Assessing Ability Emotional Intelligence in a Collaborative Problem-Solving Context: A Case Study in a Primary School in Ireland

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List of Abbreviations and Acronyms

AEI	Ability Emotional Intelligence
ATC21S	Assessment and Teaching of 21st Century Skills
CHC	Cattell-Horn-Carroll Theory of Intelligence
CPS	Collaborative Problem Solving
EI	Emotional Intelligence
MEMA	Multimedia Emotion Management Assessment
MSCEIT	Mayer-Salovey-Caruso Emotional Intelligence Test
OECD	Organization for Economic Cooperation and Development
PISA	Program for International Student Assessment
SJT	Situational Judgement Test
STEM	Situational Test of Emotional Management
STEU	Situational Test of Emotional Understanding
TOPI	Test of Personal Intelligence

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Abstract

Assessing Ability Emotional Intelligence in a Collaborative Problem-Solving Context: A Case Study in a Primary School in Ireland

Deirdre Dennehy

The modern workplace requires a complex set of competencies, often termed transversal skills, which transcend knowledge-based skills. The assessment of transversal skills has become a particularly pertinent issue in educational and workplace settings as these skills can be difficult to measure and often require more authentic performance-based tasks than traditional paper-based tests. The research conducted for this PhD study focuses on the assessment of Ability Emotional Intelligence (AEI) through Collaborative Problem Solving (CPS) contexts. AEI is an individual's ability to understand, use and manage their emotions to solve problems in everyday life (Mayer, Caruso & Salovey, 2016). Similar to other intelligence theories, it is proposed that it develops over a lifetime and can be improved with practice and instruction. Those with well-developed AEI tend to have high quality social interactions, are more competent collaborators and better communicators.

The present research explored the types of emotional abilities that are observable and assessable when children were working on CPS tasks involving Lego Spike Prime Education materials. Using a qualitative case study design, 26 primary school students between 10 and 12 years of age were video recorded in a classroom in Ireland as they worked collaboratively on completing the Lego tasks. Findings indicate that although AEI can be observed and assessed while working on CPS tasks, group dynamics can impact the types of abilities that can be observed. The outcomes of this study will help to inform future assessment research in the area, as well as assisting educators in developing the transversal skills needed to support learning during the primary school years. Study outcomes will also have implications for the assessment of AEI beyond primary education and in contexts beyond formal education.

Chapter One: Introduction

1.1 Organisation of Chapter

This research explores the assessment of Emotional Intelligence (EI) using a novel approach. Developments in technology mean that society has substantially changed in the last number of decades. Historically, the purpose of many educational systems and curricula was to transfer core foundational knowledge to the individual (Grundy, 1987). However, as access to knowledge has become commonplace with technology, this landscape has shifted. As highlighted by De Ruyter, Oades and Waghid (2020), educational systems today generally aspire to equip students with the skills needed for lifelong flourishment and wellbeing in an adapting and changing world. Hence, individuals require skillsets and adaptive expertise that extend basic knowledge acquisition. These skills have become known as transversal skills (Greiff & Dörendahl, 2021). A central rationale governing this study is that there is a continued need for the development and assessment of transversal skills, focusing on the area of EI. It explores if EI abilities can be observed and assessed within a performance-based transversal skills task. This is a novel approach that has not been previously studied.

This chapter describes the key issues that must be addressed when undertaking this type of exploration. Two main challenges are encountered when studying EI. Firstly, there are two conceptualisations of the construct, termed the trait and ability models respectively. The trait model views EI as a stable dispositional trait (see Petrides & Furnham, 2001), whereas the ability model conceptualizes EI as an alterable and developing intelligence (Mayer, Salovey & Caruso, 2016). A sizeable challenge is therefore choosing the ‘correct’ or ‘authentic’

model from which EI can be assessed. A rationale for the selection of the ability emotional intelligence (AEI) model is presented in the initial sections of this chapter.

Secondly, assessment of EI continues to be dependent on text-based psychometric tests. In the real-life contexts of work or school, EI is not used in isolation but combined with many other types of skills to solve a problem. Therefore, these tests are somewhat limited in that they do not assess the use of EI with other types of skills, for example, cognitive problem-solving. Additionally, text-based tests do not capture the dynamics of real-life interactions between individuals. This research topic and problem are explored in the early sections of this chapter.

One group of transversal skills that has received significant attention in the literature is Collaborative Problem-Solving (CPS). As described by Griffin and Care (2015), CPS requires individuals to solve problems collaboratively in groups. Thus, both collaborative and problem-solving skills must be used simultaneously. The domain of CPS assessment is an example of how different types of skills or abilities can be assessed concurrently. The final sections of this chapter discuss the potential that CPS assessment modalities could provide for the exploration of AEI assessment, as well as the challenges that are posed by this kind of assessment design.

1.2 Research Topic

An individual's EI is significant as it has been linked with many areas of positive social functioning, including overall psychological well-being, job satisfaction, engagement and organisational commitment to one's occupation and even academic performance (e.g., Brunetto et al., 2012; Chew et al., 2015; Carmeli et al., 2009; Lopes et al., 2009). A

substantial body of research also demonstrates that EI can be enhanced and developed through training and instruction (e.g., Ruiz-Aranda et al., 2012; Slaski & Cartwright, 2003). The all-round positive consequences for an individual with high levels of EI mean that it is a construct that could be of equal interest to educators, government bodies and multi-national organisations. Although EI assessment has amassed considerable attention in the literature since it was first put forward by Mayer and Salovey in 1990, there is lack of clarity around defining the construct. The lack of transparency becomes exacerbated from the fact that two discrete conceptualisations of the construct have come into existence, i.e. the ability model and the trait model. As these terms imply, the ability model positions EI as an adaptive intelligence which can potentially develop over time (Mayer & Salovey, 1997), while the trait model views it as a personal disposition (Petrides & Furnham, 2001). The presence of multiple frameworks and definitions within each of these two central theories creates further ambiguity.

Fiori and Vesely-Maillefe (2018) posit that the most widely accepted definition of AEI is rooted in the ability model proposed by Salovey and Mayer. In this interpretation, AEI is defined as "the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions" (Salovey & Mayer, 1990, p.189). In short, AEI is considered the ability to understand and regulate emotions; as a malleable type of intelligence, it can be shaped and guided by training. A differing perspective is offered through the lens of trait EI. In Petrides' influential trait EI model EI, is derived to be made up of fifteen emotion-related facets scattered across personality dimensions and clustered under four factors, namely, well-being, self-control, emotionality, and sociability (Petrides, 2009). In this context, EI is thought of as a more stable component of an individual's temperament and behavioural tendencies. The question is

raised therefore, as to whether these two conceptual approaches should be considered as separate areas entirely or viewed as two inter-related models.

From a theoretical perspective, the differences between the models are apparent. This divergence has also been reflected in an extensive meta-analysis carried out by Van Rooy, Viswesvaran and Pluta (2005), who reported that the correlation between the ability and trait models was weak (r = .12). Additional results indicated that AEI models had an overall correlation of r = .34 with general intelligence measures, in comparison to an r of .12 with the Big Five Personality Factors. In contrast, correlations of greater than r = .3 were found between trait EI models and the Big Five personality traits while a correlation of r = .11 was found between trait EI models and measures of cognitive ability or general intelligence measures. These results suggest that trait EI is interlinked with an individual's stable personality whereas AEI is connected to cognitive skills. Consequently, Van Rooy and his co-authors argue strongly that ability and trait EI should be considered as separate constructs. A similar endorsement was put forward by Conte (2005), who, in a review of the literature on EI, reported that mixed and trait models are more strongly related to personality than existing general intelligence tests. These findings mean that for the most part, the ability model is favoured by researchers across the majority of disciplines, as it as "it purely uses cognitive ability in processing emotions and is scientifically proven" (Kanesan & Fauzan, 2019, p.241). As an intelligence, it can be shaped and developed, meaning that is it is of more relevance to educational contexts and workplaces who are seeking to improve the skills of students and employees.

Both models have also generated debate about the genetic or hereditary nature of EI and the long-term patterns of continuity and change in EI remain somewhat unexplored. Across personality theory, there is evidence for stability in personality trait differences, sustained over decades (Harris et al., 2016). As trait EI is situated within the personality space, this

would suggest that although trait EI is relatively stable across the lifespan, the relative strength of that stability is unknown. In a review of literature examining trait EI, Petrides et al. (2016) describe how the estimated heritable proportion of global trait EI is about 40%, which is very similar to the estimates obtained for other personality traits. Similar ambiguity exists regarding the hereditary nature of AEI. Mayer and Salovey (1990) argue that, in keeping with other intelligences, AEI can develop across the lifespan, albeit with reasoning abilities considered innate. This hypothesis has been both supported and rejected. Several studies found that older individuals performed significantly better on all branches of the MSCEIT, with correlations ranging from .10 to .30 (see Extremera et al., 2006). Others did not find any significant relations between age and MSCEIT scores (Farrelly & Austin, 2007). There is a lack of clarity, therefore, across both models about the developmental trajectory of EI as an individual ages across the lifespan.

An additional frequently cited criticisms of the trait model is the wide range of traits that are included as components of the theory. For instance, Locke (2005) argues that trait EI has become "so broad and the components so variegated…it is no longer even an intelligible concept" (p.426). A further critique of the trait model by Locke (2005) is that is does not provide any new information that cannot be supplied by a measure of the Big Five personality traits. Similarly, Jospeh et al. (2015) reported that correlations between trait EI measures and supervisor-rated job success were void when ability EI, self-efficacy, personality and cognitive ability were controlled for. In contrast, Joseph and Newman (2010) studied the validity of EI as theorised in the ability model. Findings strengthened support for this framework as a sequential relationship was demonstrated between AEI elements (emotion perception, understanding and regulation) and job performance. Trait EI is typically assessed using self-report instruments and a multitude are in existence. Examples include the Emotional Quotient Inventory (EQ-I, Bar-On, 1997), the Trait Emotional Intelligence

Questionnaire (Petrides, 2001) and the Schutte Emotional Intelligence Scales (Schutte et al., 1998). As reported by Goldenberg, Matheson and Mantler (2006) many of these tests lack reliability and validity. The central reason for this lies in the nature of the self-report item which are susceptible to response-bias from individuals.

With these considerations in mind, the AEI model is selected as the model of choice for this study. Put briefly, AEI is conceptualised as consisting of four fundamental branches or areas; managing emotions, understanding emotions, the ability to perceive emotion and facilitating thought through emotion. Within these four branches are several specific abilities that lend themselves to the successful use of emotions in everyday life.

1.3 Research Problem

Performance-based tests are typically used for the assessment of AEI. In these measurements, participants are presented with a number of items related to one or all of the emotional domains of the AEI model. Although criticisms of this evaluation exist, the most widely used and reputable measure of AEI is the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT; Mayer et al., 2003). A significant positive of these types of tests is that they remove the limitations of the self-reporting nature of trait EI measurements. However, the scoring of performance-based items that are related to emotions is a challenge. As argued by Fiori et al. (2014), the issue of how to identify a clear correct answer in an assessment of AEI, during which an individual can bring various frames of reference and background experience to a question is difficult. By in large, researchers depend on consensus scoring (in which the correct answer is deemed the item chosen by the largest number of participants) or expert judgement (in which a group of psychologists determine the correct answers). Consensus scoring has been criticised by researchers such as Fiori et al. (2014), who demonstrated that this type of scoring did not appear to have strong measurement precision

for distinguishing average from high AEI individuals. On the other hand, the subjective nature of expert scoring also raises concerns of validity.

Regardless of the type of test used, standardised paper-based tests remain the predominant means of assessing AEI. This dependence raises a key problem which faces the area of AEI assessment, that is the distinction between possessing a certain level of AEI and subsequently enacting AEI in any given context. Mayer et al. (2016) accept that there is no assurance that an individual who has a high-test score of AEI on the MSCEIT will implement these skills when faced with certain situations in their personal or work life. This links to another concern outlined by Salovey and Mayer in their original work in 1990. Although AEI is considered as positive construct for an individual to hold, Zeidner et al. (2008) express concern that those with high AEI may also use their skills to manage or manipulate other's emotions to their own benefit and to the significant detriment of the other person. In line with this argument, if using AEI measurements for employment selection purposes, caution must be taken when employing these types of text-based assessments. Their reflection on an individual's behaviour in the workplace or in social settings may not be as predictive as hoped.

The need for new types of AEI assessments becomes apparent when considering the limitations of text-based tests. In its essence, AEI is a social collaborative construct which is only tangible when interacting with others. Assessing AEI alone presents a very limited snapshot of an individual. Today's society and workplace regularly require individuals to use collaborative and problem-solve in dyads or in groups. Indeed, many studies have identified AEI as significant when interacting with others in the workplace. For example, in a study of 193 employees across different organisations, Kundi and Badar (2021) investigated the relationship between interpersonal conflict at work and the tendency to engage in counterproductive work behaviour (CWB). Using survey data, they reported a moderating effect of AEI on the tendency to engage in CWB when faced with interpersonal conflict in

the workplace. Other studies also have also established a correlation between measures of AEI and successful conflict resolution in group or work settings (e.g., Barczak et al., 2010; Jordan & Troth, 2021). Therefore, an individual's AEI is not demonstrated in isolation. For the vast majority of contexts, the individual is utilising their AEI in the midst of other crucial skills, which could include problem-solving abilities, creativity, communication or reasoning. It is important that as the domain of AEI assessment progresses, it reflects the needs of contemporary society. The need to ingrain AEI assessments within performance tasks lies within a wider environment of changing assessment types in a technological era. This research problem lead the design of the current study and helped to form the research questions. The importance of assessing AEI in the context of transversal skills assessment will be discussed below.

1.4 Emotional Intelligence in the Context of Transversal Skills

AEI assessment is significant against the background of global interest in transversal skills assessment which were previously termed 21st century skills. Munro (2017) argues that transversal skills become increasingly vital as advances in digitalization and globalization have led to fundamental changes in the global economy. As Artificial Intelligence (AI) comes to be commonplace, there are concerns amongst academics like Sahota and Ahsley (2019) and Smids, Nyholm and Berkers (2020) that these digital trends will leave many unprepared for the future workplace. Unlike 21st century skills which were specifically related to the workplace however, transversal skills refer to key abilities and aptitudes which are transferable across all areas of modern life and are pertinent to overall successful functioning in a digitalised society (Mainert et al., 2015). These skills give the individual the ability to manage school, work or even social problems. Historically, the type of knowledge that was esteemed amongst humanity was content and knowledge-based. Yet in the past number of

decades, various careers have transitioned from manufacturing to services. As recognized by the Organisation for Economic Co-operation and Development (OECD, 2019), jobs in the traditionally popular areas of medicine, engineering, the financial sector and law have become multi-faceted, with increased accountability and the need for more complex skills. An overarching rationale directing this research is that there is a further need for the development and assessment of transversal skills.

Transversal skills are a fusion of both cognitive and social domains. Cognitive skills have become known as 'hard' skills, as they are relatively straightforward and clear-cut to assess. On the other hand, skills such as perceiving, managing and negotiating the emotions of oneself and others, as in AEI, are components of the 'soft skills' area. As highlighted by Breaugh (2008), soft skills are notably difficult to test as they are latent and not clearly measurable constructs. Elements of the AEI model overlap with many of the soft skills included within the multiple transversal skills frameworks in existence. Thus, it may stand that a standardized measure of AEI could assist in the assessment of an individual's social competences in school or at work. However, as mentioned previously, this type of assessment falls short for a number of reasons. Modern society requires individuals to implement these hard and soft skills concurrently, often in situations which are rapidly changing and frequently involve technology. For that reason, traditional forms of assessment do not lend themselves well to the assessment of these complex skillsets. A challenge lies in the creation of a type of AEI assessment that can effectively assess both cognitive and soft skills simultaneously.

Although these kinds of assessments remain in their infancy, there are a number of evaluative forms which offer the possibility of measuring both 'hard' and 'soft' skills. For example, role plays and group exercises lend themselves to the holistic evaluation of an individual's skillset, including EI (Joshi et al., 2017; Shute & Rahimi, 2017). Role-play permits the

assessor to observe the individual engage their skill set in a setting that they would potentially face in their educational and/or work lives. Group exercises are similar to role plays but individuals typically work together to solve a problem, hence requiring them to exhibit skills such as negotiation, collaboration and problem-solving (Goodstein & Prein, 2006). Despite the assessment opportunities offered by these modalities, both are a time-consuming means of evaluating individuals. In a review of role-play and simulation assessments, Montenegro et al. (2017) outlined the significant cost involved due to the considerable expertise that is needed for the creation of appropriate situations, materials and the behaviour rating scale. Other costs incurred include the payment of trained assessors and other role-players (Montenegro et al., 2017). On the other hand, situational judgement tests, in which test-takers respond to hypothetical scenarios, are much less expensive to administer as the applicant is provided with a hypothetical task and a list of five to eight possible solutions (Breaugh, 2008; Polyhart, 2006). Scoring can be electronically completed and can therefore be distributed to a large population. According to Breaugh (2008), the limitations of this type of assessment lie largely in the argument that they do not adequately reflect the complex nature of human interactions. Optimistically, swift developments in technology offer the possibility of creating assessment environments that are less time-consuming and laborious.

Given its classroom-based context, the study is directly relevant to how AEI might be assessed during the years of primary schooling. However, it's significance is not confined to this context alone. Support for the conduct of this study came from a grant from Prometric Inc. to the Centre for Assessment Research Policy and Professional Practice (CARPE) at DCU. As a global assessment services provider of credentialling (license and certification) tests, decision makers at Prometric are interested in how AEI might be dovetailed with existing and/or new assessments within that field (especially medical assessments). The issue

of the study's relevance to workplace assessments will be addressed in the final chapter of the thesis.

1.5 Technological Advances in the Assessment of Transversal Skills

Advances in digital-based assessments present a conceivable breakthrough in the area of complex skills assessment. With developments in Artificial Intelligence (AI) and virtual reality, there is the possibility of recreating real-life situations in a more time-effective manner (Qian & Clark, 2016; Sourmelis et al., 2017). As recognised by Qian and Clark (2016), the capabilities of virtual-reality assessments have yet to be explored to their maximum capacity. Although an exciting time, the use of digital-based assessments for transversal skills testing continues to be a challenging field of exploration. Significant change naturally incurs substantial expense (Shute & Rahimi, 2017). Advances in technology, although remarkable, have arguably not yet found a way of entirely duplicating the subtleties of social human interactions (Qian & Clark, 2016). Technological advances in the assessment of many transversal skills, including AEI remains slow. For instance, McCann et al. (2016) developed a multimedia emotion management assessment (MEMA) and compared it to the text-based assessment of emotion management used in the MSCEIT. Instead of having to read a scenario and selecting appropriate responses, participants watched short videos and responded by choosing an item from a number of options presented. Results indicated that this type of test was valid and could begin to bridge the gap between text based and digital-based EI assessments. However, there is still significant further research required before a transition to assessing AEI using advanced technology could take place comfortably. It is possible that technological advances in the evaluation of other transversal skills could benefit the evaluation of AEI in a more sophisticated manner.

