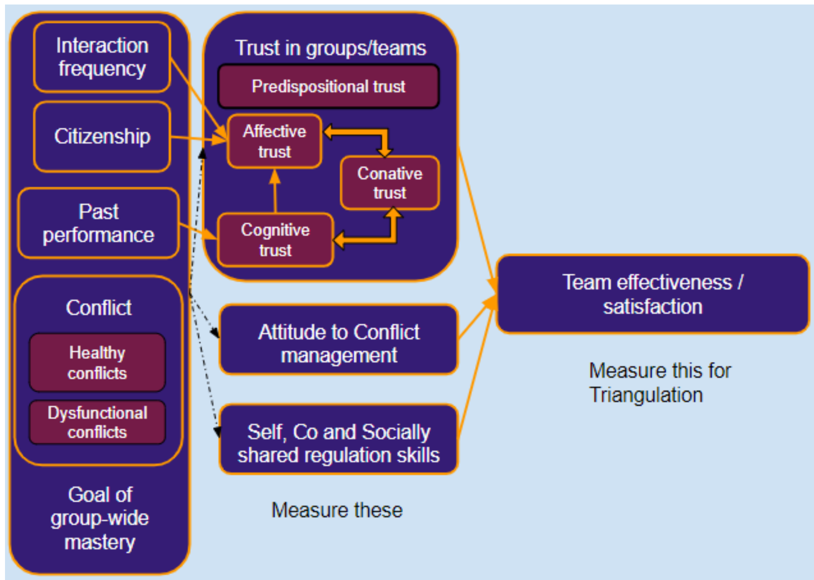

Figure 2 ***Theoretical Framework guiding this research.***

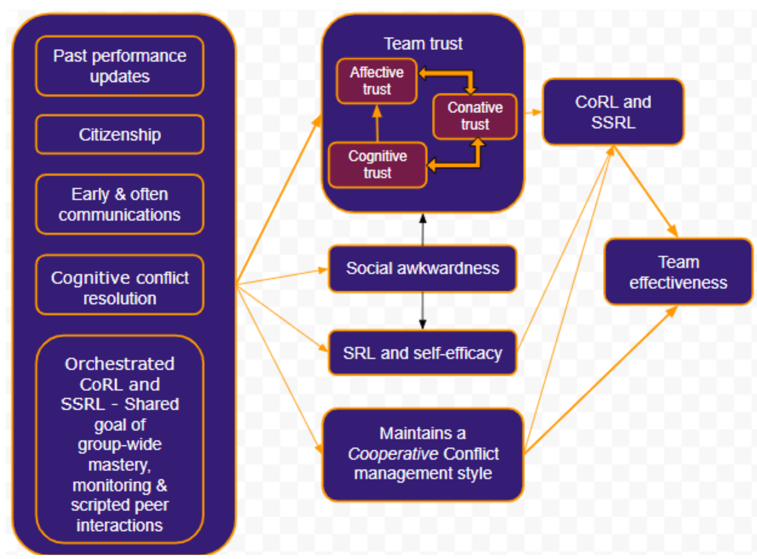

Figure 24 ***Modified theoretical framework.***

The *necessary and sufficient condition* supported by the re-coded data led to confirmation of many of the links shown in **Figure 2** and discovery of new ones. For example, *team effectiveness* is shown to be linked with CM and regulation skills as well as trust between teammates from **Figure 2**. I tested its links with additional constructs, such as *self-efficacy, early and often communications, trust, shared goals* and *social awkwardness*. This resulted in the modified framework of **Figure 24**, which summarises the supported propositions and the lessons learned through this cross case analysis.

The results from this cross-case analysis are used in the next chapter, to answer the research questions in greater details.

8.1 Criteria for re-coding

Propositions relating to each construct shown in **Figure 2** and those emerging from the data from the cases dictated what to extract and re-code for testing empirically. The criteria used for this are stated in **Table 41**-**Table 49** below for team level data. e.g., the first column in **Table 41** shows the exact criteria used for coding of Team effectiveness. The codes used along with the chain of evidence from the cases are provided in columns 2 and 3 of **Table 42** respectively. Here, based on the number of teammates that were dissatisfied with the team effectiveness (the criteria), I coded first five teams in **Table 56**-**Table 57** (see section 8.2) as *medium* (as 1 teammate showed dissatisfaction) and the remaining two teams as *low* (as 2 or more teammates showed dissatisfaction) in team effectiveness. To answer RQ1, which relates to development and transfer of team working skills, links were established between team effectiveness, SSRL skills and their potential antecedents as shown in **Table 56**-**Table 57**. Likewise, for individual level data, to answer e.g., RQ1.2, I searched for patterns in the data relating to the antecedents of trust, these were re-coded (see **Table 58**, section 8.2) using **Table 50**-

Table 53. Evidence to answer RQ1.1 was also analysed in the same manner. In this way all necessary and sufficient conditions were explored. In Chapter 9, the research questions are answered using these results and other data collected in this study.

8.1.1 Criteria for re-coding team level data.

The criteria used for coding the relevant dependent and independent variables are listed below:

a) Team effectiveness

Criteria: Number of people dissatisfied with team's outcome/processes	Team effectiveness	Chain of evidence
None.	High	**Table 11** to **Table 12** (Ch. 4)
1	Med.	**Table 23** and **Table 24** (Ch.5)
2 or more	Low	**Table 34** to **Table 36** (Ch. 6)

Table 41 Criteria for coding for team effectiveness.

No dissatisfaction with the team's outcomes and processes by anyone indicates *High* team effectiveness especially where the team task was completed. The re-coded data is tabulated along with the likely antecedents in **Table 56-Table 57** to perform the pattern-search.

b) SSRL during SOWT activity

Using **Table 42** teams were coded, e.g., as *medium* where only some members engaged in SSRL elements such as *shared goals, planning, working, monitoring and/or reviewing*, as shown in **Table 56-Table 57** along with its likely antecedents for pattern-searching.

Criteria: Reported elements of SSRL	SSRL in SOWT	Chain of evidence
All	High	**Table 11** to **Table 13** (Ch. 4)
Some	Med.	**Table 23** to **Table 25** (Ch. 5)
No one showed any element of SSRL	Low	**Table 34** to **Table 37** (Ch.6)

Table 42 Criteria for coding self-reported SSRL in SOWT activity.

c) Majority CM style before SOWT activity.

Each team's most common top CM style, as measured by the Style Matters ® survey data before entering the SWOT activity, was used as the *majority CM style* for that team as shown in **Table 61**.

d) Self-efficacy before SOWT activity.

Criteria: Low Normalised learning gains, confidence expressed in interview.	Self-efficacy	Chain of evidence
None	High	**Table 8**, **Table 10** and **Table 15** (Ch. 4) **Table 20**, **Table 22** and **Table 27** (Ch.5) **Table 32**, **Table 36** and **Table 39** (Ch. 6)
1	Med.	
2 or more	Low	

Table 43 Criteria for coding self-efficacy in team prior to SOWT session.

For this first the self-efficacy was coded based on normalised learning gains for each student and was corroborated with the SSRL and interview data. As shown in **Table 56**, teams were coded as '*High'* where no teammate had low self-efficacy prior to SOWT phase and so on, as per the criteria in **Table 43**.

e) Facets of team trust after COLT/SOLT sessions.

Criteria: trust survey scores	Team trust	Chain of evidence
All or majority score 6-7 for each facet.	High	Figure 7-8 & **Table 10** &**Table 15** (Ch. 4) Figure 12-14 & **Table 22** & **Table 27** (Ch.5) Figure 18-20 & **Table 34** & **Table 37** (Ch. 6)
All or majority score 5 (or equal number at 6-7 as at 5)	Med.	
All or majority score of 1-4.	Low	

Table 44 Criteria for coding facets of team trust in teammates in COLT/SOLT sessions.

As shown in **Table 56**, the raw data was coded as *High* where all or majority of teammates responded with scores of 6-7 and qualitative data also supported high trust and so on, as per the criteria in **Table 44**.

f) Unresolved conflict during COLT/SOLT sessions.

Criteria: Unresolved conflicts reported in SSRL survey	Unresolved conflicts	Chain of evidence
3 or more occasions	High	SSRL data for each case. **Table 15** (Ch. 4) **Table 27** (Ch.5) **Table 34** (Ch. 6)
1 to 2 occasions	Low	
Never.	None	

Table 45 Criteria for coding unresolved conflicts in COLT/SOLT sessions.