1.6 The Role of Collaborative Problem-Solving in the Current Study

The vast network of transversal skills means that some skillsets have gathered a great deal more significant global attention than others. Naturally, those that have been included within international projects have also become the focus of researchers worldwide. Due to its selection for inclusion within the Program for International Student Assessment (PISA) and the Assessment and Teaching of 21st Century skills Project (ATC21S), one construct which has amassed sizeable attention through its digital assessment, is that of Collaborative Problem Solving (CPS). CPS differs from individual problem solving due to the communicative process that is involved. Chen et al. (2019) outline that collaborative procedures comprise the soft skills components of the construct, whereas the problem-solving elements require cognitive skills.

There are a number of reasons for why CPS was selected as the medium through which AIE assessment could be explored. Each is unpacked in Chapter Two and Three. For now it is worth noting that firstly, there is a strong theoretical overlap between the abilities of AEI and the collaborative skills of CPS. Thus, it is likely that CPS contexts also elicit the use of AEI in individuals. Additionally, the area of CPS assessment has received ample international research interest. Researchers such as Hesse et al. (2015) and, more recently, Sun et al. (2020) have provided significant guidance on how to successfully assess the dual components of CPS, much of which could be used in the design of this study. Furthermore, CPS is also an area of increasing relevance to educational and organisational research in its own right and is selected as an area of personal interest for the researcher.

1.7 Challenges to Embedding an Ability Emotional Intelligence Assessment within a Collaborative Problem-Solving Performance Task

The assessment of the cognitive and social aspects of CPS raises the possibility that other soft skills like AEI can be assessed in accordance with hard skills. However, there are many issues to overcome before it can be declared that both social competencies and cognitive abilities are being assessed equally and simultaneously. In the design of any assessment task, the construct that is the subject of the exploration must be defined clearly (Griffin & Care, 2015). Subsequently, a framework of behaviours which correspond to the definition and model chosen must be established (Scoular et al., 2017). The assessment of latent constructs like AEI is problematic, as targeted behaviours which are hypothesised to map onto the ability must be selected in order to generate adequate inferences about an individual's skills (Care & Kim, 2017). This approach raises additional and unique challenges in comparison to the traditional forms of testing, in which the individual self-reports on their own perception of their traits, or an answer is typically correct or incorrect on a cognitive test.

The OECD included an assessment of CPS in the 2015 Program for International Student Assessment (PISA) assessments. Following a considerable review of the literature in the area, PISA researchers designed an interlinking matrix of 12 key observable skills which involved both collaboration and problem solving (OECD, 2015; 2017). Similar to AEI, varying interpretations of CPS are in existence. Thus, several models were modified to create a framework which suited the purposes of this international standardised study (Hesse et al., 2015; OECD, 2015; 2017). A similar framework was created for the Assessment and Teaching of 21st Skills Project (ATC21S) to allow the formative assessment of CPS (Hesse et al., 2015). The assessment of the collaborative soft skills of CPS can potentially provide an

exemplar of how AEI could be assessed in a similar way. For AEI, an assessment framework of observable behaviours which map onto the construct of AEI would need to be adapted.

An additional challenge is whether the unit of assessment within a collaborative context should be the performance of the participant in a group or the group as a whole. Although an individualised performance appraisal creates a comprehensive trajectory of the participant's performance from start to finish, concentrating on the group or dyad may permit a more holistic picture of the interactive social and cognitive processes to emerge (Graesser et al., 2018; OECD, 2017). In PISA, this individualised approach was the most feasible way of conceptualising CPS skills in a standardised assessment. However, it remains a contentious issue (Hao et al., 2019; Liu et al., 2016). In a review of the literature, Hao and his co-authors (2019) argue that an assessment of CPS cannot reflect the construct as a whole without a thorough analysis of the interactions between the agents, rather than just the individual's actions. Furthermore, they propose that the type of assessment used in PISA is largely a cognitive task rather than an analysis of an individual's social collaborative abilities (Hao et al., 2019). In the ATC21S project, the focus of assessment was also on the individual within the collaborative context. Unlike PISA however, there was a greater focus on the assessment of the types of interactions between group members, to build a more comprehensive picture of the skills used. The development of an AEI assessment conceptualising both cognitive and social elements would face similar considerations in design.

Determining the group composition for the task at hand is a related challenge to the one discussed above. With the onset of technology, there is potential for the human participant to interact with other human or digital group members in an AEI assessment. For example, in PISA's CPS assessment, students interacted with a pre-programmed agent in order to solve different types of problems (OECD, 2017). Both human-agent (H-A) and human-human (H-H) types of interactions have different benefits. The H-A method, as used in PISA's study of

CPS has a number of distinct advantages. Most critically, He et al. (2017) argue is that the researchers are assured that the participant will face a range of diverse collaborative scenarios and encounter various personality types in the form of computer avatars. For an international assessment designed by the OECD, this standardisation was a critical prerequisite for assessment (Rosen, 2014). Issues of time are also regulated by this structure. When humans collaborate and work together, a considerable period of time is needed for introductions, assigning roles and generally getting to know the focus of the project or problem at hand. In contrast, a computer assessment like PISA permits a comprehensive picture of the individuals' skills to emerge in a short two-hour frame, as the participant launches quickly into solving the problem and working with their partner (OECD, 2017).

The potential of computer agents as assessment companions is significant and continues to grow. For instance, in some virtual learning environments that have been studied (e.g., Biswas, Segedy & Bunchongchit, 2016; K Han et al., 2021), computer avatars can hold conversations and have speech recognition techniques embedded in their systems. However, the use of these agents remains highly complex, expensive and time-consuming (OECD, 2017). Research examining the potential use of conversational agents in collaborative assessment contexts therefore remains relatively scare. As a consequence of these difficulties, the response items available to these students in PISA were closed (OECD, 2017). When collaboration was required, participants selected a response from a set of pre-programmed answers, instead of communicating with the agent through chat or conversation (OECD, 2017). Although this method permits comprehensive and effective scoring techniques, it is a highly artificial environment and may not reflect the non-linear dynamics of human interaction (Rosen, 2014). Support of this argument was found in a study conducted by Rosen and Foltz (2014) who found that students placed in H-A computer-based tasks outperformed their peers who participated in H-H collaborative contexts. It may be that individuals react

differently to the behaviour displayed by a computer agent in contrast to another human. Rosen and Foltz's results raise questions about the validity of H-A tasks in soft skills assessment. In an area as complex as AEI, the incorporation of H-A interactions would also raise significant challenges. An alternative to this type of development is to focus on Human-Human contexts which involve the use of EI skills.

Efforts to assess soft skills through Human-Human contexts have also met challenges. The central complication that occurs in these types of tasks is the analysis of data. Many H-H CPS assessments incorporate chat boxes, in which two human participants solve a task by typing responses to each other about the presented problem (Hao et al., 2015). Whereas each item chosen in PISA was mapped onto a proxy for a certain behaviour and subsequently quantitatively analysed, this becomes difficult for chat conversations which are unpredictable. Researchers have used a number of different methods to analyse this type of data. Hao et al. (2015) integrated a human aspect in that expert researchers classified the social skills displayed into four main categories, guided by the matrix of skills provided in PISA (Hao et al., 2015). Attempts have also been made to assess H-H collaborative action by adding additional analytical techniques to counteract the limitations of technology. For instance, Cukurova et al. (2017) devised a method to analyse students CPS skills in a group context through the use of hand position and head direction data. Graesser et al. (2018) also discuss the potential of automated qualitative algorithms in assessing complex transversal skills like CPS and AEI. However, these types of studies are rare and require a great deal more study. The search for an equilibrium between strong internal validity (achieved through the standardised human-agent transactions) and external validity (achieved through a reflection of human-human interaction) continues.

Regardless of the type of group used, the choice of tasks included in a concurrent social and cognitive task must be carefully thought out. Participants being a range of prior knowledge

and experiences that may influence the way in which they approach an assessment activity. Cultural differences in social responses also play a part in influencing behaviour. Within PISA, the researchers assumed that the students participating had a basic level of English and Maths abilities. They also attempted to create problems that were of interest to this teenage age group internationally. However, it is difficult to control for the wide array of factors which may influence an individual's behaviour in an assessment. Difficulties may also arise in the design of tasks which map onto each element of complex constructs like AEI. PISA researchers attempted to overcome this difficult through the use of a number of short scenarios so as to ensure that the individual being tested had to use all required skills. Although this was successful in capturing an individual's skills set in the area of CPS, it is unlikely that a real-life context would be as structured and linear.

The construct of CPS has been used here to highlight some of the potential challenge which will occur when designing a transversal skills assessment which explores if AEI abilities could be observed and assessed in a performance task. Upon reflection on the issues discussed above, a number of key questions arise:

- What types of assessment are currently used to assess AEI?
- To what degree could AEI abilities be observed or assessed within a performance task?
- What types of tasks would facilitate this type of assessment?

It is clear that the design of this type of AEI assessment is not without its challenges and remains in the exploratory stages. Nevertheless, an opportunity to explore what is possible in the context of a primary school classroom is an exciting prospect in the age of digital advancement. While not a central concern of the thesis, findings from such a study will also be of interest to those more focused on the assessment of AEI in adult education and

credentialing contexts such as the one in which organisations such as Prometric operate within.

1.8 Thesis Organisation

This introduction is one of five chapters of the thesis. This chapter has described the research topic, the problem and the key concerns around EI assessment. It has situated the area of AEI assessment within a broader context of transversal skills assessment. Chapter Two expands on the theory of AEI and provides a theoretical comparison of the overlap between AEI abilities and the skills of CPS. Chapter Three defends the research methods chosen to best answers the research questions. Chapter Four presents the key findings and Chapter Five discusses these findings and makes recommendations for policy-makers and researchers.

Chapter Two: Literature Review

2.1 Introduction

A description of how this chapter is organised follows immediately on from a brief outline of the two core models that lie at the heart of this thesis: Ability Emotional intelligence (AEI) and Collaborative Problem-Solving (CPS). In this chapter, literature with respect to each is reviewed, with the intention of elaborating on each of the following observations:

1 Ability Emotional Intelligence is one of three models[1] of emotional intelligence, the other two being the trait model of EI and the mixed-model. AEI is used in this thesis because, as noted in Chapter One, the ability model is considered to be the 'gold standard' for defining EI (Jordan et al. 2010). Trait and mixed models define EI as a wide array of personality characteristics that lead to emotionally intelligent behaviour (Petrides & Furnham, 2001; Petrides, Pita, & Kokkinaki, 2007). As reviewed by Conte (2005), mixed and trait models have been criticised widely in the literature as they are, in fact, more strongly related to personality rather than intelligence.

2 Assessment[2] methods for AEI are typically performance tests[3] and situational judgement tests. Typically, they present a range of hypothetical vignettes or scenarios and ask the test-taker to choose the most suitable solution to solve an emotional problem. A substantial body of studies have examined the reliability and validity of these tests, with mixed findings emerging across the literature. Although these tests can be helpful in assessing AEI, they have a number of limitations. As they do not require the test-taker to apply their skills within dynamic and real-life contexts, they may assess emotional knowledge rather than emotional abilities. They test AEI in isolation and do not capture how an individual may use AEI abilities with other types of transversal skills. The

development of new types of AEI assessment modalities that offer a more authentic representation of how AEI is used in real-world settings is important, particularly for educational and organizational settings.

3 Existing assessments of Collaborative Problem-Solving (CPS) can provide guidance on how to explore if AEI abilities could be observed and assessed in a performance-based task. Due to the theoretical overlap between the social skills of CPS and the mental abilities of AEI, it is probable that CPS tasks elicit many of the abilities of AEI. Furthermore, unlike traditional assessment modalities, CPS tasks assess problem-solving and collaborative social skills simultaneously. Thus, the considerations for CPS task design could be applied and adapted in this research.

As the Venn Diagram in Figure 2.1 summarises, AEI and CPS are the two main areas of research included in this chapter. They are linked through a theoretical overlap between the mental abilities of AEI and the social skills of collaboration. Assessment is included in the Venn Diagram as a core focus of this study. As the intersection in the Venn Diagram indicates, new assessment modalities that have been developed for CPS, like those used in PISA and the ATC21S project could be used to explore new assessment mediums for AEI.

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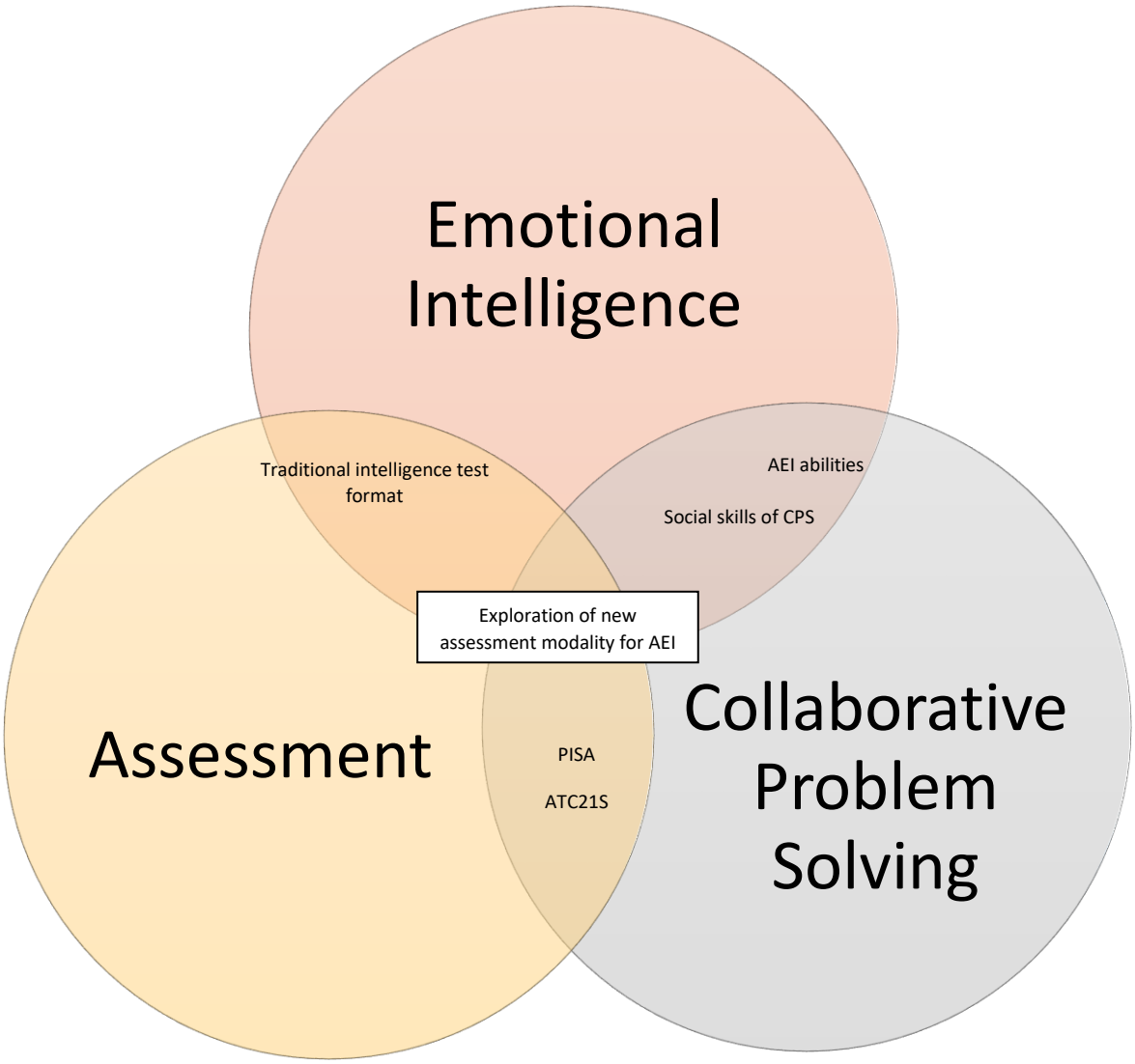
[1] *Model:* A theory, usually including a mechanism for predicting psychological outcomes, intended to explain specific psychological processes (APA, 2020).

[2] *Assessment* is defined as the process of collecting, synthesising, interpreting and using data to answer questions, solve problems or facilitate decision making (Russell & Airasian, 2012)

[3] *Test/Measure* is a type of assessment. A test/measure involves the administration of a set of questions with the aim of obtaining a score about an individual's performance (Russell & Airasian, 2012)

Figure 2.1

Areas of Focus in the Present Literature Review



The chapter is organised as follows. Section 2.1.1 contextualizes AEI within broader intelligence theory. In Section 2.2, AEI is defined and its theoretical framework is mapped. This is followed by Section 2.3 in which the main modalities and uses of AEI are critically reviewed. Core concepts relating to CPS and a theoretical model underlying its use are discussed in Section 2.4. An analysis of the convergence between the social components of the CPS model and the branches of the EI model are outlined in Section 2.5. In Section 2.6, Section 2.6 the implications for the current study are addressed.

2.1.1 Evolution of AEI in the Context of Broad Intelligence Literature

AEI theory emerged from advancements in two main areas of psychological research: (a) research that examined cognition and/or intelligence and (b) research that examined emotions. In order to understand the genesis and the development of the AEI model employed in this research, a potted history of intelligence theory more generally is offered, with a particular focus on how these evolutions impacted the model of AEI that is described in this chapter. Situating AEI within intelligence theory is not a linear or straightforward process, as theorists have drawn on different intelligence perspectives in the literature. This section begins with a review of general intelligence theory, followed by a specific focus on social intelligence and a subsequent overview of the role of emotion research in this model. Finally, an overview of how AEI theory has adapted in line with more recent intelligence theory is presented.

While interest in defining intelligence can be dated back to Greek and Roman philosophers, more formal studies of intelligence began in the early 20th century. Using statistical factor analysis, Charles Spearman (1904) identified *g*, a distinct underlying intelligence factor that he proposed as fundamental for performance on all cognitive tasks. Although the existence of '*g*' is generally agreed upon by academics and researchers, the nature of 'g', was, and remains, a highly debated issue (see Beier et al., 2019 for a review). Theories of intelligence vary from having an array of primary mental abilities to numerous category-specific intelligences. During the 1980s, there was sudden increase in both theoretical and empirical interest in the area of multiple intelligences (see Gardner, 1983; Sternberg, 1985). Simultaneously, research which explored the interaction between emotion and cognition was becoming more commonplace (Matthews et al., 2002). During this period, the first scientific literature on EI emerged (Mayer et al. 1990, Salovey & Mayer 1990).

In their early work, Salovey and Mayer (1990) maintained that AEI should not fit exclusively within any one intelligence theory. The expansion of intelligence theory to include multiple intelligences by Gardner was referenced but not expanded on in great detail and was not included in subsequent publications by Salovey and Mayer. Instead, they proposed that AEI could be included as a component of a previous definition of intelligence put forward by Weschler (1944, p.3), as the "…aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment". Although Weschler did not place a significant emphasis on emotional intelligence, Salovey and Mayer (1990) argued that this definition encompassed the areas that were historically included in intelligence theory, including the distinction between Abstract (Verbal) and Mechanical (Visual/Spatial) intelligences. Additionally, the definition was sufficiently broad to encompass incorporate the widening of theory to include new intelligences like AEI.