As shown in **Table 56**, the SSRL survey was coded afresh for this, counting mentions of unresolved conflicts on each day and coding was applied to the team's data as per the criteria in **Table 45**.

g) Early and often communications in COLT/SOLT sessions

Criteria: Most students reported interactivity	Early and often communications	Chain of evidence
All days.	High	SSRL data for each case. **Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** & **Table 37** (Ch. 6)
Up to 2 of 7 days.	Low	

Table 46 Criteria for coding Early and often communications in COLT/SOLT sessions.

As shown in **Table 56-Table 57**, the SSRL survey was coded afresh for this, counting mentions of *early and often communication* during the COLT/SOLT session on each day and coding was applied to the team's data as per the criteria in **Table 46**.

h) Reduction in social awkwardness during COLT/SOLT sessions

Criteria: Most students reported interactivity	Reduction of social awkwardness	Chain of evidence
All days.	Yes	SSRL data for each case. **Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** & **Table 37** (Ch. 6)
Up to 2 of 7 days.	No	

Table 47 Criteria for coding reduction in social awkwardness in COLT/SOLT sessions.

As shown in **Table 56-Table 57**, teams were coded as '*Yes'* where all teammates reported early interactivity and *No,* where interactivity was late and/or limited to cliques, as per the criteria in **Table 47**.

i) Internalising shared goal orientedness in COLT/SOLT sessions.

Criteria: worked on their own initiative towards a shared goal	Internalised shared goal orientedness	Chain of evidence
All	Yes	SSRL data for each case. **Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** (Ch. 6)
Some or none.	No	

Table 48 Criteria for coding internalising of goal orientedness in COLT/SOLT sessions.

As shown in **Table 57**, teams were coded as *Yes* where all teammates worked together towards a learning goal and *No* otherwise, as per the criteria in **Table 48**.

j) Shared planning, monitoring, regulation attempts and reviewing in COLT/SOLT sessions

Criteria: Students worked on their own initiative towards the elements of SSRL	Shared regulation attempts made	Chain of evidence
All	Yes	SSRL data for each case. **Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** (Ch. 6)
Some or no	No	

Table 49 Criteria for coding shared planning in COLT/SOLT sessions.

As shown in **Table 57**, teams were coded as *Yes* where all members worked together on *shared planning, monitoring, and regulation of team and shared reviewing of their work* and *No* otherwise, as per the criteria in **Table 49**.

As explained at the start of the chapter, I look next at the individual student's data for team trust, CM skills and other constructs to discover patterns within individual level data. For this the SSRL data was re-coded deductively using the theoretical framework and the criteria below. Data from SSRL analysis earlier and interview data was used to corroborate the re-coding. As before, the framework of **Figure 1** and the data dictated which constructs to code. For example, trust is linked with past-performance, citizenship and other antecedents and the same are re-coded for this analysis.

8.1.2 Criteria for re-coding individual level data.

Table 58 shows data that was extracted and coded, as per criteria stated in **Table 51**-**Table 53**, for possible antecedents for team trust. It shows cases where the initial team trust was either *low* or *medium* and patterns relating to how it changed after COLT/SOLT sessions. Excluded data is also presented in **Table 59** to show where initial trust was high either maintained (in cases 1 and 2) with the exception of Ethan's case after 7 sessions (who lowered his trust in his teammates due to the banter and unresolved guesses) or maintained or decreased (in case 3). **Table 60** shows the patterns related to maintaining preference for a cooperative CM style before SOWT re-coded using Style Matters® survey data collected at relevant points as reported in chapters 4-6.

a) *Past-performance in COLT/SOLT sessions*

Criteria: Number of sessions where students enhanced their knowledge of strengths and weaknesses of others	Knowledge of past-performance	Chain of evidence
Most sessions.	High	**Table 10** & **Table 15** (Ch. 4)
50% of the sessions.	Med.	**Table 22** & **Table 27** (Ch.5)
Less than 50% of the sessions	Low	**Table 34** & **Table 37** (Ch. 6)

Table 50 Criteria for coding past-performance in COLT/SOLT sessions.

As shown in **Table 58**-**Table 59**, where the knowledge of *strengths and weaknesses* of their teammates was mentioned by an individual in most sessions, *past-performance* was updated and it was coded as '*High',* as per the criteria in **Table 50**.

b) *Citizenship in COLT/SOLT sessions*

Criteria: Number of sessions where students helped a student	Citizenship	Chain of evidence
Most sessions.	High	**Table 10** & **Table 15** (Ch. 4)
50% of the sessions.	Med.	**Table 22** & **Table 27** (Ch.5)
Less than 50% of the sessions.	Low	**Table 34** & **Table 37** (Ch. 6)

Table 51 Criteria for coding citizenship in COLT/SOLT sessions.

As shown in **Table 58**-**Table 59**, where an experience of *receiving and/or helping each other* was mentioned by a student in most sessions, *Citizenship* was coded as '*High',* as per the criteria in **Table 51**.

c) *Cognitive conflict resolution in COLT/SOLT sessions*

Criteria: Number of sessions where students experienced cognitive conflict resolution	**Cognitive conflict resolution**	**Chain of evidence**
Most sessions.	High	**Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** & **Table 37** (Ch. 6)
50% of the sessions.	Med.	
Less than 50% of sessions.	Low	

Table 52 Criteria for coding cognitive conflict resolution in COLT/SOLT sessions.

As shown in **Table 58**-**Table 59**, where an experience of *cognitive conflict resolution* was mentioned by a student, *Cognitive conflict resolution* was coded as '*High',* as per the criteria in **Table 52**.

d) *Top CM style before COLT/SOLT sessions and before SOWT session*

As shown in **Table 60** (see section 8.2), if a student's top CM style preference, as measured by the Style Matters® survey, was *cooperative* before the study and/or just before the SOWT activity, it was coded as *Yes,* otherwise as *No.*

e) *Increased team trust after 4 and 7 COLT/SOLT sessions and before SOWT session.*

Criteria: Compared to initial team trust for a given student, the team trust score after sessions or before SOWT session	**Increased team trust after sessions or before SOWT session**	**Chain of evidence**
More	Yes	Team trust survey raw data as well as **Table 10** & **Table 15** (Ch. 4) **Table 22** & **Table 27** (Ch.5) **Table 34** & **Table 37** (Ch. 6)
Otherwise	No	

Table 53 Criteria for coding increase in trust.

As shown in **Table 58**-**Table 59**, where student's team trust score (sum of cognitive, conative and affective trust scores) was more at different points during the study than at the start, this was coded as '*High',* as per criteria in **Table 53**.

8.1.3 Criteria for re-coding pair level data.

Criteria	Instances / frequency over COLT/SOLT sessions	Chain of evidence
Citizenship frequency - helping the regulated was present in more than 50% of COLT/SOLT sessions.	H	SSRL daily survey data corroborated with interview data.
It was present in half the sessions.	M	
Otherwise.	L	
Cognitive conflicts resolved between the regulator and the regulated in more than 75% of COLT/SOLT sessions.	H	
Cognitive conflicts resolved in > 50% but <75% of COLT/SOLT sessions.	M	
Otherwise.	L	
Resolving cognitive conflicts helped regulator in > 75% of COLT/SOLT sessions.	H	
Resolving cognitive conflicts helped regulator in > 25% but <75% of COLT/SOLT sessions.	M	
Resolving cognitive conflicts helped regulator in > 0% but <25% of COLT/SOLT sessions.	L	
Otherwise	No	
For each facet, a high trust score and several mentions of citizenship acts, knowledge and reliability of the regulator by the regulated were there.	H	
Combination of trust score (High/Moderate) and some mentions of citizenship acts, knowledge and reliability of the regulator by the regulated were there.	M	
Combination of trust score (low/moderate) and little or no mention of citizenship acts, knowledge and reliability of the regulator by the regulated were there.	L	
Where the frequency of communication between the regulator and regulated increased each day the social awkwardness was coded as	Down	
If this frequency was up but not each day, social awkwardness was codes as	Partial	
If this frequency was up but only in last 2-3 sessions.	Delayed	
Regulator was able to regulate the other throughout during the activity successfully.	Yes	
Regulator was able to regulate the other sometimes during the activity successfully.	Partly	
Regulator was unable to regulate the other throughout during the activity.	No	

Table 54 Criteria used in coding antecedents of Self-efficacy and CoRL.

Table 54 shows the criteria and the re-coding of the data that was extracted for each possible regulator and regulated pair in each team. Possible antecedents for Self-efficacy and CoRL, before entering the final activity day, for each student are shown here. The SSRL daily survey data was used in understanding the interactions between teammates for this re-coding. This was corroborated with the interview themes.