Salovey and Mayer (1990) also drew on a distinct area of intelligence theory, the field of social intelligence (SI), to reinforce the place of AEI in wider intelligence theory. The historical basis for SI dates back to 1920 and Thorndike's proposal that intelligence could be divided into three facets: abstract intelligence, mechanical intelligence and SI. Thorndike (1920, p.228) referred to as SI "...the ability to understand and manage men and women, boys and girls – to act wisely in human relations". In later years, Vernon (1933, p. 44) broadened this definition to develop a more wide-ranging definition of SI as the "…ability to get along with people in general, social technique or ease in society, knowledge of social matters, susceptibility to stimuli from other members of a group, as well as insight into the temporary moods or underlying personality traits of strangers". From Salovey and Mayer's perspective, such definitions of SI underlined research interest in social interactions (which could encompass emotions) from those working and researching intelligence theory. However, SI had many vocal critics including Cronbach (1960), whose criticisms, according to Mayer and

Salovey (1990) may have impeded the field's growth. Cronbach's reservations were largely based on the argument that SI was difficult to test using standardised psychometric formats. Furthermore, tests that had been developed, such as the George Washington Social Intelligence Test (GWSIT), were highly correlated with abstract intelligence, suggesting that it was difficult to discriminate between SI and general cognitive abilities (Thorndike & Stein, 1937). Hence, initially, the positioning of AEI within SI was not uncontroversial.

As interest in intelligence theory broadened to incorporate other types of intelligences, such as SI, increased research in the 1980s also demonstrated how cognition and emotion were in fact integrated processes; emotion influences many elements of cognitive functioning. In keeping with the position adopted regarding intelligence, Salovey and Mayer (1990) did not link AEI to one emotion theory exclusively but drew on the work of a wide range of scholars in the area. For example, they referenced the work of Ekman (see Ekman & Friesen, 1975) and Izard (see Izard, 1977) who furthered Darwin's original evolutionary perspective on emotions (Darwin, 1872), by positing that some basic human emotions are inherent and are common or universal across various cultures or experience. This thinking was incorporated into AEI theory with some emotional reactions to environmental experiences considered innate.

Salovey and Mayer (1990) also referenced cognitive theories of emotion when discerning the role of emotions in an overall intelligence. In both Schachter and Singer's (1962) Two-Factor Theory of Emotion and Lazarus' Theory of Emotion (1982), emotions are composed of both physiological arousal and cognitive appraisal. According to the Schachter-Singer Theory of Emotion, the psychological arousal causes the strength of the emotion, while cognitive appraisal determines the emotion label. The order of the response is different in Lazurus' theory in that the cognitive appraisal comes before the physiological arousal or emotion. Individual's appraisals of emotions can therefore differ. Thus, while 'basic' emotions are

included in AEI theory, Salovey and Mayer (1990) considered cognition to have an important role in complex emotional reactions, arguing that individual can learn how to react with appropriate emotion to particular environmental triggers or situations.

Salovey and Mayer's reference to the role of emotions in their intelligence theory has remained largely consistent in their model. However, their thinking on where AEI sits within existing intelligence theories has varied. In later years, the theorists attempted to establish the position of AEI empirically within the well-established Cattell-Horn-Carroll model of intelligence (Mayer, Caruso & Salovey, 1999; Mayer et al., 2000). The Cattell-Horn-Carroll model of intelligence drew together the work of Cattell, mentioned above, John Horn and John Carroll, and operates on a hierarchical three stratum model. The first over-arching stratum *g* represents general overall intelligence, while the second and third stratum subdivides *g* into a range of broad and specific mental abilities including comprehension knowledge, visual processing, reading and writing and short-term memory (see Scheider & McGrew, 2018 and McGrew, 2009 for reviews). Section 2.2.5 delves into this exploration in more detail and outlines how some researchers (e.g., MacCann et al., 2014) have carried out a small number of empirical studies which hypothesised that AEI, as measured by an ability based test, could be included as a group factor of the Cattell-Horn-Carroll model of intelligence.

In recent years, there continue to be diverse and contested views on how intelligence should be defined and conceptualised. As highlighted by Lievens and Chan (2017), the area of SI remains of interest to many intelligence theorists and academics, although it is still accepted that it is difficult to operationalise and measure. Furthermore, it has been consistently proposed in Mayer et al.'s more recent update of AEI theory (2016) that AEI could be a component of SI. Later in this chapter, Section 2.2.4 provides an overview of Mayer et al.'s current theory and evidence around the relationship between EI and SI.

The purpose of this overview was to demonstrate how changing research perspectives have altered and shifted the landscape of where AEI could be positioned within the broader facet of intelligence theory. What has remained consistent throughout the decades is that gaps in the literature exist and research continues to emerge to address those gaps. The following sections outline the model of AEI and the assessment modalities that are currently available for this model.

2.2 Ability Emotional Intelligence

2.2.1 The AEI Model: Theoretical Evolution

Across the literature, the dominant AEI theory is presented by Mayer and his co-authors. Unlike trait or mixed models of EI, alternative AEI theories have not yet been put forward. The theory of AEI proposes that the information value of emotions can make thinking more intelligent. Salovey and Mayer (1990) theorised that those who can understand and process information about emotions effectively are more likely to experience positive outcomes in many areas of their lives.

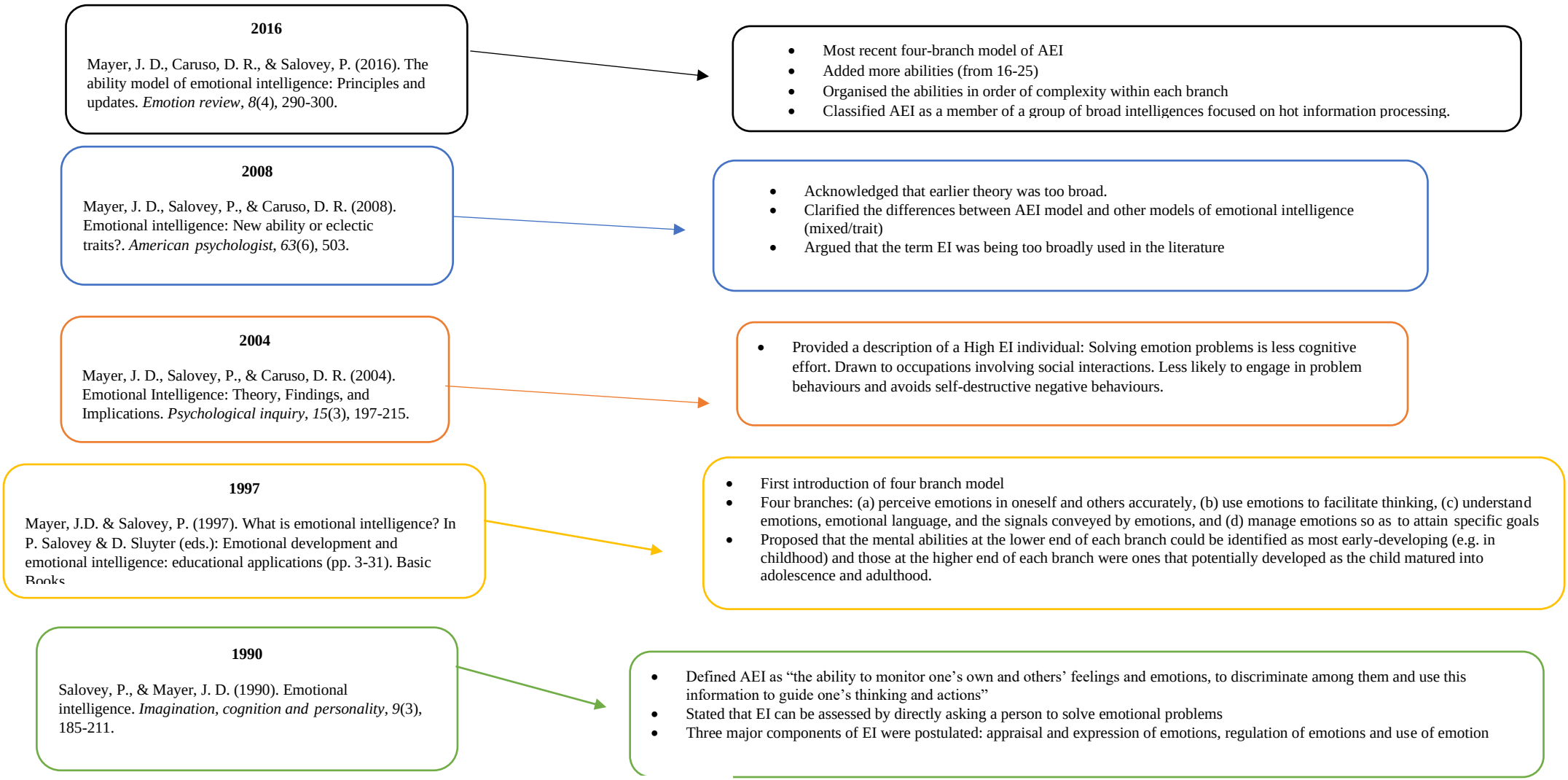
In the ability model, emotion is defined as a feeling state (including physiological responses and cognitions), that conveys information about relationships and influences aspects of cognitive functioning, including memory, attention and decision making (Salovey & Mayer, 1990; Mayer & Salovey 1997; Mayer, Salovey & Caruso, 2004). Emotion arises in reaction to an internal or external event, that has a positively or negatively interpretative meaning for the individual in question. Emotions are distinguished from the closely related but distinct concept of mood which is typically longer. Emotions relay messages from one individual to another and emotional information is one of the key types of information that human beings process. As mentioned above, emotional reactions to environmental experiences are thought to be innate but the conditions that invoke complex emotional reactions are considered

adaptive by Salovey and Mayer (1990). That is, an individual can learn how to react with appropriate emotion to particular environmental triggers or situations. For example, in its simplest form, fear is a feeling state that conveys information. An individual who recognises fear on another's face or in themselves may use this signal to leave a particular situation. However, in the modern world, encountering fear may not permit the abandonment of a situation, but the discernment of an appropriate emotional reaction or behaviour to manage the context. Critical to the theory of AEI, Salovey and Mayer (1990) argued that an individual's capacity to react and manage emotional information implies the existence of a broader emotional intelligence.

As Figure 2.2 outlines, there have been several revisions and adaptations to AEI theory since its inception in 1990 by Salovey and Mayer, with the most recent amendments made in 2016. In the 2016 update, AEI is defined as "…the ability to reason validly with emotions and with emotion related information, and to use emotions to enhance thought" (Mayer et al., 2016, p. 298). Those high in AEI possess the mental abilities to process, interpret and manage emotional information well, hence the term 'ability model'. AEI is conceptualised as an intelligence which can be further subdivided into four 'branches' or problem-solving areas (Mayer et al., 2016). The term branch came into reference when Salovey and Mayer (1990) were describing the figures that presented the AEI model in their earliest work. Figures contained lines that branched off from the central overarching domain of emotional intelligence. The term is therefore a practical one, with each branch referring to a problem-solving area that is further sub-divided into a discrete set of mental abilities that encompass the intelligence. Under these four problem-solving branches exist a range of mental specific abilities related to the processing of emotional information. AEI theorists often use the terms branches and problem-solving areas interchangeably throughout the literature.

Figure 2.2

Key literature related to Developments in AEI Theory



In AEI theory, the ability to acknowledge, understand, and regulate one's own emotions is classified as having equal importance to the ability to perceive, appraise and assist the regulation of emotions in others (Salovey & Mayer, 1990). Responses to one's own and other's emotions are viewed as intertwined facets of AEI. The individual uses their ability to respond to their own emotions as guidance for how to respond to the emotions of others, and vice versa. However, the branches themselves are organised in order of complexity, reflecting the most fundamental problem-solving area, (1) perceiving emotions, at the bottom of the table, regarded as the most basic and innate of the branches. The model then proceeds through the more cognitively complex branches of (2) facilitating thought by using emotions (3) understanding emotions and (4) managing emotions in oneself and others (Mayer & Salovey, 1997; Mayer et al., 2016). Within each branch, a series of mental abilities are outlined Figure 2.3 illustrates how these abilities are also organised from bottom to top in order of complexity, a revision that was made in 2016 by the authors. Although they are organised in order of complexity, they are equally weighted and include abilities which relate to the self and to others. The mental abilities of the four branches refer to specific cognitive abilities that are used to solve a psychological task or solve a problem (Mayer et al., 2016). In the case of AEI, these problems or tasks are always emotion related, and the abilities that people have to solve or deal with these problems is reflective of an overall intelligence.

Figure 2.3

Four Branch Model of Ability Emotional Intelligence.

The Four Branches	Types of Reasoning
Manging Emotions	• Effectively manage others' emotions to achieve a desired outcome[b] • Effectively manage one's own emotions to achieve a desired outcome[b] • Evaluate strategies to maintain, reduce, or intensify an emotional response[b] • Monitor emotional reactions to determine their reasonableness • Engage with emotions if they are helpful; disengage if not • Stay open to pleasant and unpleasant feelings, as needed, and to the information they convey
Understanding Emotions	• Recognize cultural differences in the evaluation of emotions[c] • Understand how a person might feel in the future or under certain conditions (affective forecasting)[c] • Recognize likely transitions among emotions such as from anger to satisfaction • Understand complex and mixed emotions • Differentiate between moods and emotions[c] • Appraise the situations that are likely to elicit emotions[c] • Determine the antecedents, meanings, and consequences of emotions • Label emotions and recognize relations among them
Facilitating Thought Through Emotion	• Select problems based on how one's ongoing emotional state might facilitate cognition • Leverage mood swings to generate different cognitive perspectives • Prioritize thinking by directing attention according to present feeling • Generate emotions as a means to relate to experiences of another person[c] • Generate emotions as an aid to judgment and memory
Perceiving Emotion	• Identify deceptive or dishonest emotional expressions[b] • Discriminate accurate vs. inaccurate emotional expressions[b] • Understand how emotions are displayed depending on context and culture[c] • Express emotions accurately when desired • Perceive emotional content in the environment, visual arts, and music[b] • Perceive emotions in other people through their vocal cues, facial expression, language, and behavior[b] • Identify emotions in one's own physical states, feelings, and thoughts

Note. Copyright Sage Publications. Reprinted from Mayer et al. (2016) with permission.

[a] The bullet-points are based on Mayer and Salovey (1997) except as indicated in superscripts b and c. Within a row, the bulleted items are ordered approximately from simplest to most complex, bottom to top. The four-branch model depicts the problem-solving areas of emotional intelligence and is not intended to correspond to the factor structure of the area.

[b] An ability from the original model was divided into two or more separate abilities

[c] A new ability was added.

[d] Note that the Branch 2 abilities can be further divided into the areas of *generating emotions to facilitate thought* (the bottom two bulleted items) and *tailoring thinking to emotion* (the top three bulleted items).

The initial, most basic branch of the AEI model is perceiving emotion. This branch begins with the ability to *identify emotions in one's own physical state, feelings and thoughts.* Individuals can vary in their ability to recognise and appraise their own emotional states and through facial expression, body language, pictures and voices, a person can also recognise the emotions of others. Significant debate exists around the area of emotional recognition in the literature. Several theorists have conceptualised emotion recognition or emotion perception as a set of a skills, while other academics have linked emotion recognition ability with intelligence (see Eickers & Prinz, 2020; Schlegel et al., 2020 for reviews). Mayer and Salovey (1997) and Mayer, Salovey and Caruso (2004) took the latter approach and theorised that emotion perception abilities (see Figure 2.3) were specific mental abilities which could be incorporated under the broader ability model of intelligence. They used literature from the area of child development to support their argument that emotional perception abilities develop with age. This theory is line with several intelligence theories where it is proposed that intelligence can adapt and improve across the lifespan, shaped by environmental contexts and factors (Mestre et al., 2016).

As argued by Hoehl and Striano (2010) as well as by Ruba and Pollack (2020), in the early stages of development, the child learns to perceive emotions in facial expressions. For example, the child cries when distressed, or smiles in happiness, and observes their reaction reflected in the parent's face, as the parent emphatically mirrors those feelings. In a study of 32 pre-schoolers aged between three and five years of age, Boyatzis, Chazan and Ting (1993) found that children's ability to identify facial expressions improved with age for both boys and girls. Similar findings were reported by Gross and Ballif (1991) and Herba and Phillips (2004). Boyatzis, Chazan and Ting (1993) also reported that children displayed higher accuracy when identifying positive facial expressions like happiness than more negative ones like fear or disgust, a finding which has also been supported by other literature (e.g., Camras

& Allsion, 1985; Widen & Russell, 2007); some of which was referenced by the theorists in their earlier papers when disseminating each branch of the ability model. Mayer and Salovey (1997) therefore theorised that as the child gets older, they may learn to discriminate more effectively amongst genuine versus simply polite smiles or other nuances of expression. Similar to other types of intelligence, emotion recognition abilities have been found to improve up to a certain age, after which they experience cognitive decline, with older adults often scoring lower on tests of emotion recognition than younger or middle-aged adults (e.g., Connolly, Young & Lewis, 2021; Magai et al., 2006). As Figure 2.3 outlines, the mental abilities in this branch proceed vertically to the highest ability which is to *identify deceptive or dishonest emotional expressions.* This capacity to successfully perceive emotions in the face or voice of others provides a critical starting point for the more advanced understanding of emotions.

The second branch, facilitating thought through emotion, relates to a person's ability to use emotions as a component of their cognitive system and to guide thinking (Mayer & Salovey, 1997; Mayer et al., 2016). As Figure 2.3 notes, it begins with the ability to *generate emotions as an aid to judgement and memory* and moves sequentially to the ability to *select problems based on how one's ongoing emotional state may facilitate cognition*. Individuals who use emotion to facilitate thought well are adept at decision-making based on their knowledge of their own and other's emotions. A person who responds emotionally to key issues will generate attention to the most significant situations in his or her life. In contrast, as described by Mayer et al. (2016), if the person is continually frustrated, for example, by a fellow co-worker's small mistakes, then more pertinent issues may not be approached. One practical well-established test which reinforces Mayer's theory is the Emotional Stroop Test (Stroop, 1935).

In the original Stroop task (Stroop, 1935), participants are presented with names of colours and are asked to name the colour of the ink in which the word is written. In the congruent condition, the names of the colours are the same as the colour of the ink (e.g., blue is written in blue). In the incongruent condition, the names of the colours are not in the same colour ink (e.g., blue is written in black). Typically, the Stroop test is used to assess an individual's ability to inhibit cognitive interference, and, as reviewed by Martin and Thomas (2011), the original task consistently reported slower response times in the incongruent condition. The Stroop Task was later adapted to assess other types of cognitive processes, including the processing of emotional information. In the Emotional Stroop Task, individuals are asked to name the colours of both neutral and emotion words, with the negative emotion words typically referencing anxiety or dysphoria (Gotlibb & McCann, 1984). A consistent finding from studies using this test is that individuals who reported experiencing low mood or depression tended to have slower response times to these negative words (Gotlib & MacCann, 1984; Mittershiffthaler et al., 2008). These results were interpreted by researchers, including Mayer, Salovey and Caruso (2008) as indicating that negative emotion words were typically more salient for individuals who experienced lower emotional functioning, which inhibited their own cognition. In more recent years, findings from a number of studies (e.g. Elfenbein et al., 2017; Martin & Thomas, 2011; Megias et al., 2017) have consistently indicated that individuals who score higher in AEI measures tend to perform better on the Stroop test. These findings suggest that individuals with higher scores on AEI measures do not experience as much interference from the emotion words as those who score lower, and were used by the theorists to demonstrate that cognition plays an important role in emotional processing.

The third branch, understanding emotions, is the ability to understand complex emotions and emotional 'chains', how emotions transition from one stage to another, the ability to

recognise the causes of emotions and the ability to understand relationships among emotions (Mayer et al., 2016). While the majority of people have the ability to recognise basic facial expressions, fewer are skilled at recognising the nuances of complex emotional relationships. Each emotion can convey a series of possible meanings and actions connected with those meanings. A message of anger, for instance, may indicate that an individual feels that they have been treated wrongfully. This anger, in turn, may be connected with certain categories of possible actions, vengeance-seeking, arguing and retaliation. Understanding emotional messages and the actions connected with them is a fundamental element of this skill. Once a person can identify these messages and potential actions, the ability to reason with and about these emotional messages and actions becomes of importance as well. Mayer et al. (2008) reported that those who are skilled at understanding emotions have a rich feelings vocabulary and understand the relationships among vocabulary describing various feelings states. The fourth and final branch, Managing Emotions includes the ability to *be aware of one's emotions, even those that are unpleasant*, the ability to *determine whether an emotion is clear or typical* and the ability to *solve emotion-laden problems without necessarily suppressing negative emotions*. In the latest four branch model outlined in Figure 2.3, the managing emotions branches begins with the ability to *stay open to pleasant and unpleasant feelings* and rises sequentially to the ability to *effectively manage others' emotions to achieve a desired outcome.*

As described in Figure 2.2, the 2016 four-branch model is a more detailed and comprehensive model than those outlined in previous literature. The original 1990 model outlined by Mayer and Salovey (1990) contained three branches of skills related to AEI but this was widened to four branches, along with a considerable revision of the overall model in 1997. The 1997 adaptation gave each of the four branches equal weight, increased the number of specific abilities from 10 to 16 and for the first time, positioned the specific abilities in sequential and

developmental order under each branch. It was proposed that the mental abilities at the lower end of each branch could be identified as developing earliest (e.g. in childhood) and those at the higher end of each branch were ones that potentially emerged as the child developed into adolescence and adulthood. In 2016, these branches were revised a second time and broadened to include new mental abilities, expanding the specific abilities under the branches from 16 to 25 (see Figure 2.3 for most up to date abilities within each branch). Additionally, Mayer et al. (2016) diverted from their previous position that each ability was organised in a developmental order, stating that there was not enough evidence in the area of emotional development to substantiate these developmental arguments. However, they preserved the sequential order of the abilities in each branch, moving from simple to complex. Those of high emotional intelligence would be adept at using all abilities at the top of each branch, whereas those lower in EI would be comfortable using the abilities at the lower end of each branch.

Like all models of EI, there have been criticisms of the AEI theory described above. As Section 2.1.1 outlined, AEI theorists drew on many areas of intelligence and emotion theory to underpin their thinking. With this diversity, it can sometimes be challenging to pinpoint if each mental ability outlined is rooted in this historical research or whether it is a novel ability theorised by the researchers themselves. Further, some researchers argue (see Matthews, Emo, Funke et al., 2007, p.7) that the AEI model is too restrictive and limited, with several qualities commonly attributed to EI excluded, such as emotional expressiveness, empathy, perspective-taking, and self-control.

Although having a high level of AEI is typically interpreted as a positive, Zeidner et al. (2008) cautioned that those with high AEI may be able to use it to manipulate or coerce others. In more recent work, Davis and Nichols (2016) reinforce this argument, suggesting that the potentially negative effects of some AEI abilities have not yet been explored

comprehensively, particularly in the area of mental health. In general, AEI theory does not differentiate for those who experience pathologically high levels of emotions. For these individuals, the successful identification of emotions may lead to significant distress and emotional management can be extremely difficult. This raises questions about whether there is an optimal level of AEI, a question which has not yet been addressed fully by AEI scholars. Finally, a further limitation of AEI theory is that it does not describe the developmental trajectory of AEI abilities from childhood to adulthood, although some reference is made to developmental research in their work. The following section outlines relevant literature examining AEI in children.

2.2.2 Literature Examining Ability Emotional Intelligence in Children

Mayer et al.'s 2016 model sequentially outlines the specific abilities that encompass AEI. The most basic abilities are at the bottom of each branch and the most complex abilities are at the top of each branch. Mayer et al. (2016) do not make specific reference to the type of developmental trajectory that AEI follows when using these abilities from childhood to adulthood, but state that the intelligence develops gradually, similar to other types of intelligence. Much of what has been included in AEI theory has been discerned from existing developmental and psychological research about children's emotional abilities, and not from direct evidence from the newest AEI theoretical model hypothesised by Mayer et al. (2016). Although it is not explicitly understood how children's development aligns with the abilities of the AEI model, there is a considerable body of evidence that makes reference to children's development in the areas of emotional perception, understanding and management.

The first branch of AEI, the perception of emotion by children has been well-researched. In early infanthood, babies learn how to identify and distinguish between different fundamental emotions in themselves and others (Mayer & Salovey, 1997). Researchers have shown that

ability to differentiate between emotional facial expressions and to react to parents' expressions begins and develops from an early age (e.g. Caron et al., 1988: Klinnert et al., 1988). For example, Widen & Russell reported that children can typically recognise facial expressions that show happy, sad and angry emotions before they can recognise surprise, fright and disgust. Similar outcomes were reported by Malset, Panama and Gentaz (2006) who found that as children's cognitive, linguistic and social development progresses, they can recognise more complex emotions.

Expressing emotions successfully is another element of the perceiving emotion branch. Developmental research from Groassard et al. (2018) and from Lawrence, Campbell and Skuse (2015) has shown that after the age of 10 years children have acquired a parallel ability to interpret and understand facial expressions as adults. From the age of 10 years onwards, abilities may be developed or improved, however no new abilities or significantly substantial augmentations tend to occur (Grossard et al., 2018; Lawrence Campbell & Skuse, 2015). Similar outcomes were reported by Hasslett and Samter (2020) and McClure (2020) in that emotional expressiveness appears to develop at a quicker pace for happiness and sadness than disgust and anger, which are in turn, easier to express than fear and surprise. Difficulties in emotional perception and expression have been linked to negative experiences at school, including lower ratings of academic success, social competence and bullying (Zimmer-Gemback et al., 2011). A number of studies (e.g. Matsumoto et al., 2016; Rutherford & Towns, 2008; Soles et al., 2008), have found that children who have autism often score poorly on measures of emotional perception and expression, which has also been linked to their increased likelihood to report social difficulties at school. These findings align with Rivers et al.'s (2012) conclusion that the ability to perceive one's emotions effectively and communicate them successfully, contributes to social development as well as overall well-being and health.

Branch 2, facilitating thought through emotion is linked with the extent to which emotions help, promote and determine patterns of cognition, reasoning, information processing and decision making (Mayer et al., 2016). It suggests that those who select and use the most effective emotions for a certain setting are highly emotional intelligent. It requires reflecting on past experiences, hence linking to the significance of initially developing the abilities of emotion perception and expression. There is relatively little research on how these group of abilities develop in children but it is considered to become notably less challenging for children as they move towards pre-adolescence, due to a more nuanced ability to understand the sources of emotions and the time sequence of emotions (Denham, 1998).

Branch 3, understanding emotions, entails the ability to analyse emotion, understand how they are altered overtime and discern the potential causes of emotional behaviours and responses (Mayer et al., 2016). According to Bunnett et al. (2021), the developmental trajectory for understanding emotions may progress from the use of external clues to the use of more intricate combinations and internal thoughts. Using the youth version of the Mayer Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT-YV), Rivers et al. (2012) found that students (n= 756) who scored higher on the understanding emotions branch test were rated as more socially competent by their teachers. This finding led Rivers et al. to conclude that children who have a greater understanding of emotion can effectively use problem-solving strategies to deal with negative and positive life events. Understanding emotions also has its roots in the development of perspective taking in children, as it involves awareness of one's own and other's emotions. Although the understanding emotions branch is one of the more complex branches of AEI, perspective taking begins from a young age, suggesting that children may develop abilities in this area from early childhood (Bailey & Im-Bolter, 2020; Bunnett 2021). When summarising child development research, Denham

(1998) outlines that perspective taking typically begins from the age of five and develops considerably by the time children are aged 10-12.

The most complex branch of AEI, managing emotions, involves the effective regulation of emotions. This requires an individual to be conscious and open to an emotional state, even if they are feeling an undesirable emotion and encompasses the ability to manage emotions in oneself and in others. McKown et al. (2009) describe how emotional regulation begins from a young age and progresses throughout the lifespan. Infants learn to seek solace from a caregiver or to self-soothe if they are experiencing negative emotions. Hay (2019) found that toddlers and young children become more adept at using techniques like distraction or removal from a situation to avert and manage difficult emotions like jealousy. By the age of eight, children have usually learned how to regulate their emotions cognitively. Raffaeilli, Crockett and Shen (2005) conducted an eight-year longitudinal study on emotional regulation and its development in children and reported that developmental increases in the ability to regulate emotions improved rapidly between the ages of five and 12. Children who regulate emotions well are able to accept that both negative and positive emotions have a role in their lives. They can use strategies to cope with the emotions that they encounter (Mayer & Salovey, 1997).

2.2.3 Ability Emotional Intelligence within the broader context of 'Hot Intelligences'

In 2016, Mayer and Salovey reclarified their position on where AEI should be positioned amongst other intelligences. In line with earlier work from the authors (Mayer & Salovey, 1997; Salovey & Mayer, 1990; Mayer et al. 2004; 2008), it was theorised that EI is a hot intelligence. Hot intelligences pertain to the processing of information that is related to human interaction and is personal and emotional in nature. In contrast, cool intelligences refer to the processing of objective verbal, spatial and related logical information. Emotional

intelligence falls within this category of hot intelligences as it concerns the processing and use of emotional information. In 2016, Mayer et al. continued to build on this theory and outlined that AEI is one member of a group of inter-related hot intelligences. Having recently published work in the area of personal intelligence, they also began to explore how these intelligences related to one another. As Figure 2.4. outlines, two other members of this proposed hot intelligences group are Social Intelligence (SI) and Personal Intelligence (PI) and both relate to the dimensions of social interaction and emotional communication (Mayer et al., 2016). Mayer et al. (2016) argue that in order to comprehensively understand AEI as an intelligence in its own right, its relationship with SI and PI must be reflected on.

Figure 2.4

Overview of Emotional, Personal and Social Intelligence

Characterization of intelligence	Type of hot intelligence		
	Emotional	Personal	Social
Brief definition	The ability to reason validly with emotions and with emotion-related information, and to use emotions to enhance thought.	The ability to reason about personality—both our own and the personalities of others—including about motives and emotions, thoughts and knowledge, plans and styles of action, and awareness and self-control.	The ability to understand social rules, customs, and expectations, social situations and the social environment, and to recognize the exercise of influence and power in social hierarchies. It also includes an understanding of intra- and intergroup relations.
Problem-solving areas	• Identify emotional content in faces, voices, and designs and ability to accurately express emotions. • Facilitate thinking by drawing on emotions as motivational and substantive inputs. • Understand the meaning of emotions and their implications for behavior. • Manage emotions in oneself and others.	• Identify information about personality, including introspection into one's feelings and reading personality from faces. • Form models of personality including labeling traits in ourselves and others and recognizing defensive thinking. • Guide personal choices with inner awareness, including discovering personal interests and making personality-relevant decisions. • Systematize plans and goals, including finding a satisfying life direction and meaning.	• Identify group memberships: recognize dyadic relationships; understand group relations such as age, gender, ethnic, socioeconomic, and other groups. • Identify social dominance and other power dynamics among groups. • Understand contributors to group morale, cohesion, and dissolution. • Understand how groups use power among one another. • Recognize and understand the exercise of leadership and group power.
Aims of reasoning	• To achieve desired emotional states and experiences in oneself and others.	• To attain goals of self-development, effective personal action, and desired interactions with others.	• To achieve membership status in preferred groups, and to influence the reputation of the group in a desired way.

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Firstly, these three intelligences can be distinguished from one another by definition. As Figure 2.4 summarises, AEI is defined as the ability to reason validly with emotions and with emotion-related information. PI has its roots in Gardner's theory of multiple intelligences and is defined as the ability to reason about personality, both our own and the personalities of others. As discussed in Section 2.1.1, definitions of SI have evolved since the early 1920's. Mayer et al. (2016) have incorporated aspects of this earlier work to define SI as the ability to understand social rules customs, and expectations, social situations and the social environment, and to recognize the exercise of influence and power in social hierarchies (Mayer et al., 2016). By content alone, the mental abilities involved in these three intelligences overlap considerably. Theoretically, Mayer et al. (2016) argue that it follows naturally that a socially intelligent individual who is adept at understanding and managing social situations has moderate to strong abilities in using and processing emotional information. On a similar conceptual level, it stands to reason that an individual who is proficient in processing information about their own and other's personalities is reasonably skilled at processing the emotional information that accompanies differing personality traits. This thinking was echoed by Lievens and Chan (2017) who advanced a theoretical overview incorporating both the overlap between SI and EI (as well as practical intelligence).

Although all three intelligences relate to the domain of human relationships, Mayer and Salovey (2016) accept that it is not currently known where they can be positioned amongst one another. Other researchers have theorised where EI should sit with other types of hot intelligences. For example, Crowne (2009) argued that EI, SI and cultural intelligence should exist in one integrated model with EI as an element of SI. She argued that this integrated model would help in the understanding of each and therefore advance the field of intelligence in general. In Mayer et al.'s (2016) theory, they present that each intelligence may be of comparable complexity involving reasoning of a sophisticated nature. Nevertheless, from a

biopsychosocial perspective[4], the three intelligences differ in the system that they concern; emotions are small psychological subsystems, personality exists at the individual level and social organisation involves groups of people. It is possible, Mayer et al. (2016) argue, that because EI operates at the lowest psychological level it could actually be subsumed as a specific mental ability within personal or social intelligence.

[4]The *biopsychosocial model* is an interdisciplinary model that looks at the interconnection between biology, psychology, and socio-environmental factors. The model specifically examines how these aspects play a role in topics ranging from health and disease models to human development (Engel, 1977). A growing body of literature has explored the relationship between these hot intelligences. Examining the association between SI and AEI is challenging as SI is an ability construct with a long theoretical history that has yet to be consistently validated by empirical studies (Brown et al., 2019; Conzelmann et al., 2013; Mayer et al., 2016). Conzellman et al. (2013) found that social intelligence tests show low convergent validity and can hardly be differentiated from measures of general and academic intelligence. Without a valid measure of SI, the relationship between AEI and SI remains largely unexplored, and, as accepted by Mayer et al. (2016), it is difficult to move beyond the theoretical arguments put forward. However, there are some empirical indications to endorse the argument that AEI and PI are related. First developed in 2012, with later versions adapted, a Test of Personal Intelligence (TOPI) was designed by Mayer, Caruso & Panter (2017; 2019). The TOPI is an ability-based measure consisting of four sections of multiple-choice items about personality that assesses the ability to reason about personality traits, trait-behaviour links, goals and other aspects of understanding oneself and others (Mayer et al., 2019; Mayer et al., 2017). In a study of 962 participants, Mayer et al. (2019) examined the relationship between the TOPI and other tests of well-established intelligences, including AEI. In relation to AEI, the TOPI showed a strong correlation at $r = 0.65$ to 0.69 (Mayer et al., 2019). The strength of this correlation

demonstrates significant overlap between the two intelligences and could suggest that tests of AEI and PI are assessing similar if not equivalent mental abilities.

However, the TOPI requires further empirical support as a reliable measure and issues remain in clarifying the factor structure of the mental abilities that underly the intelligence (Mayer et al., 2019). As accepted by Mayer in 2016, it is possible that AEI may in fact be a distinct mental ability within a larger broad ability of PI. However, it is also proposed that AEI and PI are conceptually distinct and hundreds of test items could be written about both without encountering an overlap between the two. For now, until further evidence is found, Mayer et al. (2016) propose that AEI remains a distinct intelligence in its own right. As outlined by Lievens and Chan (2017), future research is needed to establish the nature of this relationship between the proposed hot intelligences. As has been reviewed in this section, the majority of the research has been carried out by AEI theorists themselves and would benefit from further critique and examination from external scholars. These gaps in the empirical literature mean that it is not yet fully understood if AEI is a part of a group of hot intelligences and if so how are these hot intelligences related to one another.

2.2.4 Ability Emotional Intelligence and Cattell-Horn-Carroll Intelligence Theory

Although Mayer & Salovey's most recent publications centre on positioning AEI amongst other hot intelligences, earlier theory proposed that AEI may fit the well-established Cattell-Horn-Carroll (CHC) model of intelligence. CHC theory operates on a hierarchical three stratum model. The first over-arching stratum *g* represents general overall intelligence. The second stratum subdivides *g* into a range of broad abilities including comprehension knowledge, visual processing, reading and writing and short-term memory. These broad abilities are recognised as intelligences in their own right that operate under the universal cognitive ability of *g* (McGrew, 2009). At the lowest level, stratum three, specific mental

abilities pertaining to the broad abilities are outlined. The CHC model of intelligence is supported by a vast body of robust factor-analytic evidence, as well as a large body of literature available on the relations between the broad cognitive CHC abilities and academic and occupational outcomes (see Scheider & McGrew, 2018 and McGrew, 2009 for reviews).

In order for AEI to be classified as an intelligence in its own right and a new group factor of CHC intelligence theory, three "correlational criteria" were developed by Mayer, Caruso & Salovey (1999). Criterion one was that intercorrelations amongst each of the four branches should be high enough so that together they could be defined as a single higher order factor. High correlations between the perceiving, facilitating, understanding and managing emotions branches therefore provides evidence for the existence of a broader AEI intelligence. The second criterion was that tests of AEI should show positive manifold with other established tests of intelligence. Positive manifold is a well-established empirical phenomenon used in intelligence investigations (McGrew, 2009). Performance measures of intelligence tend to correlate positively with each other (Mayer et al., 1999). Therefore, if a measure of AEI correlates positively with other intelligence tests, this is viewed as evidence that it is in fact a test of intelligence and not a measure of another psychological construct. The third criterion used was that AEI must be distinct from other existing group factors of intelligence. That is, although AEI should demonstrate positive manifold with other intelligence markers as in Criterion 2, this correlation should not be so high that it would revoke the existence of a new EI intelligence test (Mayer et al., 1999)

In a study of 503 adults, Mayer et al. (2000) asked participants to complete the older version of the well-established test of AEI, the MSCEIT, the Multifactor Emotional Intelligence Scale (MEIS, Mayer et al., 1999), as well as additional measures of general intelligence, empathy and life satisfaction. Exploratory factor analysis provided strong empirical evidence for a three-factor model of the MEIS with strong corelations between each of these subtests

and each of the factors loading on to a general AEI factor. Additionally, the correlations between the AEI measure and other tests of intelligence were moderate. For example, the correlation between the scores on the MEIS and scores on a test of verbal intelligence was $r = 0.36$, $p < 0.001$. This moderate correlation demonstrated positive manifold that the MEIS was related to other intelligence tests. The moderate strength of the correlation also provided evidence that AEI was not already measured by the abilities assessed within this test of verbal intelligence. A second additional study carried out by Mayer et al. (2000) found that the performances of adults significantly outperformed those of adolescents on the MEIS. These findings added weight to the argument that the mental abilities involved in in AEI are acquired and developed throughout the lifespan as with other types of intelligence.