As mentioned in section 8.1.1, self-efficacy was coded based on the normalised learning gains of each student and was also corroborated with SSRL and interview data themes as shown in **Table 43**. It was assumed to be the same for a given student irrespective of the other student in the pair. Trust, however, depended on who the other student was in the pair being considered. Likewise, antecedents of trust were also coded using the criteria in **Table 54**, between each regulator-regulated pair from the SSRL data and interview themes. This re-coding made it possible to look for patterns related to interactions between the various antecedents considered and the self-efficacy but also on CoRL abilities of the regulator for a given student pair in each team.

8.2 Lessons learned by comparing all three cases

Next, I present a summary of empirically supported propositions in **Table 55** and a summary of how these were supported by the re-coded dependent and independent variables in **Table 56**-**Table 58** and **Table 60**-**Table 61**. Different cases are shown in different colors in these tables. Excluded data for the analysis of trust and its antecedents is also presented in **Table 59** to show where initial trust was already high at the start of the study. The propositions are organised in three areas, namely: *developing team working skills; team trust and self-efficacy; and team effectiveness during SOWT sessions.* Propositions A1, B1 (partially), C1, C3 and C5 are based on the theoretical framework of **Figure 2** and A2-10, B1-B3, C2 and C4 on data from the three cases.

S. No.	Empirically supported propositions	Evidence
A	***Developing team working skills***	
A1	*Early and often communications* leads to *SSRL*	**Table 56**
A2	*Internalising shared goal-orientedness* during COLT helps *triggers SSRL.*	**Table 57 and Table 61**
A3	*Shared monitoring* (enabled by COLT) triggers *SSRL*.	
A4	*Cognitive trust* leads to *SSRL*	
A5	*Self-efficacy* leads to *SSRL*	
A6	*Shared review* of their plans during learning together sessions *leads to SSRL*	
A7	*Attempting un-orchestrated shared regulation of emotion, motivation and behaviour* during COLT sessions successfully leads to *SSRL*	
A8	Regulator helping in *cognitive conflict resolution* leads to *CoRL*	
A9	*Self-efficacy may* lead to *CoRL*	
A10	*Affective and cognitive trust in the regulator may* lead to *CoRL*	
B	***Team trust and self-efficacy development***	
B1	*Past-performance updates, early and often communication and citizenship* leads to an increase in *trust* in teammates.	**Table 58**
B2	*Cognitive conflict resolution* leads to an increase in *trust* in teammates.	
B3	*Citizenship & resolving cognitive conflicts by the regulator* increased *self-efficacy*.	**Table 61**
C	***Team effectiveness during SOWT***	
C1	*SSRL* leads to team effectiveness.	**Table 56**
C2	*Self-efficacy* leads to team effectiveness.	
C3	*Early and often communications* leads to *team effectiveness*.	
C4	*Cognitive trust* (medium to high) between teammates leads to *team effectiveness*.	
C5	*Leaving no conflicts unresolved* leads to *team effectiveness.*	

Table 55 Empirically supported propositions.

The supported links between these variables are shown in the modified framework of **Figure 24** as a result of this work. In the next chapter, I use these results in answering the research questions as highlighted earlier.

There were three types of conditions that were supported in the above table. C5 is an example of a *sufficient but not necessary* condition for team effectiveness. In **Table 56**, wherever *unresolved conflicts* was *none* (column 10) team effectiveness was *medium* (column 12) but this was not true vice-versa. This was supported empirically as teams with *team effectiveness* coded as not *medium*, the *unresolved conflicts* was also not *none*.

Other *sufficient but not necessary* conditions that were supported include propositions: A6-7 relating to SSRL (column 8) and the two corresponding antecedents (column 7 and 6 respectively) as evidenced in **Table 57**; A8 relating to CoRL (column 12) and successful *cognitive conflict resolution* (column 5) by the regulator helping the regulated as evidenced in **Table 61**; B1-2 linking *team trust pre-SOWT* (column 9) with its antecedents (columns 2-5) as evidenced in **Table 58**; and B3 linking *self-efficacy* (column 6) with *Citizenship* (column 3) and *resolving cognitive conflicts by the regulator* (column 5) as evidenced in **Table 61**.

Team & Cases	Last COLT/SOLT session: Affective team trust	Last COLT/SOLT session: Cognitive team trust	Last COLT/SOLT session: Conative team trust	Pre-SOWT: Affective team trust	Pre-SOWT: Cognitive team trust	Pre-SOWT: Conative team trust	Early & Often Communications during LT sessions	Self-efficacy pre-SOWT	Unresolved conflicts during LT session	Self-reported SSRL in SOWT activity	Team effectiveness
Team 1, Case 1	High	Med.	High	High	Med.	High	High	High	None	Med.	Med.
Team 2, Case 1	High	Med.	High	High	Med.	High	High	High	None	Med.	Med.
Team 1, Case 2	High	High	High	High	High	Med.	High	High	None	Med.	Med.
Team 2, Case 2	High	Med.	Low	High	High	High	High	High	High	Med.	Med.
Team 3, Case 2	High	Med.	Med.	Med.	Med.	High	High	High	High	Med.	Med.
Team 1, Case 3	Med	Low	Med.	Med.	Low	Med.	Low	Low	Med.	Low	Low
Team 2, Case 3	High	Low	Med.	Low	Low	Low	Low	Low	Low	Low	Low

Table 56 Antecedents of team effectiveness.

Team & Cases	Early reduction in social awkwardness	Shared goal internalised	Shared planning	Shared monitoring	Shared Regulation of motivation, emotion and behaviour	Shared review for GWM	Self-reported SSRL in SOWT activity	Team effective-ness
Team 1, Case 1	Yes	Yes	Yes	Yes	Yes	Yes	Med.	Med.
Team 2, Case 1	Yes	Yes	Yes	Yes	Yes	Yes	Med.	Med.
Team 1, Case 2	Yes	Yes	Yes	Yes	Yes	Yes	Med.	Med.
Team 2, Case 2	Yes	Yes	Yes	Yes	Yes	No	Med.	Med.
Team 3, Case 2	Yes	Yes	Yes	Yes	No	Yes	Med.	Med.
Team 1, Case 3	No	No	Yes	No	No	No	Low	Low
Team 2, Case 3	No	No	Yes	No	No	No	Low	Low

Table 57 Antecedents of SSRL in SOWT activity (learning together phase).

A2 is an example of a *necessary and sufficient condition*. It can be seen from **Table 56-Table 57**, for wherever Shared goal internalised is *medium* (column 3) SSRL is also *medium* (column 8) and vice-versa. This was supported as for teams with SSRL reported not *medium*, the Shared goal internalised was not *medium* and vice-versa. Making Shared goal internalization a *necessary and sufficient condition* for medium SSRL. Other necessary and sufficient conditions include propositions A1 (*early and often communications*) and A3-5 (*Shared monitoring, cognitive trust and self-efficacy respectively*) linking SSRL and its antecedents as evidenced in **Table 56-Table 57**. The *necessary and sufficient* conditions C1-C4 in **Table 55**, were empirically supported linking team effectiveness (column 12) to *SSRL* (column 11)*, self-efficacy* (column 9)*, early and often communications* (column 8) *and cognitive trust* (columns 3 and 6) respectively as shown in **Table 56**.

Teammate & Case	Past performance updated	Early & often communication	Citizenship (teammates helped me)	Cognitive conflict resolution	Initial Team trust	Team trust @ 4	Team trust @ 7	Team trust pre-SOWT
Bob, Case 1	High	High	High	Med.	Med.	Yes	NA	Yes
Evan, Case 1	High	High	High	Low	Low	Yes	NA	Yes
Dan, Case 1	High	High	High	Med.	Med.	Yes	NA	Yes
Frank, Case 1	High	High	High	Med.	Med.	Yes	NA	Yes
Andy, Case 2	High	High	High	High	Med.	Yes	Yes	Yes
Cathy, Case 2	High	High	High	Med.	Med.	Yes	Yes	Yes
Giles, Case 2	High	High	High	High	Med.	Yes	Yes	Yes
Harry, Case 2	High	High	High	Med.	Med.	Yes	Yes	Yes
Ira, Case 2	High	High	High	Med.	Med.	Yes	Yes	Yes
Rita, Case 2	High	High	High	Med.	Med.	Yes	Yes	Yes
Chi, Case 3	Low	Low	Low	Low	Med.	Yes	Yes	No
Dee, Case 3	Low	Low	Low	Low	Med.	Yes	Yes	Yes
Erik, Case 3	Low	Low	Low	Low	Med.	No	No	No

Table 58 Antecedents of team trust.