One seminal study carried out by MacCann et al. in 2014 also hypothesised that AEI could be included as a broad mental ability within stratum two of the CHC model. 702 undergraduate students from a number of U.S. universities undertook an assessment battery, composed of the MSCEIT to measure AEI, as well as 15 cognitive tests drawn from the Educational Testing Service Kit of Factor Referenced Cognitive Tests (Ekstrom et al., 1976), designed to measure five of the nine broad abilities of the CHC model included in the study; fluid reasoning, comprehension-knowledge, quantitative knowledge, visual processing and long-term storage and retrieval. The measurement of only five of the broad abilities from CHC theory was because abilities related to sensory modalities like visual processing were impractical to test in a group testing environment. Examples of these cognitive tests included a mathematical aptitude test and a figure classification test. To analyse whether AEI was a 2nd stratum factor of intelligence, data were fit to a number of structural models involving three indicators for each of the existing nine broad abilities, as well as two indicators for each of the four branches of the AEI model. In order for AEI to be classified as an intelligence in its

own right and a new group factor of CHC intelligence theory, the three "correlational criteria" developed by Mayer et al (1999, p.271) were examined.

Findings from the structural equation modelling carried out by MacCann et al. (2014) indicated support for the model of AEI, albeit using a three branch instead of a four-branch model of EI. This lead MacCann et al. to remove the branch of facilitating thinking through emotion from their own structural modelling analysis. Meeting the first criterion outlined, inter-correlations amongst the three branches of emotion perception, emotion understanding and emotion management were strong. All three branches saliently defined under one global factor of AEI in the three-factor model. Results also showed that the MSCEIT demonstrated positive manifold with conventional measures of intelligence, as well as forming a second-order factor that related to *g* or overall intelligence in the three-branch structural model used in analysis. These findings meant that the second criterion of positive manifold with other intelligence tests was met. Finally, as required by criterion three, AEI was also found to be distinct from general intelligence. This finding meant that the mental abilities assessed within the MSCEIT were not replicates of ones tested in other intelligence test. Based on the results summarised in this study, MacCann et al. (2014) argued that AEI may form part of the CHC structure of human abilities, as a second stratum broad intelligence, that could be further subdivided into the narrow stratum abilities of perceiving, managing and using emotions. This study was a critical study in providing strong evidence that AEI could be positioned within well-established intelligence theories but more critically, it established evidence that EI was a distinct intelligence in its own right.

Overall, the legitimacy of AEI as an intelligence is a controversial issue in the history EI literature. MacCann et al. (2014) were not the first researchers to raises questions about the legitimacy of the four-branch area. Using factor analysis and structural modelling of the MSCEIT, numerous other studies have also recommended the exclusion of the Facilitation

(facilitating thought through emotion) branch from the four-branch model (e.g. Evans et al., 2020; Fiori et al., 2014; Palmer et al., 2005). For example, Fan et al., (2010) conducted a meta-analysis to examine the factor structure of the test and reported extremely high correlations between the Facilitation and Perception branches as measured by the MSCEIT (*r* = .90). This high correlation suggests a strong overlap between the mental abilities needed to perceive emotions and those required to facilitate thoughts with emotion. On this basis, a three-factor solution was suggested as a best-fitting alternative model of MSCEIT structure and the authors highlighted the need for possible modification of the Four-Branch Model. Despite these factor structure issues, Mayer et al. (2016) argue that they do not detract from the legitimacy of AEI an intelligence, but rather highlights the relative infancy of the research in this area.

2.2.5 The Predictive Validity of Ability Emotional Intelligence

As described by Frey (2018), predictive validity refers to the extent to which scores on a scale predict scores on another criterion measure. Among the most debated issues in the literature is whether AEI can predict meaningful variance in life outcomes, an issue which is further complicated by the presence of multiple models of EI and an equal number of EI assessments. There are many aspects of a person's cognition that can influence behaviour, separate from intelligence. For instance, an individual's personality comprises motives and emotions, social styles, self-awareness and self-control, all of which impact consistent behaviours, apart from intelligence. Among the Big Five Personality Traits, for instance, correlations between personality traits and intelligence rarely exceed *r* =. 20 (De Young et al., 2014; Furnham et al., 2007 Mottus et al., 2008). These correlations demonstrate that intelligences are relatively independent of personality which has a significant impact on people's behaviour in various contexts. Mayer et al. (2016) accept that intelligence tests also tend to measure potential better than the typical performance of everyday behaviour. For

these reasons, the direct prediction from intelligence tests to instances of behaviour in varying contexts is a contentious issue. Nevertheless, Mayer et al. (2016) point to the solid bank of literature that has shown that emotionally intelligent individuals often have outcomes that differ from those who are less emotionally intelligent. Table 2.1 outlines a summary of the correlations which have been found between AEI and academic and workplace performance, as well as a variety of personal life outcomes.

Table 2.1

Summary of Correlations of AEI with Life Outcomes

Outcome	Correlation
Academic Performance (MacCann et al., 2020)	.20
Workplace Performance (Joseph & Newman, 2010)	.18
Workplace Performance (O'Boyle et al., 2011)	.24
Life satisfaction (Extremera & Rey (2016)	.40
Subjective Wellbeing (Sanchez-Alvarez, Extremara & Fernandez-Berrocal, 2016)	.22
Self and peer reported positive interactions with friends (Lopes et al., 2004)	.33
Physical Aggression in Adolescents Garcia-(Sancho, Salgeuro & Fernandez-Berrocal, 2017)	-0.21

Many studies which have examined the link between academic performance and EI have not distinguished between measures of trait, mixed or ability EI. Results from this body of wider research have been mixed in university settings but has been more consistent for secondary school and primary school outcomes (Costa & Faria, 2014; Hoffman, Ivcevic & Brackett, 2018). Researchers generally attribute this higher correlation in the early years due to the developing nature of emotional abilities. MacCann et al. (2020) outline how a 5 year with

lower-than-average emotional intelligence may spend their school day crying, upset or unable to focus their attention on learning. In contrast, a university student with lower-than-average emotional intelligence is more likely to be able to manage their emotions to focus on academic tasks and study. In order to examine the degree to which AEI was associated with academic performance across all educational settings, MacCann et al. (2020) carried out a meta-analysis of 162 studies involving 1,276 correlations and representing 27 different countries. As outlined in Table 2.1, an overall effect size of $p = .20$ was reported. This effect size suggests that AEI has a small to moderate association with academic performance, operationalised either as teacher-grades or standardised assessments, such that students with high emotional intelligence are more likely attain higher grades and test scores. Unlike the findings of earlier research, age was not found to be a moderating factor of the relationship between AEI and academic performance. The association between AEI and higher academic performance was therefore consistent for students across primary, secondary and third-level settings. Further analysis revealed that AEI was the third most important predictor of academic performance, after intelligence and the personality trait of conscientiousness. Within AEI, the understanding and management branches had stronger effects on academic performance than the perception or facilitation branches. Although this meta-analysis confirmed that there was a relationship between AEI and academic performance, particularly for the management and understanding branches of AEI, it could not examine the causes underlying this link. MacCann et al. (2020) proposed a number of potential mechanisms that may account for this relationship. Firstly, individuals higher in AEI may be better able to manage the negative emotions such as anxiety, boredom and disappointment that are typically involved in academic study. If this is correct, emotion management would be responsible for the effects. Secondly, students with higher AEI may be able to manage the social world around them more competently, leading to the formation of positive supportive

relationships with teachers and fellow students, in turn providing a greater network of supports and the sharing of resources for academic performance. If this is the case, emotion management would again be responsible for the effect. Although additional longitudinal and causal research is needed, the body of work examined by MacCann et al. (2020) supports the AEI/academic performance relationship. Their results suggest that the branches of managing and understanding emotions play a particularly important role in this relationship.

There is also a considerable body of work that supports an association between various workplace outcomes and AEI, with some research suggesting that this varies according to the type of job in question. For instance, one recent study carried out by Zhao, Li & Shields (2019) examined the relationship between emotional-management ability, as measured by the MSCEIT and job burnout. Results from the study of 343 Chinese employees, from a wide range of occupations, found that emotional-management ability was negatively related to a measure of job burnout, especially in jobs that required high emotional labour. These jobs include teachers, nurses, lawyers and social workers, all of which deal with people and their emotions on a daily basis. Zhao et al. (2019) argue that employees who are better able to deal with the emotional and social demands of their jobs are less exhausted and fatigued, subsequently leading to less burnout and time off work. Despite the relatively dated nature of the study, O'Boyle et al.'s (2011) meta-analysis remains an important review of the job performance and AEI link (see Table 2.1). As well as providing an overview of the strength of the relationship between AEI and job performance, this review aimed to establish if AEI measures incrementally predict job performance when measures of personality and cognitive intelligence are included as predictors. Although a final sample of 43 effect sizes relating to job performance and EI were examined, only 9 of these used the ability model and measured AEI with the MSCEIT. Only studies in which job performance was measured as a quantifiable performance outcome (e.g. supervisor rating, sales performance) were included

in the analysis. Consistent with the researchers' hypothesis, AEI was correlated positively with job performance as well as exhibiting substantial relative importance in the presence of cognitive attention when predicting job performance. These findings support the work of a previous meta-analysis by Joseph and Newman (2010) who found that ability EI measures had incremental validity over cognitive ability and personality in predicting job performance (see Table 2.1). Although, the need for a more recent meta-analysis, as well as increased exploration of the causal mechanisms behind the AEI/performance link is needed, these studies demonstrate that those who are highly emotionally intelligent appear to perform better in the workplace.

As well as having associations with both academic and job performance, AEI demonstrates an association with other personal life outcomes (see Table 2.1) For example, in a meta-analysis of the relationship between EI and subjective wellbeing, Sánchez-Álvarez, Extremera, and Fernández-Berrocal (2016) found that performance based measures of AEI were positively correlated with reported wellbeing. Extremera and Rey (2016) also found that tests of AEI and life satisfaction measures were positively correlated in a sample of 721 Spanish undergraduate students. Garcia-Sancho, Salgeuro and Fernandez-Berrocal (2017) studied the relationship between physical and verbal aggression across a number of age groups. Controlling for personality, there was a significant negative relationship between AEI and physical and verbal aggression in the adolescent age-group. In a study of 118 American college students, high levels of AEI were also linked to the quality of self and peer rated social interactions (Lopes et al., 2004). Collectively, these studies suggest that tests of AEI can consistently predict a range of life outcomes.

As summarised by Mayer et al. (2016, p.291) more emotionally intelligent people appear to "have outcomes that differ in important ways from those who are less emotionally intelligent". As outlined in Table 2.1, and as reviewed by Fiori and Vesely-Maillefer (2018),

the strength of the relationship between many life outcomes and AEI variously presents as moderate, or in some cases weak. However, the diversity of life outcomes that show some relationship to AEI establishes its importance as a model that should be studied and assessed. Mayer et al. emphasise that "…the prediction from intelligence to individual instances of 'smart behaviour' is fraught with complications and weak in any single instance" (Mayer et al. 2016, p.291). This is a significant critique of intelligence testing in general and is an issue that is well-debated in the literature (see Appendix A for a critical review and critique of broader intelligence testing). Another argument put forward by Fiori and Vesely-Maillefer (2018) is that there are several unresolved issues related to the way that AEI has been measured, which weakens the validity of the interpretations that can be made from these studies. Scoring well on hypothetical written performance test may not reflect how a person uses AEI within real-life educational and workplace contexts. These questions suggest that the predictive validity will improve once these measurement and theoretical issues have been clarified. A number of the testing issues are discussed when addressing the common assessment modalities for AEI.

2.3 A Critical Review of Current Assessment Modalities for Ability Emotional Intelligence

2.3.1 The Mayer-Salovey-Caruso Emotional Intelligence Test

Mayer, Caruso & Salovey (1999) first developed a test called the Multifactor Emotional Intelligence Test to assess the four-branch model of EI. This instrument was later adapted to become the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), (Mayer, Salovey, & Caruso, 2002). The MSCEIT is the most widely accepted measure of AEI in the research community (Kong, 2014; Kuo et al., 2019). As discussed above, the MSCEIT has met a number of criteria to establish its validity as an intelligence test. Additionally, it has

established predictive validity for many life outcomes. In spite of these strengths, the MSCEIT has limitations as a test of AEI. Firstly, the scoring of emotion-based problems is problematic given that there is often not one 'perfect' solution in existence to this type of problem. The test also has an over-reliance on static images, even though emotions are also expressed and perceived through body language, voice and expressions. Additionally, not all of the mental abilities are assessed within the test, meaning that is somewhat limited in the abilities of AEI that it assesses. These critiques mean that it is difficult to gauge if the MSCEIT can assess how AEI abilities are applied in work-place and educational contexts.

The MSCEIT assesses the four-branch model of AEI (perceiving, using, understanding, and managing emotions) with 141 items that are divided among 8 tasks (two for each branch). The Perceiving Emotions (Branch 1) is assessed with two emotion perception tasks: (1) the faces tasks which entails identifying emotions communicated through expressions in photographs of people's faces; and the (2) the pictures task which involves identifying emotions in pictures of landscapes and abstract art. For both tasks, respondents are asked to rate on a 5-point scale the degree to which five different emotions are expressed in each question (Mayer et al. 2002; 2003). Facilitating Thought (Branch 2) is evaluated with two tasks: (1) the facilitation task involves assessing how different moods may facilitate specific cognitive activities; and (2) the sensations task asks the respondent to imagine particular emotions and to specify the degree to which they match varying sensations. For both tasks, individuals are asked to identify which of the different emotions best suit the directed activity or sensation.

Understanding Emotions (Branch 3) is evaluated with two multiple-choice tests: (1) the changes test involves questions about how emotions relate to various setting and how emotions may evolve and change over time; and (2) the blends test involves questions about how different emotions combine and interact to form new emotions (Mayer et al., 2002;

2003). For both tests, respondents are asked to choose the most suitable of five possible response options. The Managing Emotions (Branch 4) is assessed with two situational judgment tests (SJTs) using a series of vignettes depicting real-life social and emotional situations: (1) the emotion management test requires evaluations about strategies for regulating the individual's own emotions in each context; and (2) the emotional relations test requires evaluations about strategies for managing emotions within the individual's social interactions. For both tests, individuals are asked to rate the degree of success of different strategies, ranging from 1 = very ineffective to 5 = very effective.

It is probable that there is no "one best way" to score emotion-based problems, and the scoring of AEI measures have generated significant debate amongst researchers (Fiori et al., 2018; Hellmann et al., 2017). On the MSCEIT, scores are organised into three categories: (i) an EI score representing an overall level of EI; (ii) two area scores, Experiencing EI representing the lower branches of the model and Strategic EI reflecting the more complex emotional branches; and (iii) four branch scores that test the four branches of Mayer and Salovey's model (Mayer et al., 2002). As highlighted by Kong (2014), in contrast to other assessment modalities, such as self-report measures, the MSCEIT is an objective means of testing and scoring, as the scoring of item responses use the correct/incorrect structure of an IQ test.

The correctness of the MSCEIT responses are determined by one of two methods. The first, termed expert scoring, is based on the degree of agreement of responses with those selected by emotion experts. Put succinctly, the answer classified as correct is selected by a group of researchers who are experienced in emotion research. The second method is consensus scoring, where the correct answer is selected by the proportion of the sample that choose the same answer (Mayer et al., 2002; 2003). Mayer et al. (2002) reported high agreement between the two scoring methods in terms of correct answers (r = 0.91) and test scores (r =

0.98). The test internal consistency reliability (split half) was $r = 0.91 – 0.93$ for the total EI and $r = 0.76 – 0.91$ for the four-branch scores, with expert scoring resulting in slightly higher reliability estimates. More recent studies by Maul (2012) and Keele & Bell (2009) have also found similar levels of convergence between expert and consensus scoring, suggesting that both methods can be availed of according to the inclination of the tester. However, the issue of scoring remains a contentious issue in the area of AEI. Both methods of scoring have drawn criticism in the literature.

With regard to expert scoring, concerns have been expressed by academics like Fiori et al. (2014) and MacCann, Matthews and Zeidner (2014) about how the experts were chosen and how they derived the correct answer to a question when given such a significant role in the testing process. Unlike tests of cool intelligence, like verbal or mathematical intelligence, clear-cut answers to emotion-based problems do not exist. In fact, there may often be multiple appropriate responses to an emotion-related problem. Correctness of emotional responses may depend on the frame of reference for analysing a response as correct. For instance, suppressing anger when encountering negative feedback from a supervisor may be an effective means of managing emotions if the aim of the individual is to maintain a satisfactory relationship with the boss. However, it might not be deemed an effective reaction if the criterion is to improve self-esteem and reduce frustration. Originally, the expert scoring criterion for the MSCEIT was derived from responses to the test chosen by Mayer et al. (2002). In light of the significant criticisms that this gathered, the MSCEIT expert scoring criterion was revised and was subsequently based on responses to the items from 21 members of the International Society of Research in Emotion (IRSE, Mayer, Salovey & Caruso, 2012) Nevertheless, as argued by Fiori et al. (2014; 2018), it is still not clear how these emotional experts come to an agreement on the correct answer for each item.

Consensus scoring of the MSCEIT has shown to be best suited to discriminate individuals situated at the lower end of the EI ability distribution (Fiori et al., 2014; Matthews et al., 2002; Maul 2012). More specifically, Maul (2012) found that whereas individuals at the low levels of AEI provided different answers to items, individuals at the mean and high level of AEI provided the same answers to items regardless of whether they were higher or lower on EI. Maul (2012) argues that for those high in AEI, variation in the MSCEIT scores may not reflect true variation in AEI ability. An additional limitation of these approaches is that the MSCEIT has been developed predominantly on neurotypical populations and populations without mental health difficulties, which suggests that there are 'correct' and 'incorrect' ways of identifying and dealing with emotions. Hence, questions about the appropriateness of the tool to assess AEI across the wider population are raised. In the future, the development of new types of assessment modalities for AEI may open further possibilities for denoting the correct or incorrect item on an emotion ability test. For instance, an observational approach may assist in assessing how individuals use their abilities in realistic contexts, instead of just responding hypothetically.