Teammate & Case	Past performance updated	Early & often communication	Citizenship (teammates helped me)	Cog conflict resolution	Initial Team trust	Team trust @ 4	Team trust @ 7	Team trust pre-SOWT
Alex, Case 1	High	High	High	Med.	High	Yes	NA	Yes
Cyrus, Case 1	High	High	Low	Med.	High	Yes	NA	Yes
Ben, Case 2	High	High	High	Med.	High	Yes	Yes	Yes
Don, Case 2	High	High	High	High	High	Yes	Yes	Yes
Ethan, Case 2	High	High	High	High	High	Yes	No	Yes
Finley, Case 2	High	High	High	Low	High	Yes	Yes	Yes
Adam, Case 3	Med.	High	Med	Low	High	Yes	Yes	Yes
Bill, Case 3	Low	Low	Med	Low	High	Yes	Yes	Yes
Farhaad, Case 3	Low	Low	Low	Low	High	Yes	Yes	Yes
Guru, Case 3	Low	Low	Low	Low	High	Yes	Yes	Yes

Table 59 Excluded data.

Teammate & Case	Coop Pre-study	Coop before SOWT
Alex, Case 1	Y	Y
Bob, Case 1	Y	Y
Cyrus, Case 1	N	Y
Dan, Case 1	N	Y
Evan, Case 1	N	Y
Frank, Case 1	N	N
Andy, Case 2	Y	Y
Ben, Case 2	Y	Y
Cathy, Case 2	N	N
Don, Case 2	Y	Y
Ethan, Case 2	Y	Y
Finley, Case 2	N	Y
Giles, Case 2	Y	Y
Harry, Case 2	N	Y
Ira, Case 2	N	Y
Rita, Case 2	N	N
Adam, Case 3	Y	N
Bill, Case 3	Y	N
Chi, Case 3	N	Y
Dee, Case 3	N	Y
Erik, Case 3	Y	Y
Farhaad, Case 3	Y	Y
Guru, Case 3	Y	N

Table 60 Patterns related to maintaining cooperative style preference before SOWT.

Regulator	Regulated	Citizenship frequency	No of days Cognitive conflicts resolved	*CCR helped Regulated*	Self-efficacy (domain knowledge)	Affective trust in regulator pre-SOWT	Cog. trust in regulator pre-SOWT	Con. trust in regulator pre-SOWT	Anxiety related Social Awkwardness	Coop as top CM style pre- study	CoRL in activity.
Alex	Cyrus	L	H	No	L	H	L	H	Down	Y	No
Alex	Bob	L	H	L	L	H	M	M	Down	Y	No
Cyrus	Bob	M	H	M	H	H	H	H	Down	N	Yes
Cyrus	Alex	H	H	M	H	M	H	L	Down	N	Yes
Bob	Alex	H	H	L	H	H	H	H	Down	Y	Yes
Bob	Cyrus	M	H	L	H	H	H	H	Down	Y	Yes
Dan	Evan	H	H	M	H	H	M	H	Down	N	Yes
Dan	Frank	H	H	L	H	H	M	L	Down	N	No
Evan	Dan	L	H	L	H	H	L	H	Down	N	No
Evan	Frank	H	H	M	H	H	M	M	Down	N	Yes
Frank	Evan	H	H	L	H	H	M	H	Down	N	No
Frank	Dan	H	H	L	H	H	H	H	Down	N	No
Andy	Ben	H	H	M	H	H	H	H	Down	Y	Yes
Andy	Cathy	H	H	M	H	H	H	H	Down	Y	Yes
Ben	Andy	H	H	M	H	H	H	H	Down	Y	Yes
Ben	Cathy	H	H	L	H	M	H	M	Down	Y	No
Cathy	Ben	L	H	L	M	L	L	L	Partial	N	No
Cathy	Andy	L	H	L	M	H	L	L	Partial	N	No
Don	Ethan	H	H	H	H	H	H	H	Down	Y	Yes
Don	Finley	M	H	H	H	H	H	H	Down	Y	Yes
Ethan	Finley	H	H	H	H	H	H	H	Down	Y	Yes
Ethan	Don	M	H	H	H	H	H	H	Down	Y	Yes
Finley	Don	L	H	L	M	L	L	L	Down	N	No
Finley	Ethan	M	H	L	M	M	M	M	Down	N	Yes
Giles	Harry	M	M	M	H	M	M	H	Down	Y	Yes
Giles	Ira	M	H	M	H	H	H	H	Down	Y	Yes
Giles	Rita	H	H	L	H	M	H	M	Down	Y	No
Harry	Giles	L	M	L	M	M	L	L	Down	N	No
Harry	Ira	M	M	L	M	H	H	H	Down	N	No
Harry	Rita	M	H	L	M	M	H	M	Down	N	No
Ira	Rita	M	H	M	H	M	H	M	Down	N	Yes
Ira	Giles	M	H	L	H	H	M	H	Down	N	Yes
Ira	Harry	M	M	L	H	M	M	M	Down	N	No
Rita	Giles	L	H	L	H	L	L	L	Down	N	No
Rita	Harry	L	H	L	H	L	L	L	Down	N	No
Rita	Ira	M	H	L	H	H	H	H	Down	N	No
Adam	Bill	M	L	L	M	H	L	H	Down	Y	No
Adam	Chi	M	L	L	M	H	M	M	Down	Y	No
Adam	Dee	M	L	L	M	M	M	M	Down	Y	No
Bill	Adam	L	L	No	L	M	L	M	Delay	Y	No
Bill	Chi	L	L	L	L	L	L	M	Delay	Y	No
Bill	Dee	L	L	L	L	M	M	M	Delay	Y	No
Chi	Adam	L	L	L	L	H	L	H	Delay	N	No
Chi	Bill	L	L	L	L	H	L	H	Delay	N	No
Chi	Dee	L	L	L	L	M	M	M	Delay	N	No
Dee	Adam	L	L	No	L	M	L	M	Delay	N	No
Dee	Bill	L	L	L	L	M	L	M	Delay	N	No
Dee	Chi	No	L	L	L	L	L	L	Delay	N	No
Erik	Farhaad	L	L	No	M	H	M	M	Delay	N	Yes
Erik	Guru	L	L	No	M	M	M	M	Delay	N	No
Farhaad	Erik	L	L	No	M	H	M	H	Delay	Y	Yes
Farhaad	Guru	L	L	No	M	M	M	M	Delay	Y	No
Guru	Farhaad	L	L	No	L	M	L	L	Delay	Y	No
Guru	Erik	L	L	No	L	L	L	L	Delay	Y	No

Table 61 Pattern search for self-efficacy, top CM style preference and CoRL.

A9 is an example of *necessary but not sufficient* condition for CoRL, see **Table 61**, as wherever *CoRL* by the regulator within SOWT session was *Yes* (column 12) the *self-efficacy of* the regulator was *medium or above* (column 6), but the reverse relation was not true. This was supported empirically as where the *self-efficacy* of the regulator was *low*, the *CoRL* was also not '*Yes'*. Other such conditions include propositions A10 linking affective and cognitive trust in the regulator (columns 7 and 8 respectively) and CoRL (column 12) as shown in **Table 61**.

8.3 Lessons learned by comparing COLT and SOLT cases

Table 62 lists the propositions organised similarly to **Table 55**. These propositions were only supported by two COLT cases. The shared goal oriented computer orchestrated teams in cases 1 and 2 were similar to student orchestrated teams in many ways already shown above. However, the differences between these two contexts meant that the computer orchestration in COLT cases expedited the development of self-efficacy, trust and team working skills compared to the SOLT case. This meant that COLT teams were more effective during SOWT than the SOLT teams due to the role COGLE played in coercing GWM, orchestrating many helpful interactions between teammates throughout the COLT sessions, remedial video support and allowing flexibility to overtake COGLE in Co and SSRL. This suggests that the theoretical replication based on the rival explanation of simply learning together (SOLT) does not support development of trust, self-efficacy and team working skills and attitudes in the same ways as COLT.