A further critique of the MSCEIT test is that the reliance on static images and text-based items does not adequately reflect how emotional information is processed in real-life contexts (Davis, Morningstar & Qualter, 2020; Fiori et al., 2018). As mentioned previously, the first branch of AEI, Perceiving Emotions, is measured by asking respondents to identify emotions in photographs of people's faces (Faces) as well as the emotions suggested by artistic designs and landscapes (Pictures). Adequate information is portrayed in the facial expression or picture so that the relatively perceptive individual can generate a judgement about the targeted emotion of the person in the picture. The respondent's score on these two subtests is then considered an adequate representation of their mental abilities in the branch of emotion perception. However, as outlined by Mayer et al. (2016, p.294), the second mental ability in

emotion perception branch involves the ability *to perceive emotions in other people through their vocal cues, facial expression, language and behaviour*. Indeed, there is ample research that has determined that emotions are both perceived and expressed through audio-visual gestures such as body language, altering facial expressions and tone of voice (e.g. Bänziger, T., Grandjean & Scherer, 2009; Bänziger & Scherer, 2005; Sauter et al., 2010; Scherer & Ellgring, 2007; Ververidis & Kotropoulos, 2006). Fiori et al. (2018) argue that reducing this test of emotion perception to pictures and photographs may therefore provide a partial assessment of an individual's emotional perception abilities. Davis et al. (2020) reported some empirical evidence to show that the mental abilities involved in the perception of emotion through facial expressions may differ to those required for the perception of emotion in voice. In a study of 122 adolescents aged 11-18 years, Davis et al. (2020) found that young people who scored high on the youth version of the MSCEIT were not more accurate at recognising vocal emotions in audio clips than those who scored lower on the MSCEIT. Contrary to theoretical predictions, those high in AEI did not appear to have superior mental abilities in recognising emotions through voice. Consequently, there is a need for further studies to examine the generalizability of emotion perception across modalities and to determine whether non-facial recognition tasks should be added to the EI assessments. In the future, the inclusion of audio or indeed video may better represent the conditions in which emotional information is perceived and represented in real-life contexts.

An additional critique of the MSCEIT raised by Fiori et al. (2018) and O'Connor et al. (2019) is that the tasks included in each of the 8 subtests do not assess all of the complex mental abilities outlined in the higher end of each of the four branches. As reviewed above, in the Emotion Perception branch, the facial and picture recognition task does not address all of the mental abilities outlined in the perception branch, particularly the more complex abilities of discriminating accurate or inaccurate emotional expressions and identifying deceptive or

dishonest emotional expressions. Additionally, it focuses solely on the perception of the emotions of others and does not address the abilities relating to the perception of emotions in oneself. This is the case across the MSCEIT subtests as it is not explicitly outlined which items map onto specific abilities for each branch. Mayer and Salovey (2016) argue that assessment of each subskill is not necessary for an adequate overview of EI ability to be revealed. They conclude that other types of intelligence tests have to make similar exceptions due to time constraints. Providing the example of verbal intelligence tests, they argue that although each sub-element of the intelligence is not typically assessed, these tests are predominantly accepted as true indicators of verbal capabilities. While this is not an issue exclusive to the MSCEIT alone, it does raise questions about whether each branch in the complex model of AEI outlined by Mayer et al. (2016) can be comprehensively tested using an omnibus test of a relatively short duration (45 minutes).

On the whole, these critiques have implications for AEI assessment. Attempting to predict the behaviour of an individual in real-life contexts from a text-based test is problematic. As acknowledged by Mayer et al. (2016), superior mental abilities can be distinct from the routine application of these abilities in real-life social-emotional interaction. Another compelling challenge is that the extent to which AEI depends on conscious versus automatic processes is unknown. The majority of ability EI research has dealt with the examination of how individuals thoughtfully and meaningfully reason about their own and others' emotional experiences in a conscious manner. Respondents on the MSCEIT consciously choose an appropriate answer to an emotion-based problem. However, there is a body of studies which show that some emotional behaviour is, in fact, not conscious (e.g. Balconi et al., 2017; Feldman, 2007; Vergallito et al., 2020). Applied to AEI, this may mean that individuals may be able to use emotions intelligently, without being aware of how or why they do it. A performance based test like the MSCEIT cannot be expected to capture the automatic and

perhaps nonverbal abilities underlying the conscious and non-conscious processing of emotion. Although alternatives to the MSCEIT are available, many are similar in design and structure, in that they rely on static and hypothetical assessment modalities.

2.3.2 Alternatives to the MSCEIT: Tests of Emotional Understanding and Management

Currently, there is no alternative assessment for AEI that tests all four branches like the MSCEIT. However, there are assessments that measure some of the mental abilities outlined in single branches. Table 2.2 outlines each branch of the four-branch model and includes some alternatives to the MSCEIT. More recently, there has been an significant advancement in AEI measurement: the development of a second generation of AEI tests, notably the Situational Test of Emotional Understanding (STEU), the Situational Test of Emotional Management (STEM, MacCann & Roberts 2008), and more recently the Multimedia Test of Emotion Management (MacCann et al. 2016). All three follow the Situational Judgement Test (SJT) structure, similar to the one used for the managing emotions branch of the MSCEIT. Respondents are presented with short vignettes describing real-life emotional problems (42 on the STEU and 44 on the STEM) and are asked to select, from a list of five, which emotion best reflects how the protagonist would feel in each context (STEU), or which proposed course of action would be the most beneficial in managing emotions in each described situation (STEM). Correct answers on the STEU are scored according to Roseman's (2001) appraisal theory. Appraisal theory is an emotion model, in which the emotion felt by the person is derived from their appraisal of the emotion-generating situation. When certain appraisal dimensions are combined, it is theorised that they form specific emotions. For example, relief is associated with the perception that an unpleasant situation has stopped or been averted. An example from the STEU is: An irritating neighbour of Eve's moves to another state. Eve is most likely to feel? (a) regret, (b) hope, (c) relief, (d) sadness, (e) joy. In this item, the unpleasant situation has been stopped, hence the appropriate and

correct response is relief. Similar to the expert scoring method on the MSCEIT, correct answers on the STEM are scored according to the judgements provided by emotion experts. In total, 19 experts, all of whom were professionally trained psychologists holding a Masters degree or higher, or who were members of an EI research consortium were involved in creating a scoring criterion for the STEM (MacCann & Roberts, 2008).

Table 2.2

Alternatives to MSCEIT

Branch and Definition	Standardised Assessments
Perceive Emotions	• Diagnostic Assessment of Non-Verbal Abilities (DANVA): Faces, Voices, Postures [a] • Japanese and Caucasian Brief Affect Recognition Test (JACBART) [b] • Profile of Nonverbal Sensitivity (PONS)[c] • Multi-modal Emotion Recognition Test (MERT)[d] • Geneva Emotion Recognition Test (GERT) [e] • The Reading the Mind in the Eyes Test [f] • Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) Perception Tests: Faces and Pictures [g]
Understand Emotions	• Situational Test of Emotional Understanding (STEU)[h] • Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) Understanding Tests: Changes and Blends[g]
Managing Emotions	• Situational Test of Emotional Management (STEM) [h] • Multimedia Emotion Management Assessment (MEMA)[i] • Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) Managing Tests: Emotion Management & Relations[g]
Facilitating Thought Through Emotion	• Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) Facilitating Thoughts Through Emotion Tests: Emotion Management & Relations [g]

Note: [a] Nowicki and Duke (1994), [b] Matsomoto et al. (2000), [c] Rosenthal et al. (1979), [d] Banziger et al. (2009), [e] Schlegel et al., (2009), [f] Baron-Cohen et al. (2001), [g] Mayer et al., (2002), [h] MacCann & Roberts (2008), [i] MacCann et al. (2016)

A series of studies have examined the reliability of the two tests which was reported to be between α= 0.71 and 0.72 for the STEU and between α= 0.68 and 0.85 for the STEM (Allen, 2015; Austin 2010; de Motta et al., 2020; Libbrecht & Lievens, 2012; MacCann & Roberts, 2008). As Cronbach's alpha scores of over .7 demonstrate high internal consistency, the STEU and the STEM were reported to be reliable (Allen, 2015; Libbrecht & Lievens, 2012; MacCann & Roberts, 2008). Similar to the criterion used for the MSCEIT above, if the STEU and STEM are to be classified as intelligence tests, they should demonstrate moderate correlations with tests of other types of intelligences. A small number of studies reported moderate correlations (r = .49 and r = .41) between the STEU and STEM respectively with tests of verbal intelligence (Allen, 2015; Austin 2010; Libbrecht & Lievens, 2012; MacCann & Roberts, 2008). These findings support the assertion that both the STEU and the STEM are measuring mental abilities that are not already tested in existing intelligence tests and support their use as tests of emotional mental abilities.

An issue remaining with the STEU and the STEM however, is their relatively low correlations with the MSCEIT. Correlations between the STEU/STEM and the MSCEIT should be relatively high if they are measuring equivalent mental abilities of emotional understanding and management. The literature on this relationship remains scant. MacCann & Roberts (2008) showed moderate positive correlations between the STEU and the STEM and MSCEIT total scores (r = .33 and r = .36 respectively). Focusing on the one branch of emotion perception, Austin (2010) found low correlations between scores on this branch of the MSCEIT and the STEM and STEM. As reviewed by Allen (2015), further examination of the relationship between the MSCEIT and the STEM/STEU are required to explore if they are measuring the same mental abilities involved in AEI.

Both the STEU and the STEM are important developments in AEI assessment as they provide an alternative to using the MSCEIT. Unlike the MSCEIT, they are not subject to

considerable reproduction and administration fees and can be easily obtained for research purposes (de Motta et al., 2020). However, these tests have similar limitations to the MSCEIT. Being text-based, they may not reflect participants' ability to understand and manage emotions in real-life situations (see Figure 2.5 for sample items). They lack the type of stimuli that must be processed in real-life emotional contexts such as body language, facial expressions and voice.

Figure 2.5

Sample items from STEU and STEM

Xavier completes a difficult task on time and under budget. He is most likely to feel?

(a) Surprise
X (b) Pride
(c) Relief
(d) Joy

Wai-Hin and Connie have shared an office for years but Win-Han gets a new job and Connie loses contact with her. What action would be the most effective for Connie?

(a) Just accept that she is gone and the friendship is over
(b) Ring Wai-Han and ask her out for lunch or coffee to catch up
(c) Contact Wai-Han and arrange to catch up but also make friends with her replacement
(d) Spend time getting to know the other people in the office, and strike up new friendships.

Note. Reproduced from MacCann and Roberts (2008) Open-access measure. Retrieved from https://www.academia.edu/9477571/Test_Protocol_The_Situational_Test_of_Emotional_Understanding_STEU_

With these limitations in mind, MacCann et al. (2016) developed a new version of the Situational Test of Emotion Management (STEM), the Multimedia Emotion Management Assessment. On the basis of the original text-based items used in the STEM, scripts for short video-based scenarios and responses were developed. Both the scenarios and responses to the scenarios were presented in video format, and both could be played numerous times For all of the items on the MEMA, the video depicted an interaction among the protagonist and at least

one other person (including facial expressions, body language, and vocal information). This was followed by four short videos of possible response items to the scenario shown. The respondent chose the video that they best felt showed the most appropriate emotional reaction. In a study of 427 college students, MacCann et al. (2017) found significant correlations between scores on the branches of the MSCEIT and those on the MEMA, suggesting that the MEMA was assessing the same management abilities as those measured in the four-branch test. The MEMA was also positively related to established intelligences, was distinct from personality traits and was related to indicators of emotional functioning and academic achievement. However, Cronbach's alpha was relatively low at .61, meaning that it was below the accepted rate of internal reliability typically used for tests. These findings highlight the need for further studies that continue to examine the validity and the reliability of the MEMA. However, little to no research has been carried out since MacCann et al. first introduced the test in 2016.

The MEMA is the first AEI test to include multimedia. Its strength lies in fact that the participant can judge the situation based on body language and facial expressions rather than reading from the text. As summarised by Fiori et al. (2018), the MEMA is an important progression in AEI assessment but additional advancements are required. Now, AEI assessment needs to move forward in replicating real-life conditions where participants must display their AEI in workplace, educational or personal contexts.

2.3.4 Alternatives to the MSCEIT: Tests of Emotional Perception

There are several long-existing standardised measures of perceptual accuracy in recognising emotions, many of which were developed even before the model of AEI. Consequently, these are not classified as AEI tests but do correspond to the perceiving emotions branch of AEI and could be considered as suitable alternatives to the MSCEIT. Research outside of the

MSCEIT measurement tradition has often used the term ‘emotion recognition’ to describe such abilities, whereas the MSCEIT refers to “emotion perception”. As Table 2.2 summarises, the most widely used of these tests are the Diagnostic Analysis of Nonverbal Accuracy (DANVA; Nowicki & Duke 1994), the Profile of Nonverbal Sensitivity (PONS; Rosenthal et al.,1979), and the Japanese and Caucasian Brief Affect Recognition Test (JACBART; Matsumoto et al., 2000). Similar to the MSCEIT faces task, these tests involve observing a range of stimuli depicting another person’s emotion, and the respondent’s task is to correctly identify the emotion expressed. However, moderate to low correlations have been found between the majority of these emotion recognition tests and the emotion perception branch of the MSCEIT, suggesting that they are not testing equivalent mental abilities. One explanation for these results is that unlike the rating-scale format of the MSCEIT faces items, these tests use a multiple-choice format, where respondents must choose one emotion, from a list of several, that best matches the picture. This variance in response could account for the weak convergence between performances on the MSCEIT branch and these emotion recognition tests (MacCann et al., 2016).

Emotion recognition tests use different forms of stimuli and modalities, including photos of faces and audio recordings, to present varying sequences of target emotions. For instance, the DANVA has 24 photos of male and female facial expressions and 24 audio recordings of the same neutral sentence (“I am going out of the room now but I’ll be back later”), portraying 1 of 4 emotions (happiness, sadness, anger and fear) in 2 intensities either weak or strong. The PONS is categorised as a test assessing interpersonal sensitivity, or the precision in judging other people’s nonverbal cues and affective states. It uses 20 short audio and video parts of a woman for a total length of 47 minutes. The goal is to identify which of the two emotion situations more accurately captures the woman’s expression. The JACBART has 56 pictures of Japanese and Caucasian faces expressing one of 5 emotions (fear, happiness, sadness,

anger, surprise, contempt and disgust). This test is unique in that it uses a very short presentation time (200ms). Every expressive picture is preceded and succeeded by a neutral version of the same person expressing the emotion in the target picture, in order to reduce post effects of the images and obtain an unprompted reaction to the perceived emotion. Unlike other tests, including the MSCEIT, the JACBART recognises the importance of unconscious emotional perception.

As discussed previously, the MSCEIT perceiving branch has been scrutinised for its focus on a single modality (i.e. still photos and images), as well as for its restricted range of target emotions (only one of them positive), which limits its ecological validity and may reduce the assessment's ability to discriminate between more complex and nuanced emotional states (Fiori et al., 2018; Schlegel et al., 2017. A new series of emotion recognition tests designed at the Swiss Centre for Affective Sciences: the Multimodal Emotion Recognition Test (MERT; Bänziger et al., 2009) and the Geneva Emotion Recognition Test (GERT; Schlegel et al., 2014), intend to amend these issues through the use of more ecologically valid stimuli. The GERT employs 83 videos, 1 to 3 seconds long, of male and female actors expressing 14 emotions (joy, amusement, pride, pleasure, relief, interest, anger, fear, despair, irritation, anxiety, sadness, disgust, and surprise), through facial expressions, audio and nonverbal body language. A short version with only 42 items is also available (Schlegel & Scherer 2015). Emerging examination of the GERT shows that it has good internal consistency for both the longer and short version of the test (Cronbach's alpha was .74 and .80 respectively). Schlegel et al. (2017) also found that scores on the GERT correlated positively with scores on the STEU and the STEM, while controlling for scores of cognitive ability. These results suggest that the GERT is related to emotion management and emotional understanding abilities beyond what can be explained by cognitive ability. Although future studies are needed to address the validity of the GERT, this test demonstrates how developments in technology can

assist in better representing the conditions in which people encounter emotional problems in their everyday lives.

2.3.5 Ability Emotional Intelligence Measures for Children

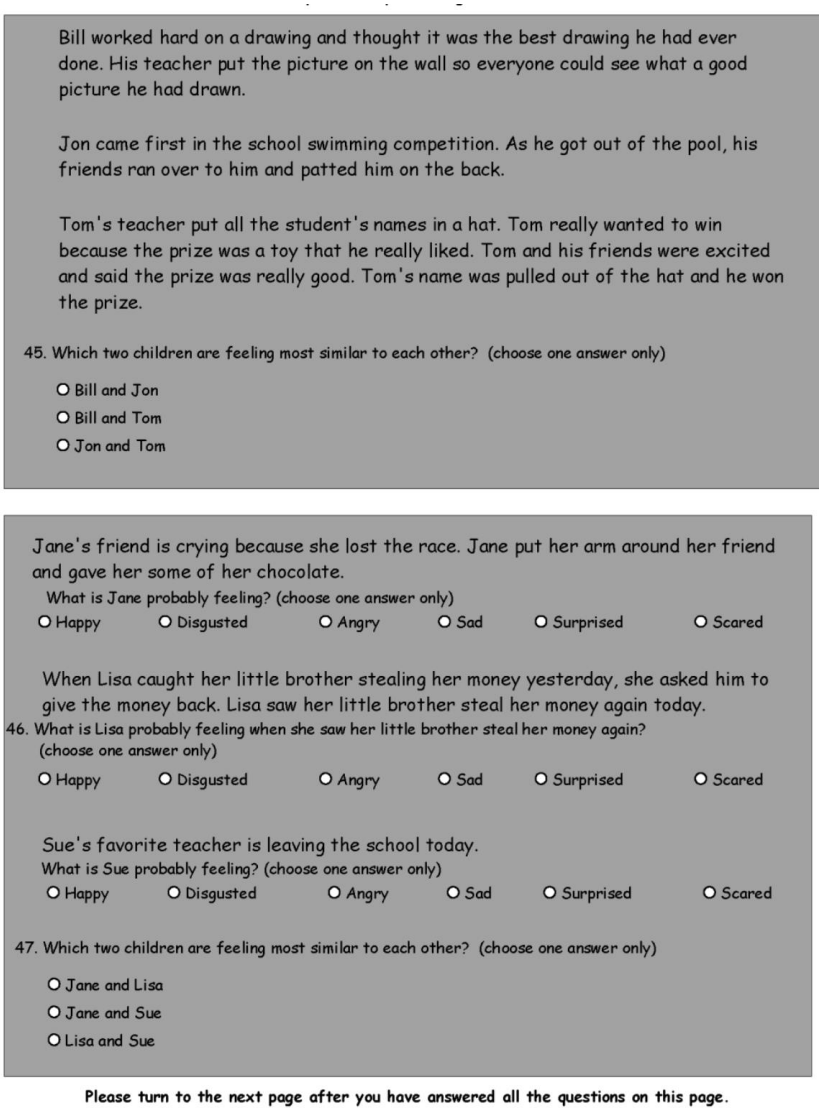
As highlighted by researchers in the area of AEI (e.g., Billings et al., 2014; Bunnett 2021; Lloyd, 2014), there has been a dearth of empirical research that has been conducted concerning the presentation of AEI in children and pre-adolescents. This limited research represents the few assessment modalities that are available for AEI, with many child EI measures centred on the assessment of trait or mixed-model EI using self-report measures. The most popular measure available for those under 18 is the youth version of the MSCEIT. Developed by Mayer et al. (2005), the MSCEIT-YV was designed to assess the four branches of AEI in children aged 10-18 years of age, using a total of 101 items, 97 which are scored. Like the adult version, the scale incorporates a range of performance-based tasks, including the rating of facial expressions (Branch One), describing emotions using physical descriptors (Branch Two), use of emotional adjectives and adverbs to describe emotional definitions and causes (Branch Three) and explaining mechanisms through which emotions (in vignettes) may be modified (Branch Four). Research has provided support for the internal reliability of the scale, ranging from .67 on Branch One to .87 on Branch Three, despite an overall EI Cronbach's alpha of .91 (Climie et al., 2019; Rivers et al., 2012). Studies have also supported the predictive validity of the measure, with higher scores on the MSCEIT-YV positively correlated to higher academic performance, social competences and psychological wellbeing (MacCann et al., 2020; Rivers et al., 2012).

More recently, the Swinburne University Emotional Intelligence Test was adapted by Lloyd et al. (2012; 2014) to design a measure of AEI for pre-adolescents, but has only been tested with children aged between 9 and 13 years of age. It is a 68 item measure and provides scores

for the four AEI areas. Unlike the MSCEIT-YV, it assesses the branches of AEI using both self-report and performance based items. The self-report items are rated on a 5 point Likert scale from 1 ‘Not at all like me’ to 5 ‘Exactly like me’, while the performance based items present a series of emotional scenarios, from which participants must select the most appropriate description of the characters’ experiences from a set of item-specific multiple choice response items (see Figure 2.6 for sample item). Although the initial studies by Lloyd (2014a; 2015b) identified many limitations of the measure, a recent study by Bunnett et al (2021) revised the scale and reported greater internal consistency (Cronbach’s alpha of .87). As this scale remains in the early stages of study, further research is required to validate its use as an assessment of AEI in children.

Figure 2.6

Sample item from SUEIT measure for Pre-Adolescents



Bill worked hard on a drawing and thought it was the best drawing he had ever done. His teacher put the picture on the wall so everyone could see what a good picture he had drawn.

Jon came first in the school swimming competition. As he got out of the pool, his friends ran over to him and patted him on the back.

Tom's teacher put all the student's names in a hat. Tom really wanted to win because the prize was a toy that he really liked. Tom and his friends were excited and said the prize was really good. Tom's name was pulled out of the hat and he won the prize.

45. Which two children are feeling most similar to each other? (choose one answer only)

- O Bill and Jon
- O Bill and Tom
- O Jon and Tom

Jane's friend is crying because she lost the race. Jane put her arm around her friend and gave her some of her chocolate.

What is Jane probably feeling? (choose one answer only)

O Happy O Disgusted O Angry O Sad O Surprised O Scared

When Lisa caught her little brother stealing her money yesterday, she asked him to give the money back. Lisa saw her little brother steal her money again today.

46. What is Lisa probably feeling when she saw her little brother steal her money again? (choose one answer only)

O Happy O Disgusted O Angry O Sad O Surprised O Scared

Sue's favorite teacher is leaving the school today.

What is Sue probably feeling? (choose one answer only)

O Happy O Disgusted O Angry O Sad O Surprised O Scared

47. Which two children are feeling most similar to each other? (choose one answer only)

- O Jane and Lisa
- O Jane and Sue
- O Lisa and Sue

Please turn to the next page after you have answered all the questions on this page.

Note. Reproduced from Lloyd (2012). Open access Swinburn Research Bank. Retrieved from: http://hdl.handle.net/1959.3/230577

2.3.6 Alternative Assessment Methods for Emotional Intelligence: Observational Tools

As described above, the majority of assessment methods for AEI are performance text-based tests. Consequently, a recurring criticism of current AEI assessment types is that they may not indicate how an individual uses AEI in authentic, real-life settings. Research around the

broader landscape of EI and socioemotional skills has explored the development of observational tools, a number of which are briefly discussed.

Using EI literature from both trait and mixed models, the Emotional and Social Competency Inventory (ESCI) was developed by Hay Group, a global management consulting firm. in order to improve organisational productivity and success. Relating to employee performance in the workplace, the inventory assesses twelve competencies from the area of social and emotional intelligence, combing self-report measures with rater scales (Hay Group, 2006). Another example comes from the field of nursing, where, having identified a lack of EI measures which specifically related to nursing, Mayor-Silva et al. (2018) developed an observer-based emotional measurement tool, the Situational Emotional Response Scale (ERES), which can be used to observe the performance of a nursing student's emotional skills in a conflict situation with a patient. A panel of 6 experts refined 80 skills to 34, which are assessed by the observer using a Likert scale. Although this scale was not developed with any particular model of EI in mind, it demonstrates how behaviours related to EI can be observed within everyday nursing contexts. Another area where observation of behaviours related to emotions have been developed is in the area of child socio-emotional development and early screening cognitive and language screening instruments. For example, the Brigance Screens – Infant and Toddler Screen (Brigance & Glascoe, 2002) involves direct observation of skills, including socio-emotional skills.

Although these observational assessment tools have considerable differences in terms of their audience, purpose and setting, they have similar challenges and benefits. Observational assessment tools have limitations as an individual's subjectivity may influence his/her interpretation and assessment of behaviours, particularly when evaluating the behaviour of others in the area of emotions (Mayor-Silva et al., 2018). This issue of subjectivity is well-documented in qualitative research, where issues of researcher-bias can impact data

interpretations (Dado, Spence & Elliot, 2023; Smit & Onwuegbuzie, 2018). Observers, therefore, often need to be highly trained. This is emphasised in the use of the ECSI, which recommends the involvement of at least two raters are in the completion of rating scales for the employee (Hay Group, 2006). An additional option is that external ratings can be verified by other types of data sources, such as self-report measures.

Although not without challenges, these initial studies show there is also scope for the emergence of a new form of assessment which better mirrors the real-life conditions in which AEI is used. Rather than responding to hypothetical situations, test-takers could immerse themselves within a task that would reflect the educational and work environments in which they regularly use their AEI abilities. The following section reviews CPS and highlights how it may be used to further advance the area of AEI assessment.

2.4 Collaborative Problem-Solving

CPS involves the cognitive skills of problem-solving as well as the social skills[5] of collaboration. Researchers in CPS have successfully adapted problem-solving assessments to include an assessment of the social skills of collaboration.

2.4.1 An Overview of the CPS Model developed for the Assessment and Teaching of 21st Century Skills Project

Collaborative problem solving (CPS) has been identified an essential skill in the 21st century as technology has altered the way that humans live, learn and work (Sun et al., 2020). In this study, a skill is defined as an ability or proficiency acquired through training or practice (Scott, 2020).CPS draws together a number of these skills to form a single model that has roots in collaboration, problem-solving and social-learning theory. Throughout the literature, there have been a number of CPS models proposed. Although there is considerable overlap

between all of the models mentioned above, there is no clear consensus on how CPS should be defined and how it should be measured effectively (Sun et al., 2020). The present study uses the definition of CPS that was created for the Assessment and Teaching of 21st Century Skills (ATC21S) project, an initiative designed to develop and explore teaching and assessment approaches in CPS (Hesse et al., 2015). In this project, CPS is defined as a "joint activity where two or more people work together to contribute resources they alone control, to progress through a series of cognitive states that involve collection and analysis of information and the formulation of hypotheses that they jointly set out to test" (Hesse et al., 2015). The problem to be solved is a common goal for all of the individuals involved. Individuals may bring different resources, information and expertise that is not available to others to the problem. No one individual can solve the problem and collaboration with others is required for success.

The collaborative aspect of CPS includes a number of important elements. The first element is communication, the sharing of knowledge or perspectives to make best of individual experience. This element is a necessary but not an essential element of CPS- it requires that communication move beyond the exchange of information (Stadler et al., 2020). The second element is co-operation, which is fundamentally an agreed allocation of responsibilities (Scoular, Care & Hesse, 2017). A third element is responsiveness, representing active and responsive participation and interaction with other group members Care, Scoular & Griffin, 2016; Hesse et al., 2015;). Problem solving, on the other hand, is an exercise in which a person observes a disparity between a current state and a desired goal state, recognises that this disparity does not have a clear solution, and consequently attempts to alter the situation in order to achieve the goal state (Hesse et al., 2015). From these definitions, CPS means approaching a problem responsively by working together and exchanging ideas. It is

particularly useful when addressing problems that are complex (Care et al. 2016; Hesse et al., 2015; Scoular et al., 2017).

Hesse et al. (2015) outline five main processes that are involved in CPS. The first, problem identification is where all group member recognise the problem and which elements of the problem they can each attempt to solve. The second, problem representation, refers to the shared representation of the problem amongst group member. That is, group members should have a 'mental understanding' of the problem that is the same and that there is no misunderstanding about the problem to be solved. The third area, planning, requires group member to put a shared endeavour into action in order to achieve the goal state. The final two steps, executing and monitoring, involve enaction of the plan and evaluation of its success.

As described by Hesse et al. (2015), CPS is not a linear, uniform process but a complex activity between two or more individuals. As a result, effective CPS does not depend on a uniform set of skills but rather a range of cognitive and social skills that are engaged in accordance with situational needs. Although the five processes mentioned above can be used as a tool to describe CPS, it is not the case that CSP skills can be easily mapped to the varying stages (Andrews-Todd & Forsyth, 2020). Often CPS groups will move back and forth through each of these processes in order to solve the problem. Many skills transfer across several problem-solving stages (Care et al., 2016; Hesse et al., 2015).

The theoretical approach taken by the ATC21S project (Care et al., 2016; Hesse et al., 2015; Scoular et al., 2017) was to develop a model of skills that play an important role in CPS. In turn, this model could be used as assessment framework to explicitly assess CPS skills. They pinpointed two over-arching domains: social and cognitive. The social domain makes reference to the collaborative skills involved in dealing with other individuals when solving the problem, whereas the cognitive domain refers to the problem-solving skills required to

manage and deal with the task. Therefore, collaborative skills relate to the domain of 'hot' intelligences and involve the processing of emotionally-salient information (Ahonen & Harding, 2018). In contrast, problem-solving skills relate to the domain of cool intelligences and require logical reasoning and perceptual processing. To clarify this distinction, it is presented that the social skills are about managing participants and oneself, whereas cognitive skills are about managing the task to be solved (Scoular et al., 2017). The present research centres on the social skills domain of CPS as these are related to the branches of the AEI model.

The social domain in the CPS framework presented by Hesse et al. (2015) categorises collaborative skills in three main areas or what they term elements: Participation, Perspective Taking and Social Regulation (see Figure 2.7). These are then divided into more specific skills. Indicators or behaviours which represent these skills are also included in the model. These indicators are divided into low, middle or high, with low representing behaviours from individuals at the lowest level at the skill and high representing behaviours from individuals at the highest level of the skill.

Figure 2.7

Social Skills of Collaboration in CPS.

Element	Indicator	Low	Middle	High
Participation				
Action	Activity within environment	No or very little activity	Activity in familiar contexts	Activity in familiar and unfamiliar contexts
Interaction	Interacting with, prompting and responding to the contributions of others	Acknowledges communication directly or indirectly	Responds to cues in communication	Initiates and promotes interaction or activity
Task completion/ perseverance	Undertaking and completing a task or part of a task individually	Maintains presence only	Identifies and attempts the task	Perseveres in task as indicated by repeated attempts or multiple strategies
Perspective taking				
Adaptive responsiveness	Ignoring, accepting or adapting contributions of others	Contributions or prompts from others are taken into account	Contributions or prompts of others are adapted and incorporated	Contributions or prompts of others are used to suggest possible solution paths
Audience awareness (Mutual modelling)	Awareness of how to adapt behaviour to increase suitability for others	Contributions are not tailored to participants	Contributions are modified for recipient understanding in the light of deliberate feedback	Contributions are tailored to recipients based on interpretation of recipients' understanding
Social regulation				
Negotiation	Achieving a resolution or reaching compromise	Comments on differences	Attempts to reach a common understanding	Achieves resolution of differences
Self evaluation (Metamemory)	Recognising own strengths and weaknesses	Notes own performance	Comments on own performance in terms of appropriateness or adequacy	Infers a level of capability based on own performance
Transactive memory	Recognising strengths and weaknesses of others	Notes performance of others	Comments on performance of others in terms of appropriateness or adequacy	Comments on expertise available based on performance history
Responsibility initiative	Assuming responsibility for ensuring parts of task are completed by the group	Undertakes activities largely independently of others	Completes activities and reports to others	Assumes group responsibility as indicated by use of first person plural

Note. Copyright 2015 Springer Nature Reproduced from Hesse, Care, Buder, Sassenberg and Griffin (2015) with permission.

Participation refers to a person's engagement with the problem, the degree to which they persevere to tackle the problem, as well as their interaction with others. As Figure 2.7 illustrates, within the range of participation skills, the model further differentiates between three aspects: action, interaction and task completion. Action refers to the overall degree to which a person participates, regardless of whether this participation linked to the efforts and behaviours of other group members. Those high in this skill have the ability to participate in CPS without the use of scaffolds and explicit instruction. Those lower in the skill of participation may not act at all or will need support or guidance from peers or an instructor (Care, Scoular & Bui, 2015). Interaction refers to behaviour that shows interaction with and responses from others. A high level of the interaction skill is shown by those who react to communication or non-verbal behaviours from others, e.g. by answering a question or query from a collaborator. Interaction between problem-solvers is an essential prerequisite for collaboration and is carried out through verbal and non-verbal actions (Care et al., 2015). Finally, task completion skills make reference to the motivational elements of group member and their efforts to persevere with the task. Those who are adequately immersed in the problem state despite challenges encountered, score highly on this skill (Care et al.,2016; Hesse et al., 2015).

Perspective skills relate to the quality of interaction between the individuals attempting to solve the problem. If a person cannot or does not understand the perspective of others, they may have egocentric bias, that is, they attribute others thought processes to be highly similar to themselves. Understanding the perspective of others has been found to lessen conflict in CPS (Hao et al., 2017). The framework of CPS skills distinguishes between two elements of perspective taking: responding skills and audience awareness skills (see Figure 2.7). Responding skills refer to the extent to which the contributions of others are taken on board by the problem-solver. Those skilled in this area effectively integrate the contributions of

their group members into their own perspectives. Failing to recognise or address the contributions of others would put the group member at the lower end of this skill. Audience skills are described as the ability to change one's behaviour and contributions to increase suitability for others and increase opportunities success for the whole group (Care et al., 2016; Hesse et al., 2015). Perspective skills relate to the area of emotional management and understanding, which is unpacked in the section below.

As summarised in Figure 2.7, the third area, social regulation skills, refers to the individual's management of the collaborative environment. The framework is broken into four aspects: metamemory, transactive memory, negotiation and initiative. The first two of these aspects describe the ability to recognise and use group diversity as a positive factor in problem-solving. Diversity of viewpoints, opinions and backgrounds has shown to be a significant factor in CPS, but only when it is effectively nurtured. Group members must manage and understand social aspects of CPS at a sophisticated level to comprehensively benefit from diversity in a group collaborative setting (Hao et al., 2017; Graesser et al., 2018). Negotiation skills are significant when conflict between group member occurs. In any sort of conflict, individuals must manage their own and other emotions to reach a solutions that works for all collaborators (Graesser et al., 2018). Finally, initiative makes reference to the responsibility that each group member takes on board for successful problem-solving. Establishing collective responsibility for group behaviours is difficult but if completed effectively ensures greater levels of productivity and overall satisfaction (Andrews-Todd & Forsyth, 2020; Hesse et al., 2015).

The social domain of CPS contains a broad range of significant social skills that are used in problem-solving environments. As presented by Hesse et al. (2015), many of these social skills originate from different theories of social psychology, problem-solving, collaboration and more. There is yet to be a definitive and final model of the collaborative abilities

included in CPS. Care et al. (2016) acknowledge that problem-solving in a collaborative model may require more skills than those in the CPS model designed for the ATC21S or indeed less than those included, depending on the situation in question and the characteristics of the problem-solvers who were collaborating.

The following section addresses how many of the specific mental abilities of the AEI model can be integrated within the broad skills outlined by Hesse et al. (2015). Therefore, there is a strong theoretical convergence between the social skills of CPS and the mental abilities of AEI. This convergence is significant as it gives rise to the conclusion that the assessment modalities used to elicit CPS could also be used or adapted to elicit the use of AEI abilities. This type of adaptation would address the gap in the AEI assessment literature that was described above.

2.5 CPS and Emotional Intelligence: Convergence between the Social Skills of CPS and the Mental Abilities AEI

A broad range of literature was analysed when exploring the potential convergence between EI and CPS. As Tian and Zheng (2024) outline, although CPS is widely recognised as a core competency for twenty-first-century learning, it is relatively new area of study and its theory continues to be refined. To date, little is known about how the developmental trajectory from basic to more sophisticated levels can be observed or assessed (Tian & Zheng, 2024). Similarly, as reviewed by Fiori, Angoli and Davis (2023), although significant strides have been made in conceptualising and assessing EI, further insights into EI theory will continue to emerge in the coming years. Given the evolving nature of both theories, it is not surprising that an empirical relationship between the skills included in the CPS model used in this research (Hesse et al., 2015) and the abilities outlined in Mayer et al.'s (2016) model of AEI has not yet been explored.

However, CPS theorists have drawn on a solid bank of literature from areas including problem-solving, group work, collaboration and team work to inform theory development, some of which have been linked to EI. Therefore, to facilitate a more in-depth exploration of the links between components of AEI and CPS theory, the search was broadened to incorporate research which was related to these two areas, but may not have directly referenced the models used in this study. Research around collaboration and teamwork, as well as the area of EI in general, was useful in highlighting the links between the use of emotions and collaborative group work settings. The following points summarise the approach and process taken by the researcher:

- **Direct** empirical literature which examined the relationship between the ability model of EI (as measured by the MSCEIT) and CPS was sought as part of the literature review for the study.
- **Empirical** literature, in which collaboration or **aspects of collaboration** (e.g., conflict resolution) were linked with a **trait/mixed/ability model of EI,** was examined.
- **Theoretical** literature which referenced EI and its use in collaborative/team/groupwork settings was examined.

As an exploratory study, it was not always possible to make direct connections from the literature between some of the skills of CPS and the branches of the AEI model. Where literature links could not be established, the researcher used her own practical knowledge of collaborative educational settings to outline potential convergence between the two areas.

In accordance with the approach adopted, Tables 2.3, 2.4 and 2.5 illustrate how many of the mental abilities outlined in the AEI four-branch model could integrated under the broader social skills of CPS. It is probable that not all of these mental abilities are necessary for success across varying types of CPS tasks. Task characteristics, the individual differences

between team members and the platform in which the CPS tasks is being undertaken (virtual or face-face) may all impact which mental abilities of AEI and indeed which social skills of CPS are required by problem-solvers.