S. No.	Propositions	Evidence
A.	***Developing team working skills***	
A1	*High citizenship frequency may* lead to *CoRL*.	**Table 61**
A2	COLT sessions were more effective in *triggering elements of SSRL* in NT and NAT students alike.	**Table 56-Table 57**
A3	COLT sessions were more effective in maintaining the preference for *cooperativeness* in NT and NAT students alike.	**Figure 10, Figure 16,** Figure **22 & Table 60.**
A4	COLT helped improve *early & often communications* in both NT & NAT students.	**Table 10**, **Table 15**, **Table 22**, **Table 27**, **Table 34** & **Table 37**.
A5	COLT sessions were more effective in reducing the *social awkwardness* from early on in NT and NAT students alike.	
B.	***Team trust and self-efficacy development***	
B1	COLT sessions helped improve *self-efficacy* in NT and some NAT students.	**Table 10**, **Table 15**, **Table 22**, **Table 27**, **Table 34** & **Table 37**.
B2	COLT sessions were more effective in *building* evidence based *trust* quickly in NAT and NAT students alike.	**Table 58-Table 59**
C.	***Team effectiveness during SOWT***	
C1	*Majority cooperative CM style may* lead to *team effectiveness*.	**Table 56**
C2	*Affective and Conative trust* (medium or high) between teammates pre-SOWT activity leads to *team effectiveness*.	

Table 62 Propositions supported only by COLT cases.

8.4 Summary

This chapter reports on the similarities and differences between the COLT and SOLT sessions and their impact on SOWT sessions. Through this cross-case analysis I found evidence that supports many of the existing links predicted by the theoretical framework but also found support for new antecedents for some of the constructs. The qualitative nature of the data and the grounded theory based thematic analysis has allowed new insights into the interrelation between the constructs under study, which is be discussed in the next chapter.

Chapter 9: Discussion and Conclusion

In many PjBL instances, students are expected to *learn* and *work together* during and outside face-to-face timetabled sessions. In FC settings too, students are expected to engage with content individually outside the class but in class they are asked to *learn* and *work together* in interactive learning activities such as peer instruction or joint problem solving. However, cognitive load, social loafing, low self-efficacy, socio-communication challenges, power imbalance, conflicts and lack of training in collaboration are common criticisms that may render collaborative approaches such as FC and PjBL ineffective, inefficient or less inclusive.

I investigated how students acquire knowledge and team working skills using two cases of COLT (cases 1 and 2), making a literal replication, and one of SOLT (case 3) as a theoretical replication. First year NT and NAT students, who did not know each other, *learned together* in mixed teams within COLT/SOLT sessions prior to *working together* in the same team carrying out SOWT activities. The SOWT activities, allowed studying the transfer of skills developed in the COLT/SOLT sessions to the SOWT phase.

Chapters 4 to 8 presented the within and cross-case analysis and findings. Using *methodological and data triangulation*, each case (chapter 4-6) helped answer the research questions. Lessons learned from comparing different NAT student experiences across the three cases were presented in chapter 7. The necessary and/or sufficient conditions and lessons learned by comparing the three cases were empirically evaluated and presented in chapter 8. **Table 63** in this chapter lists a summary of all the lessons learned and key empirically supported propositions that emerged from chapters 7 and 8.

S. No	Lessons learned and empirically supported propositions	Chain of evidence
A	***Developing team working skills***	
1	COLT sessions were more effective in reducing the *social awkwardness* from early on in NT and NAT students alike.	**Table 10**, **Table 15**, **Table 22**, **Table 27**, **Table 34** & **Table 37**.
2	COLT helped improve *early & often communications* in both NT & NAT students.	
3	*Early and often communications* leads to successful SSRL	**Table 56**
4	COLT sessions were more effective in maintaining the preference for *cooperativeness* in NT and NAT students alike.	**Figure 10, Figure 16,** Figure **22 & Table 60.**
5	Internalising *shared goal-orientedness* during COLT helps *triggers SSRL* in COLT in NT and NAT students alike.	**Table 10**, **Table 15**, **Table 22**, **Table 27**, **Table 34** & **Table 56-Table 57**
6	*Shared monitoring* (enabled by COLT) triggers *SSRL*.	**Table 56-Table 57**
7	COLT sessions were more effective in *triggering elements of SSRL* in NT and NAT students alike.	
8	*Cognitive trust* leads to *SSRL*	
9	*Self-efficacy* leads to *SSRL*	
10	*High citizenship frequency may* lead to CoRL	**Table 61**
11	*Self-efficacy may* lead to CoRL	
12	*Affective and cognitive trust in the regulator may* lead to CoRL	
13	Regulator helping in cognitive conflict resolution leads to CoRL	
14	*Shared review* of their plans during learning together sessions *leads to SSRL*	**Table 56-Table 57**
B	***Team trust and self-efficacy development***	
15	COLT sessions were more effective in *building* evidence based *trust* quickly in NAT and NAT students alike.	**Table 58-Table 59**
16	*Past-performance updates, early and often communication and citizenship* leads to an increase in *trust* in teammates.	
17	*Cognitive conflict resolution* leads to an increase in *trust* in teammates.	
18	COLT sessions helped improve *self-efficacy* in NT and some NAT students.	**Table 61**
19	*Citizenship & resolving cognitive conflicts by the regulator* increased self-efficacy.	
C	***Team effectiveness during SOWT***	
20	*Majority cooperative CM style may* lead to *team effectiveness*.	**Table 56**
21	*SSRL* leads to *team effectiveness*.	
22	*Self-efficacy* leads to *team effectiveness*.	
23	*Early and often communications* leads to *team effectiveness*.	
24	*Cognitive trust (as well as Conative and affective trust in COLT)* between teammates leads to *team effectiveness*.	
25	*Leaving no conflicts unresolved* leads to *team effectiveness*.	
D	***Transfer of skills to SOWT session***	
26	Internalising *shared goal-orientedness* during COLT helps *transfer SSRL skills* in COLT & SOWT.	**Table 57**
27	*Shared monitoring* (enabled by COLT) triggers *SSRL* in COLT & SOWT.	
28	*Attempting un-orchestrated shared regulation of emotion, motivation and behaviour* during COLT sessions successfully leads to SSRL in COLT & SOWT.	

Table 63 Key lessons learned and empirically supported propositions.

They are organised as propositions and lessons learned relating to: *developing team-working skills, including cooperative CM skills; developing trust and self-efficacy; and transfer of these skills to SOWT sessions, which leads to team effectiveness*. **Figure 24** shows the modified interrelationships between the key constructs of the theoretical framework of **Figure 2**.

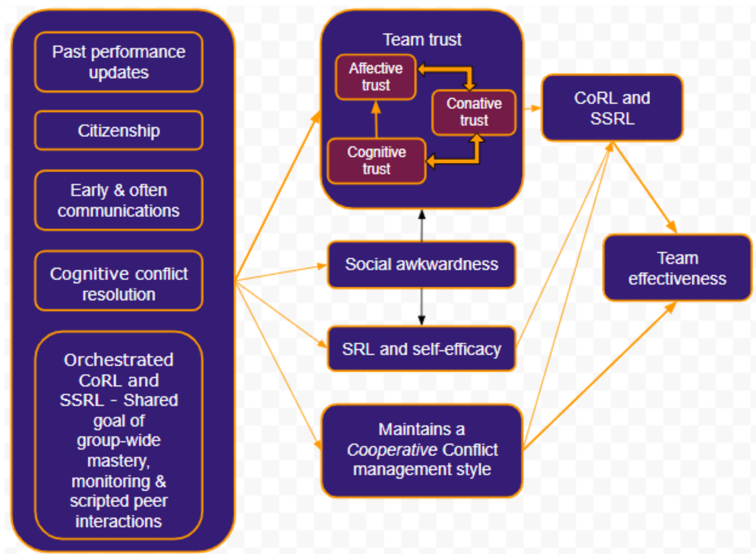

Figure 25 ***Modified theoretical framework.***

In discussing these results, I enfold extant literature and draw conclusions, as I answer each research question. I then highlight the contributions this research makes to practice, research methodology and theory. As the theme *"self-efficacy*" emerged inductively, this is presented first and separate to the research questions. However, it is also weaved into the narration in each answer and in particular RQ1, which is related to regulation skills including *self-regulation* a concept that in this study is linked closely with *self-efficacy*.

9.1 **Self-efficacy, Self-regulation, Trust, Co and Shared regulation of learning.**

9.1.1 Key findings and conclusions

The combination of the coercive *GWM* macro-script and the more flexible *PI* macro-script made NT and NAT students teach and learn from each other repeatedly until they achieved mastery and helped in developing self-efficacy and self-regulation skills. As shown by lessons learned #9 and #11 in **Table 63**, self-efficacy was important for un-orchestrated CoRL and SSRL during later COLT sessions and SOWT session. However, propositions 18 and 19 show the benefits of orchestrated CoRL and SSRL in COLT sessions in enhancing self-efficacy. This suggests that self-efficacy, self-regulation and co and shared regulation are important for each other and may develop in a cyclic fashion over time.

In COGLE, students first practiced CoRL and SSRL skills under the control of a script. After several attempts to overtake COGLE, a majority of NT students demonstrated CoRL and SSRL skills un-orchestrated during COLT and also in SOWT sessions. Cases 1 and 2 show that only if a team had a majority of self-confident students who also trusted each other (see answer to RQ1.2 in section 9.4), were they successful in achieving *GWM un*-orchestrated using their own plans and approach (i.e. showed CoRL and SSRL). Otherwise, they had to fall back on COGLE scripts to learn more and/or it triggered a shared review of their approach leading to alternate shared plans and trying again. Over time these opportunities allowed them to practice working together well.

The cyclic nature of self-efficacy, trust and regulation skills development goes well with the use of a flexible PI scripts when using a coercive GWM script. The PI script allowed students different levels of control and support when practicing these skills as they develop team trust and self-efficacy. This support and flexibility kept them motivated even in the face of frustrations due to the coercive GWM script. They developed self-efficacy and self-regulation skills over many mastery cycles. Students developed co and shared regulation skills as they became goal oriented as seen in propositions 1-14 (see section 9.2).

Students improved their self-efficacy in COLT more than in SOLT sessions. This was also validated by the difference in learning gains and themes related to knowledge acquisition. Furthermore, increasing difficulty in the content, lack of immediate feedback and no arbitration support in case 3 made students feel less confident in the topics, and cliques were formed. They did not see the goal as shared and not all students, including the autistic student, got much practice and success in *mastery, citizenship* and/or *cognitive-conflict resolution*. Unlike COLT sessions here, there was nothing to trigger and support the cyclic development. These students did not enhance their self-efficacy or self-regulation skills as a result or demonstrated CoRL and SSRL skills during SOLT or SOWT sessions. However, some NT and NAT students, although better prepared after the COLT sessions, also felt the need for more practice and interaction to boost their self-efficacy further before engaging in CoRL skills on their own.

9.1.2 Discussion of key findings and conclusions

The successful completion of GWM enhanced student's self-efficacy. Similar results have linked self-assessment with self-efficacy and SRL (Panadero et al., 2017). The direction of interrelation between Self, Co and Shared regulation is debated in the literature (Lund, 2019). In most studies CoRL by others is shown to help develop SRL and self-efficacy (Dillenbourg, 2002; Dillenbourg & Tchounikine, 2007; Malmberg et al., 2019). This relies on there being those who have CoRL skills and self-efficacy in each team. This study supports this link but it emphasises that as SRL skills and self-efficacy increase, students become more likely to do CoRL and SSRL themselves. Learning together before working together therefore helps effective team working here but orchestration of CoRL and SSRL helps trigger and support this cyclic development in SRL, CoRL and SSRL skills.

Students managed to overcome the initial frustrations and challenges posed to their *autonomy* by the *high penalty* in the coercive GWM script. The flexibility of the *peer-instruction script* compensated for this coercion. This helped with motivation and balanced threats to autonomy of the students from *over-scripting* (Dillenbourg, 2002; Dillenbourg & Tchounikine, 2007). Being motivated and goal oriented can be attributed to an increase in: their feeling of *autonomy* by practicing taking control from COGLE; their feeling of *relatedness* when they interacted as a team and helped each other and the perception of self-efficacy or *competence* as they mastered topics together in line with Self Determination Theory (Deci & Ryan, 1985).

In cases 1 and 2, practicing and explaining multiple questions to each other and immediate feedback in COGLE provided a *self-efficacy* boost to students. This worked like *arbitration* support, which gave students more confidence to *help each other* (*citizenship*) especially when resolving *cognitive conflicts* during the macro-script orchestrated CoRL. These were the *sufficient conditions* linked to self-efficacy. Similar results have been shown by other researchers who have studied self-efficacy (Adams, 2004; Koh & Frick, 2009; L. Wang et al., 2004).

Self-regulation is linked with self-efficacy only in the forethought phase (Puustinen & Pulkkinen, 2001; SAEZ et al., 2020). Achieving a simple goal of *GWM* and flexibility in the COGLE scripts motivated students, as explained by SDT (Deci & Ryan, 1985), to continue with the remaining two phases of SRL under COGLE or their own control, i.e. the execution and the evaluation phase, to correct their approach (Puustinen & Pulkkinen, 2001; Wecker & Fischer, 2011; Winne, 1997; Zimmerman, 1990), which gave students the exposure they needed to enhance their SRL skills.

9.2 RQ 1: How does learning together in small groups with neuro-typical and neuro-atypical learners affect their individual skills and attitudes relevant to team working and its transfer to un-orchestrated settings?

9.2.1 Key findings and conclusions

Lessons learned #1, #2, #4 and #5 in **Table 63**, show that when a combination of the coercive *GWM* macro-script and a more flexible *PI* macro-script orchestrated interactions within teams, NT and NAT students engaged in communicating with their teammates *early and often* during all COLT sessions. This reduced their *social awkwardness* much quicker compared to SOLT sessions. Repeated interactions, support and the high penalty associated with GWM goal, made students more *shared-goal oriented* and helped them maintain a *cooperative* CM style.

Propositions 3, 6, 10, 12, 13 and 15-19 show how COGLE orchestrated interactions and GWM helped develop team working skills as well as *trust* and *enhance self-efficacy* in students. **Figure 24** shows how team working skills, such as SRL, CoRL, SSRL are interlinked with trust and self-efficacy as shown by propositions 8-9 and 10-14, enabling students to overtake CoRL and SSRL from COGLE and internalise these skills over several COLT sessions. In contrast, cognitive trust and self-efficacy did not develop in SOLT sessions and as they were not shared goal-oriented, only partial team working and effectiveness was seen.

Both COLT and SOLT sessions saw students facing challenges during the learning phase. However, GWM script in COGLE coerced all teammates, using a high penalty, to work towards a shared goal of GWM. This created positive frustrations, which helped trigger SSRL as students were forced to reflect and correct their shared approach. Through orchestration of interactions and remedial videos students achieved mastery of knowledge and skills needed in SOWT sessions.

In conclusion, all teams in cases 1 and 2, had a majority of members with high self-efficacy who trusted others cognitively, whereas in case 3, a majority of teammates had low self-efficacy and low cognitive trust in their teammates. Repeated interactions within each session helped reduce social awkwardness from the start in cases 1 and 2. Furthermore, COGLE scripts were successful in triggering and internalising several elements of SSRL in an inclusive way. As a result, all teams in cases 1 and 2 showed a medium level of SSRL skills during SOWT. Whilst in SOLT sessions, self-efficacy and trust in teammates were delayed and not fully developed before SOWT session. This meant CoRL and SSRL were triggered very late during SOLT sessions and these skills were not practiced enough to be internalised, leading to clique formation and partial success in SOWT activities. Just learning together in SOLT did not result in as much success as in COLT.

9.2.2 Discussion of key findings and conclusions

The PI and GWM scripts orchestrated *multiple low level information sharing and high level transactive interactions,* which *helped them learn from each other's explanations* and also peacefully *resolve or defer any cognitive conflicts*. Information sharing, negotiations and turn-taking are crucial for joint problem solving skills development (Liu et al., 2016). The *peer-instruction* script works in ways similar to the ArgueGraph script (Jermann & Dillenbourg, 2003), pairing students with different answers and triggering the use and practice of higher level *argumentation skills.* Engaging in *cognitive conflict resolution* was responsible for *joint active participation* and *high level content processing*. Acquisition of domain knowledge and collaboration skills such as CoRL and SSRL relies on these processes as reported in other studies (Isohätälä et al., 2017; Liu et al., 2016; Radkowitsch et al., 2020; Summers & Volet, 2010; Volet et al., 2009). The transactive nature of the interactions in COGLE allowed students to practice CoRL, first under the control of COGLE and then independently. CoRL was a pre-cursor to shared regulation similar to findings of De Backer et al. (2017). The support COGLE orchestrated was crucial for sustained practice of regulation skills in the face of frustrations, challenges and increased cognitive load (Isohätälä et al., 2020; Sobocinski et al., 2017). The challenges posed by the high penalty and becoming shared-goal-oriented triggered some to *discover their own scripts* for CoRL and SSRL, which made them *overtake* the flexible *PI* script in COGLE and even the coercive GWM script towards the last sessions. Difficult topics made them return regulation control to COGLE for support. In other studies too, socio-emotional challenges have been shown to trigger CoRL and SSRL (Järvenoja et al., 2017; Näykki et al., 2017; Vuopala et al., 2019). This cyclical progress, before regulation skills are mastered and internalised, has also been reported by other researchers who have studied regulation in methodologically different ways using video recordings (Järvelä et al., 2019; Sobocinski et al., 2017). Furthermore, the automatic monitoring and positive climate during COLT sessions helped internalisation of monitoring elements of SSRL as displayed in SOWT session. Research on Group Awareness (GA) technologies has shown similar effects with socio-cognitive and socio-emotional monitoring (Bakhtiar et al., 2018; Näykki et al., 2017; Vuopala et al., 2019).

Key differences in this study are: COGLE provided support and worked alongside teammates to help them achieve GWM, making them goal-oriented; and the *frustrations* linked with students *guessing* or *burnout,* due to over-confident and vociferous students, along with enhanced group awareness due to shared automated monitoring triggered *shared planning* on how to achieve *GWM* by *shared working and reviewing*. Scripting all the elements of SSRL separately has been shown to not engage students in all the elements equally, possibly due to over-scripting (Näykki et al., 2017; Vuopala et al., 2019; X. Wang et al., 2017). COGLE scripts were able to successfully invoke shared planning and reviewing scripts in some students from their past experiences and for others it provided exposure for use in future mastery rounds. The challenges and frustrations actually triggered many, successful and unsuccessful, attempts to *overtake* CoRL and SSRL from COGLE by NT and NAT students alike. The *peer-instruction* script was successful here as it was flexible and allowed teammates to discuss questions with or without being orchestrated by COGLE. Whereas the GWM script was coercive, in that the students needed to master the topics by learning cooperatively and working together to achieve their mutual goal. Scripts that avoid being too specific (over-scripting) and are coercing have a greater chance of success (Dillenbourg, 2002; Dillenbourg & Tchounikine, 2007). In fact, Wang et al. (2017), show adaptable scripts were more successful than fixed scripts in triggering and transfer of various elements of SRL, which also has the same number of elements as SSRL. Over-confidence and un-warranted trust led to situations like burnout (see section 4.7.1 and 4.7.3) and correction in both self-efficacy and trust levels as a result. Unlike other studies, here, it was not required to script these SSRL elements separately. Support in the shape of pairing of students, tailored video and *arbitration of conflicts* in COGLE in conjunction with the coercive GWM script helped trigger shared planning, working and shared goal-orientedness in teammates during COLT sessions several times, helping students experience and internalise scripts, in line with SGT (Fischer et al., 2013). This was evident in the successful completion of SOWT activity even when orchestration was removed. Triggering SSRL elements like shared planning, working, reviewing and shared goal-orientedness were seen as important for effective team working (Miller & Hadwin, 2015). This link between team effectiveness and SSRL was empirically established in this study too. This study shows a new way to trigger several SSRL elements in an efficient and effective way.

ASD students are thought to be unable to do well in planning and organising due to possible executive function impairments (Hill, 2004; Ozonoff et al., 1991). However, COGLE was successful in internalising elements of SSRL in NAT students who participated in this study, in particular goal orientedness, shared planning and shared monitoring. CoRL skills on the other hand were not as well demonstrated by the ASD learners who used COGLE. Yirmiya et al. (1996), suggested that ASD students are unable to be manipulative and CoRL involves a much more active involvement in understanding what the other student knows, as purported by the Theory of Mind (Baron-Cohen et al., 1985; Ozonoff et al., 1991; Pellicano, 2007), as well as how to control their learning, behaviour, motivation and emotion. ASD students may be able to monitor and be goal oriented as this does not require active manipulation of the mental states of others (ibid). They may also be happy to work on a shared plan as directed by someone in the team but for reviewing together CM skills may need developing first. However, with enough practice NAT may also be able to engage in CoRL through practice and mastering new skills (Den Brok & Sterkenburg, 2015; Yang et al., 2017). In particular, as they all had made sufficient progress in many other antecedents to CoRL such as gaining trust of NT students, reduction in anxiety related to social awkwardness and enhancing their preference for *cooperative CM style* as shown in this study. More research is needed in this direction.

9.3 RQ 1.1 How does learning in small groups affect a learner's attitude to conflict management?

9.3.1 Key findings and conclusions

Lessons learned #20 (see **Table 63**) highlights the role in successful CoRL skills development and team-effectiveness of preference for and practicing of a cooperative CM style with your teammates as measured by *Style Matters* ® survey. Whereas, lessons learned #4 shows how COGLE was more effective in maintaining a cooperative style preference, using the coercive GWM and flexible peer-instruction scripts, than SOLT sessions.

9.3.2 Discussion of key findings and conclusions

Resolving cognitive conflicts has been shown to be beneficial for learning as well as team working skills in this and other studies (Ozturk & Hodgson, 2017). Those with a preference for *cooperative* CM style were able to *maintain* their preference whilst many others with preference for other CM styles *changed* their preference to *cooperative* or *compromising* styles. *Resolving cognitive conflicts* in each session helped practice, in-situ with the teammates, and internalisation of the *cooperative style*. This approach has been recommended by (Lencioni, 2006), but not implemented in any EE intervention before. The conflict arbitration and deferral features in COGLE meant that it provided safe practice for conflict resolution between the teammates from very early on and throughout the learning together phase. The motivation to engage in conflict resolution was provided by the flexibility in the peer-instruction script and the coercion of the GWM script. The simple and high level goal of GWM, enforced by a *high-penalty*, encouraged students to reach an agreement before moving forward (Dillenbourg et al., 1996). This encouraged early and often helpful interactions between the teammates, which encouraged open discussions and a preference for hearing each other's viewpoints. Developing and maintaining a *cooperative* CM style was enabled by COGLE as the students were supported in learning together with an over-arching goal of *GWM.* This not only enhanced their *self-efficacy* beliefs but also help build *trust* and relationships between each other such that they could *freely seek clarifications from each other* without being anxious or freely defer any unresolved conflicts until COGLE played them a relevant video to resolve the cognitive conflict. For nursing students these factors were found to determine CM skills preferences (Leever et al., 2010). In particular, those with *self-efficacy* in negotiations can reduce the resolution rate positively (Brett et al., 1996; O'Connor & Arnold, 2002). In case 3, where COGLE was not used, all students saw a decrease in their *cooperative style* score on the *Style Matters* ® survey over the course of the study. The only exception was the one ASD student who increased their *cooperative style* score. In case 1 and 2, the trends for both NAT and NT students was towards maintaining or increasing their *cooperative style* score. Since, cooperation only works when all are involved, COGLE can achieve this better than un-orchestrated learning together. Therefore, COGLE can be seen as an inclusive learning together intervention from this perspective.

9.4 RQ 1.2. How does learning together in small groups affect a learner's development of trust in their teammates?

9.4.1 Key findings and conclusions

Lessons learned #1, #2, #4 and #15-#17 (see **Table 63**) show how COLT sessions help build trust quickly within teams. The coercive GWM script and the flexible PI script ensured that there were many helpful interactions between students from the start, which helped reduce social awkwardness and helped build trust. In addition, automated monitoring in COGLE enhanced awareness of the progress each individual and team made towards their shared goal of GWM. When teammates resolved cognitive conflicts together, this was instrumental in building their trust in each other. Difficult topics were supported with remedial videos. When these were not watched by students or were not found relevant, the gap in knowledge affected the trust quickly, showing the fragility of trust in student teams.

NAT students were able to correct (reduce or enhance) their trust in others from start to finish of the COLT sessions. Thanks to various interactions orchestrated by COGLE, NT students were able to trust other NAT as well as NT students in cases 1 and 2. However, in SOLT sessions, trust was missing, in particular cognitive trust which dropped over time. The NAT student in SOLT sessions was the only student who enhanced trust in teammates even when their teammates reduced their trust in him and other NT students as time passed. In SOLT environment, in case 3, the interactions were not as balanced or frequent and cognitive and interpersonal conflicts that emerged organically were often left unresolved. This led to clique formation. In SOLT sessions, students helped one another but their knowledge levels did not allow these helpful intentions to convert into cognitive trust. It was a feeling of *psychological safety*, instead, that took hold of all teammates by the 5th session. This represented the awareness that *all teammates were in the same boat,* that none of them knew the topic better than the others. This led to a gradual reduction of social awkwardness between the students and triggered increased interactions between them. However, cognitive trust dropped and never came back up in this case. After learning together for 7 sessions, the affective and conative trust were fairly developed and stable.

The three cases show the importance of different facets of trust in team working and in particular cognitive trust for team effectiveness. Therefore, COGLE was very useful as an inclusive educational intervention that led to effective team working by quickly developing all facets of trust between teammates through multiple interactions, increasing group-awareness, and cognitive conflict presentation and resolution.

9.4.2 Discussion of key findings and conclusions

This work shows how trust can be influenced both positively and negatively in real-time. Updates to the knowledge of past performance of the teammates after every question COGLE asked and when sharing team progress data towards the GWM goal helped build trust. Knowledge of past performance is a known antecedent of trust (Ebert, 2009; McAllister, 1995). Likewise, helpful interactions, triggered by GWM goal and penalty, between teammates can be seen as citizenship acts that create a positive climate in the team during COLT sessions. Furthermore, triggering early and often communication between teammates can be seen as increased interaction frequency. Both of which are also known to help build team trust (e.g., J. C. Anderson & Narus, 1990; McAllister, 1995; R. M. Morgan & Hunt, 1994). Something that has not been shown by any other study, but was found here, is the positive impact of resolving cognitive conflicts together on building team trust.

Compared with NT, most ASD students trust others too quickly due to them not being able to pick up on social cues relating to distrust (Yi et al., 2013, 2014). This can lead to poor team effectiveness as shown in Case 3. COGLE, with its real-time *past performance*, *group awareness information* and *pairing* of students which clearly indicate who is correct and who is incorrect, made it possible for ASD, ADHD and NT students in case 1, to correct initial high trust to moderate where there was evidence to reduce trust. Yang et al. (2017) also showed that non-social cues can support ASDs to distrust others where needed. In case 2, the ASD student had already developed coping strategies to defer trust development, through prior interventions and experience, and they too were able to develop trust, like other NT students, where there was evidence. The ADHD student was also able to do this. Equally, the *high interaction frequency* between NT and NAT, supporting NAT students in turn-taking, reducing their social awkwardness and anxiety helped develop the trust of NT students in NAT students in both COLT cases. In contrast, limited socio-communication in SOLT led to teammates not trusting the ASD student, similar to Grandin (2008). Additionally, due to the absence of non-social cues and difficulties in picking up social cues, the ASD student in case 3 was unable to correct his initial high trust in others even when NT students were able to reduce their cognitive trust in all other teammates including the ASD student. It was no surprise that this high trust was misplaced and one sided, which did not result in effective team working.

9.5 Contributions to theory, practice and research methodology

A key contribution to the theory of regulation of learning in CSCL settings, is that it shows that the *motivation* and *positive frustrations* caused by a combination of a coercive yet simple *GWM* script and flexible *peer-instruction* scripts, together with various support mechanisms, can trigger and reinforce existing planning, monitoring and reviewing elements of SSRL without the need for specific and separate external scripts for these elements. This is a useful result as it shows that there is no need to script shared planning, shared monitoring and shared reviewing as the high penalty and group-awareness features in COGLE related to the GWM goal triggers these behaviours as natural responses to the challenges from COGLE use. This approach is therefore efficient, effective and yet inclusive and novel compared to previous studies (Näykki et al., 2017; X. Wang et al., 2017). The SOLT case showed that just learning together, a rival explanation, was not sufficient for team effectiveness and for acquiring Co and SSRL skills. This reinforces the role COLT plays.

Another contribution to the theory of regulation of learning is demonstrating the interrelationship between psychological constructs such as trust and self-efficacy and triggering CoRL, SSRL and team effectiveness. These were investigated for the first time as the importance of psychological-safety and trust, cognitive conflict and self-efficacy in the development of CoRL and SSRL skills within face-to-face student teams has only been mentioned as a study limitation (i.e. not been studied) or been argued to be potentially important only in the discussion sections in several different studies (Bakhtiar et al., 2018; Hurme et al., 2019; Isohätälä et al., 2020; Kim et al., 2018; Näykki et al., 2017; Vuopala et al., 2019). The cyclic nature of trust and self-efficacy development and SSRL skills development suggests that one is important for the other. In particular, self-efficacy and trust in you makes it easier to regulate others. Additionally, no other higher education study has investigated the *inclusiveness* of *learning together* and / or *working together* sessions in a scripted intervention to study regulation of learning within teams of NT and NAT higher education students. This study found that NAT students took part more effectively in SSRL as compared to CoRL and needed more time to enhance their self-efficacy, before feeling ready for CoRL.

Contributions to the theory around trust are detailed next. COGLE shared the *real-time past performance* updates of all individuals with their teammates in a non-intrusive (automatic), non-negative (controlling/suspicious) and balanced (same for all) way. This real-time *monitoring* made possible by COGLE is related to the already known antecedent of trust, *past performance* (Ebert, 2009; McAllister, 1995) and the added *fair* (equal/non-intrusive) and *real-time* nature being identified as a contribution of this work. Triggering early and often communication adds the importance of early communication to the interaction frequency as an antecedent to trust. Another contribution of this research is that resolving *cognitive conflicts* was a *sufficient condition* to help build trust between teammates. Together teammates *resolved* many *orchestrated cognitive conflicts* in *a supported* and *calm way*. Ozturk & Hodgson (2017), suggests that resolving interpersonal conflicts in groups can lead to several improvements such as: learning, quality of output of group-work and group-working itself. This study is the first to show that deliberately orchestrating and supporting *cognitive conflicts* presentation and its *resolution* is a safe, effective and sufficient condition to build trust, as interpersonal conflicts, although helpful when resolved, can be detrimental to performance if left unresolved (Karn & Cowling, 2008; Neumeyer & McKenna, 2014; Neumeyer & Santos, 2020). This is also the first time where trust between NT and NAT students developed within 2-5 learning together sessions compared with 8 weeks, where details of disability in the participants was not presented (Webber, 2008). Such speed in building trust was only possible due to so many antecedents, and in particular the cognitive conflict resolution, being orchestrated by COGLE. NAT students who can be over-trusting, were able to correct their trust or those with lower trust were able to enhance it through orchestrated interactions. Equally, trust of NT students in NAT students developed in a similar way to trust in other NT students. This is a remarkable finding related to inclusive education.

De Backer et al. (2015), presented their research on reciprocal tutoring, which can be seen as similar to *peer-instruction,* where they also saw a change in regulation behaviour around 4 weeks into the study as students resolved socio-cognitive conflicts together alongside many other antecedents also being present. However, they did not study the interrelation between trust and the socio-cognitive conflicts students resolved together. Trust developed during the learning and working together sessions can be fragile and can quickly be rebuilt in a cyclic way just like the cyclic nature of development of regulation skills. Trust and regulations skills were shown here to have an interdependent relationship when observed over a longer period of time.

In terms of contribution to practice, the results here can be used to prepare teams of NT and NAT students to develop content knowledge as well as team working skills, in situ, in an effective and efficient manner. Therefore, COLT makes constructivist approaches less resource intense, thereby reducing the risk of losing management support for PjBL and FC within engineering schools.

In terms of contribution to research methodology, since the cyclic nature of regulation skills development was captured well by using the SSRL survey, this supports the use of surveys administered daily as an alternative to video-based approaches common in the SSRL literature, which should make the research process a lot simpler.

9.6 Future work

Given the impact of COLT systems such as COGLE on developing trust between learners, future studies should investigate using it or other such systems within Massively Open Online Courses (MOOCs). Running online teamwork in an effective, inclusive and efficient way, remains an understudied area and COLT has been shown to be effective in enhancing learning gain, self-efficacy, trust and regulation skills.

Developing trust and self-efficacy were found to be important for SRL, CoRL and SSRL in this study therefore other combinations of coercive and flexible scripts, other than GWM and PI, are needed to extend the transferability of COGLE to a wider range of topics and settings. A key finding of this study is that GWM was a simple shared goal to script and there was no need to script different stages of SSRL. New ways to help internalise some simple shared goals that drive teammates to learn and work together should be searched and investigated, in particular for topics where MCQs cannot be used.

In constructivist settings where cooperative learning together using COLT before collaborative working together in SOWT activities, is not possible or not preferred, simple facilitation scripts that aim at orchestrating teams to align to a shared goal may help start the cycle regulation and trust building within the team. For example, when designing solutions for PjBL projects, teammates could propose their design goals and discuss them together before voting on a much more inclusive set of design goals that becomes the team’s shared goal. This can be done on several occasions during the starting phase to collectively review and modifying it to ensure that they are all contributing towards it and that they all feel included and trusted. This has the potential for triggering planning, reviewing and monitoring scripts that they may already have developed.

Findings on the NAT students studied here suggest that they need more time for developing self-efficacy, hence interventions that focus on this will help improve results in teams with NT and NAT students working together. Likewise, COGLE has less impact on developing CoRL skills in NAT students than developing SSRL and SRL skills. Further studies should investigate impact of scripts that trigger and allow practice of this skill more. Despite the need for further research in this area, this study is a much-needed step towards understanding how to create inclusive, constructivist approaches to EE.

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