It is important to clarify at this point, once again, the distinction between the 'skills' outlined in the CPS model and the 'mental abilities' that are organised under each branch heading in AEI theory. The term skills in CPS theory comes from the widely known term '21st century skills', referring to the skills that are necessary for the modern workplace (Care et al., 2016; Hesse et al., 2015). A skill is categorised as a broad term which may include knowledge, attitudes and specific abilities. Skills are typically thought of as adaptive in that they are acquired through formal or informal teaching and are not innate (Care et al., 2016; Hesse et al., 2015; Scott, 2015). Mental abilities are also considered adaptive and are defined as specific cognitive abilities that are used to solve a psychological task or solve a problem (Mayer et al., 2016). Skills are therefore broader and can encompass specific mental abilities.

The first broad social area that is important for CPS is Participation (see Table 2.3). Three main skills are outlined within participation (Hesse et al., 2015). One of these skills, interaction, involves engaging with others socially and responding to their contributions. There is some literature which has directly linked AEI with positive social interactions. For example, Lopes et al. (2004) reported that higher scores on the managing emotions subscale were correlated with external ratings of an individual's positive interactions with others. Similarly, Brackett et al. (2006) found that individuals who scored higher on the MSCEIT were more likely to demonstrate positive observable social behaviours when participating in a social group task. From a theoretical perspective, emotion theorists, including Izard (2013), have suggested that individuals who are adept at understanding and regulating emotions benefit in their social functioning and interaction with others.

Interaction is achieved through verbal and nonverbal means (Graesser et al., 2018; Hesse et al., 2015). As the information presented in Table 2.3 shows, there are also many practical and common sense links which suggest that having well-developed AEI would facilitate an individual when interacting with others. For example, perceiving emotion in oneself and others may assist in interacting appropriately. A person who misreads a facial expression or body language may vocally respond in an inappropriate manner. *Understanding the meanings and consequences of emotions* expressed by the members of one's team or by one's partner will assist the problem-solver in responding effectively (understanding emotions). *Generating emotions as a means to relate to the experiences of others* (facilitating thought through emotion) may help in building rapport and a sense of comradery which may improve performance overall. Effectively managing other's emotions will create desired interactions. Interaction may not always require a high level of AEI. However, as humans are by their nature emotional, it is theoretically likely that some type of emotional interaction will take place when problem-solving, particularly if that problem is complex.

Table 2.3

Convergence between AEI abilities and Participation in CPS

Participation	
Interaction: Interacting with others and responding to the contributions of others	
Perceiving Emotion: • *Perceive emotional content in the environment, visual arts, and music* • *Perceive emotions in other people through their vocal cues, facial expression, language, and behaviour* • **Facilitating Thought Through Emotion** • *Prioritize thinking by directing attention according to present feeling* • *Generate emotions as a means to relate to experiences of another person*	**Understanding Emotions** • *Understand how a person might feel in the future or under certain conditions (affective forecasting)* • *Recognize likely transitions among emotions such as from anger to satisfaction* • *Understand complex and mixed emotions* • *Differentiate between moods and emotions* • *Appraise the situations that are likely to elicit emotions* • *Determine the antecedents, meanings, and consequences of emotions* **Managing emotions** • *Effectively manage others' emotions to achieve a desired outcome* • *Effectively manage one's own emotions to achieve a desired outcome* • *Evaluate strategies to maintain, reduce, or intensify an emotional response* • *Monitor emotional reactions to determine their reasonableness* • *Engage with emotions if they are helpful; disengage if not*
Task completion/Perseverance: the extent to which the individual perseveres on the task	
Managing emotions • *Evaluate strategies to maintain, reduce, or intensify an emotional response* • *Monitor emotional reactions to determine their reasonableness* • *Engage with emotions if they are helpful; disengage if not*	

Table 2.4 illustrates how AEI mental abilities can be placed under the Social Regulation area of CPS. It does not map each mental ability to each social skill of social regulation separately as there is considerable theoretical overlap between all of these social skills and the mental abilities included. Depending on the problem-solving context and the characteristics of the problem solvers, different mental abilities may be relevant. One important skill in social regulation is negotiation, that is, solving and avoiding conflict. According to Hesse et al. (2015), negotiation should reduce ambiguity around the task, solve conflict by managing diverging opinions, and contribute to an overall solution through combined effort in CPS. There is a considerable body of research linking the area of EI with negotiation, both empirically and theoretically. Research has established that emotions and emotional abilities have a role in the negotiation process. As outlined by Schlegel et al. (2017), the negotiation process can elicit many different types of emotions such as surprise, irritation, happiness or interest, all of which are likely to affect the results of a task. Some empirical studies have reported a positive correlation between high AEI and specific negotiation outcomes like establishing trust, the desire to negotiate again with the participant and overall satisfaction with the negotiation process (e.g. Kim. Kundiff & Choi, 2014; Mueller & Curhan, 2006; Pulido-Martos, Lopez-Zafra,& Augusto-Landa, 2013). Links have also been made between other measures of EI and negotiation. For example, Reppert (2020) found that those with higher levels of emotion recognition abilities, as measured by the GERT, were rated as demonstrating more sophisticated negotiation skills. As the majority of these studies used correlational data, they did not explore the specific processes that underpin the relationship between effective negotiation and high AEI.

Theoretically and practically, there are a number of ways that those who are high in AEI are more successful at negotiation. Those high in AEI have the ability to recognise and perceive emotions well (Perceiving Emotions and Understanding Emotions). It is possible that this

may allow the negotiator to choose their selected approach strategically and to elicit particular emotions in their partner (Managing emotions). Emotion facilitation abilities may also benefit the negotiator in understanding the perspectives of their team member and to prioritise thinking to deal with the conflict presented. Effective emotion management could assist in maintaining a positive attitude towards CPS, expressing emotions in an appropriate way, which, in turn, assists conflict resolution.

Table 2.4

Convergence between AEI abilities and Social Regulation in CPS

Social Regulation	
Negotiation: Achieving resolution or reaching compromise **Self-evaluation**: Recognising one's own strengths and weaknesses **Transactive memory:** Recognising strengths and weaknesses in others **Responsibility Initiative:** Assuming responsibility for ensuring parts of the task are completed by the group	
Perceiving Emotion • Identify deceptive or dishonest emotional expressions • Discriminate accurate vs. inaccurate emotional expressions • Understand how emotions are displayed depending on context and culture • Express emotions accurately when desired • Perceive emotions in other people through their vocal cues, facial expression, language, and behavior • Identify emotions in one's own physical states, feelings, and thoughts **Facilitating thought** • Leverage mood swings to generate different cognitive perspectives • Prioritize thinking by directing attention according to present feeling • Generate emotions as a means to relate to experiences of another person	**Understanding Emotions** • Understand complex and mixed emotions • Differentiate between moods and emotions • Appraise the situations that are likely to elicit emotions • Determine the antecedents, meanings, and consequences of emotions • Label emotions and recognize relations among them **Managing Emotions** Effectively manage others' emotions to achieve a desired outcome • Effectively manage one's own emotions to achieve a desired outcome • Evaluate strategies to maintain, reduce, or intensify an emotional response • Monitor emotional reactions to determine their reasonableness • Engage with emotions if they are helpful; disengage if not • Stay open to pleasant and unpleasant feelings, as needed, and to the information they convey

As shown in Table 2.4, other skills outlined in the social regulation area are metamemory (also termed self-evaluation) and transactive memory. Metamemory is the cognitive skill of reflecting on one's own strengths and weaknesses. Transactive memory is the recognition of strengths and weaknesses of others. The skills of meta and transactive memory are rooted in area of meta-cognition, defined as "awareness and control of one's thoughts" (Hudlicka, 2012). An illustrative example of meta-cognition is when a person who is aware that they are weak at Maths undertakes additional classes or engages in additional study to counter this weakness. They are aware of their weaknesses and engage strategies to address it accordingly. Although the extent to which emotion has a role in meta-cognition is not yet fully understand, many theorists have made reference to the fact that it is significant (Alavinia & Mollahossein, 2012; Hudlicka, 2012; Norman & Furnes, 2016). Indeed, a number of studies have found a positive correlation between scores on AEI tests and the use of meta-cognitive abilities (e.g. Alavinia & Mollahossein, 2012; Ghafoor et al., 2019; Parviz & Hassan, 2012; Sarvaria et al., 2018), suggesting an empirical link between meta-cognition and AEI. Wheaton (2012) theorised that in order for people to be able to reflect on their own cognition, they must be aware of their own emotions, must monitor them appropriately and know how to self-regulate emotionally.

From a theoretical and practical perspective, each of the branches has mental abilities that may be important in self-evaluation and transactive memory. An awareness of one's own emotions may assist the problem-solver in recognising their own areas of weakness (perceiving and understanding emotions). Perceiving emotion in others may also help to identify the strengths and weaknesses of others. Body language and facial expressions can express how we feel about a task, meaning that the problem-solver can decipher how their partner feels about the problem and respond accordingly. The problem-solver must recognise that their partner may feel ashamed or defensive about their own weaknesses and manage the

situation accordingly (managing emotions). Communicating one's strengths to another individual in a problem-solving environment is not a straightforward task and requires a nuanced understanding and management of emotions. These are just a small number of examples where the mental abilities of AEI come into play in social regulation.

As Table 2.5 illustrates many of the mental abilities of AEI can also subsumed within the area of Perspective Taking. Perspective taking is divided into two main social skills: Adaptive Responsiveness and Audience Awareness. The importance of perspective taking is CPS contexts has been well-researched. Problem solvers who reconceptualise a problem using information that was provided by a team member display a high level of responding skill. In contrast, ignoring contributions from others suggests a low degree of responding skill (Graesser et al., 2018; Hayashi, 2018). Audience awareness skills are constituted by the ability to alter one's responses towards other people (Dehler et al. 2011). Depending on variables like the amount of egocentric bias, group members vary in their ability to change their own behaviours to take into consideration the opinions of others. (Hayashi, 2018; Stoefler et al., 2020).

The terms perspective-taking and empathy are often used interchangeably in research which references emotions or emotional intelligence. Although the term empathy is not used by Mayer et al. (2016) in their AEI model, emotional understanding of other's emotions is a key facet of the theory. Theorists have identified differences between empathy and perspective-taking, with perspective-taking referring to the cognitive capacity to consider the world from another's viewpoint, and empathy referring to the affective capacity to emotionally experience the emotions of others (Davis, 1983). Similar to other areas of the CPS model, empirical research has not yet examined a specific link between perspective-taking in CPS and the AEI model. However, both empathy and perspective-taking are important in collaborative settings. For example, in a study of 90 university students, Gilin et al. (2013)

found that participants who scored higher on measures of empathy and perspective-taking achieved greater success in a collaborative simulated computer game task. Table 2.5 also provides theoretical links to identify how adapting one's behaviour and responding to the contributions of others requires many of the mental abilities of AEI. *Perceiving emotions in others through their body language, facial expressions and language* assists the problem-solver in deciding on a course of action with their fellow problem-solver. *Determining the antecedents, meanings and consequences of emotions* allows the problem-solver to foresee the reaction of others to expressed emotions, and also allows them to interpret the meaning behind emotions expressed by their partner (managing emotions). *Effectively managing one's own emotions* may assist in allowing the problem-solver to respond appropriately to others (managing emotions).

Table 2.5

Convergence between AEI abilities and Perspective Taking in CPS

Perspective Taking	
Adaptive Responsiveness: Responding to contributions of others **Audience Awareness:** Awareness of how to adapt behaviour to increase suitability for others	
Perceiving Emotion	**Understanding Emotions**
• *Discriminate accurate vs. inaccurate emotional expressions* • *Understand how emotions are displayed depending on context and culture* • *Express emotions accurately when desired* • *Perceive emotional content in the environment, visual arts, and music* • *Perceive emotions in other people through their vocal cues, facial expression, language, and behavior* • *Identify emotions in one's own physical states, feelings, and thoughts*	• *Appraise the situations that are likely to elicit emotions* • *Determine the antecedents, meanings, and consequences of emotions* • *Label emotions and recognize relations among them* **Managing Emotions** • *Effectively manage others' emotions to achieve a desired outcome* • *Effectively manage one's own emotions to achieve a desired outcome* • *Evaluate strategies to maintain, reduce, or intensify an emotional response*
Facilitating Though Through Emotion • *Generate emotions as a means to relate to experiences of another person* • *Prioritize thinking by directing attention according to present feeling*	

While some of this review refers to empirical data, other connections are theoretical and some are practical and made by the researcher. The links that are made between the specific mental abilities of AEI and the skills involved in CPS are therefore tentative and exploratory, posing a potential risk to the types of interpretations that are drawn later in this research. For example, it might be argued that potential observer bias coupled with relatively limited qualitative data could threaten the validity of the conclusions that are drawn about CPS and AEI. However, as described above, there is empirical literature available that has linked some components of AEI theory with the CPS social skills that are outlined in the model designed by Hesse et al. (2015) e.g., negotiation involving emotional and social interactions.

Hence, on the basis of the theoretical overview provided here, it was determined that this research study could legitimately seek to examine if indicators of AEI abilities could be

observed during CPS tasks. Further, given the exploratory (rather than explanatory) nature of the research, it was judged appropriate to probe the nature and extent of participants' use of AEI abilities when engaged in collaborative problem-solving, in this case, based on Lego-based tasks.

2.6 Assessment Modalities for Collaborative Problem-Solving

As mentioned previously, there have been two pivotal developments in CPS assessment: (1) the assessment of CPS in PISA (OECD, 2015) and (2) the ATC21S project (Hesse et al., 2015) which aimed to develop new assessment modalities for CPS. There are many studies which have adapted these assessments to further develop and refine the area of CPS assessment (e.g. Graesser et al., 2017; Herborn, Mustafic & Greiff, 2017; Poysa-Tarhonen et al., 2018; Sun et al., 2020; Yuan, 2020). The following sections outline how existing tests of problem-solving were adapted for use by the PISA and ATC21S task developers and describes how they were redesigned to include a collaborative assessment. The significance of these developments for the present research emerges from this review.

2.6.1 Development of Tasks and Task Characteristics

The development of tasks for the ATC21S project and for PISA demonstrate that it is possible to adapt existing problem-solving assessment to include a social skills assessment. CPS can be found in many everyday activities: collaborating with work colleagues to solve a problem presented by a client, identifying a film that suits the preferences of a group of friends - all of these are illustrative examples in which a group must identify a solution that demands shared understanding and interaction in group member. What is commonplace amongst these types of tasks is that they are ill-defined (Ahonen & Harding, 2018). They are ill-defined as individuals and groups are not aware of the sequence of actions that will lead them to the goal state when they begin to attempt to solve the problem. While the vast

majority of problems in real-life are ill-defined, the significant body of research that has been carried out on problem-solving has used well-defined problems (Hesse et al., 2015; OECD, 2015; Yuan, 2020). The OECD (2015) define (well-structured) problems as those that include a distinct specification of three elements of the problem space: the initial state (the problem situation), the set of operators (rules and strategies) to solve the problem, and the goal state (the solution). The participant knows that the problem is, the rules they have to follow to solve it and the desired solution.

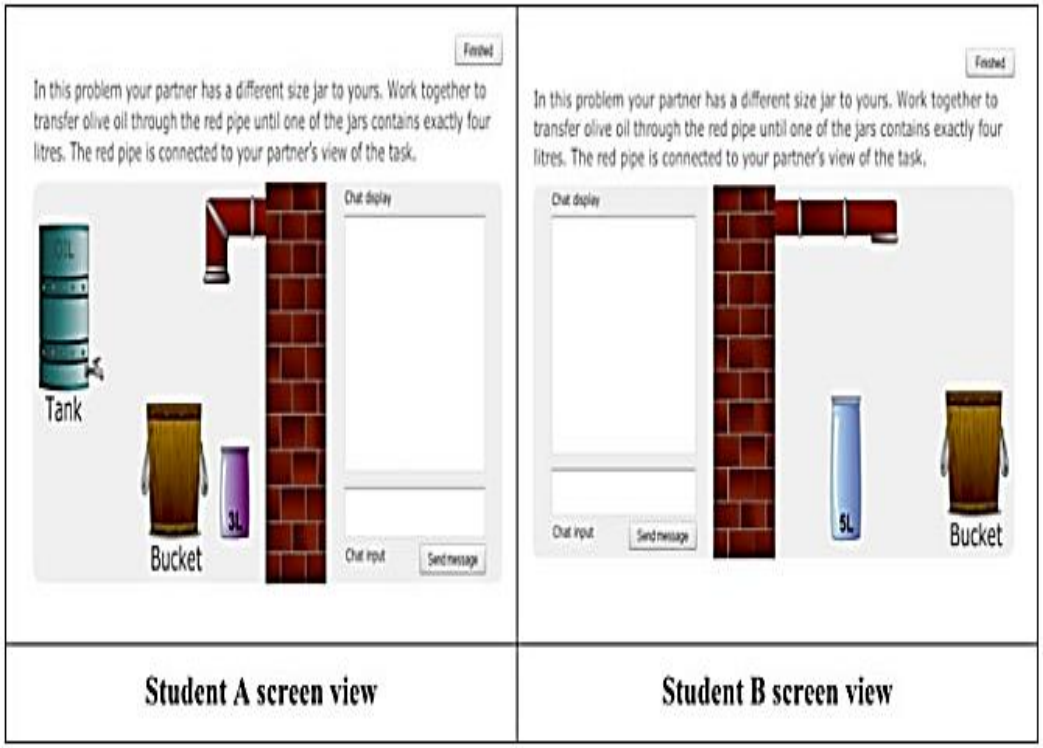
As argued by Stadler et al. (2020), the advantage of well-defined tasks is that they are relatively straightforward to use and score in research studies. The data that they generate is quantifiable and can be analysed computationally. As their use is widespread in problem-solving literature, there are agreed-upon standards for how to measure problem-solving effectiveness. Both ATC21S and PISA used tasks that were originally designed for individual problem-solving and transformed these into collaborative tasks (Hesse et al., 2015; OECD, 2015). For instance, a typical approach to elicit collaboration in a problem-solving context is to introduce resource interdependence (Hesse et al., 2015). If the participant does not have all of the resources that they need to solve the problem, they must initiate discussion or respond to their partner who has some distribution of the available resources. Existing tasks can be altered in this manner to guarantee that the problem cannot be solved by any one individual working alone. A disadvantage raised by other researchers (He et al., 2017; Tang, Liu & Wen, 2021) is that this approach may not adequately represent the types of ill-defined problems that respondents encounter in their own lives.

In an ideal context, each task would require many or all of the CPS skills in the model to be used. However, this is a difficult and time-consuming process (Care et al., 2016; Hesse et al., 2015). Consequently in both PISA and ATC21S, a number of different tasks were used, each of which would assess a different array of the cognitive and social skills of CPS. For

example, in ATC21S, a simple task based on the style of the Tower of Hanoi mathematical problem was redesigned as the Olive Oil task, and was altered to include collaborative elements (Griffin, Care & Harding, 2015). In the Olive Oil task, two participants are presented with different resources and must work together. As previously mentioned, all of the tasks were delivered through an online assessment platform. Therefore, the two participants were not collaborating in person. Instead, they communicated through a chat box where they could type messages to one another. Figure 2.8 shows the view for both students when they first begin the task. The separation of resources requires social skills to be used by both participants. The goal of the task is to fill Student B's jar with 4 litres of olive oil. Student A has a three litre jar, an olive oil container, an "entry" pipe and a bucket. Student B has a five litre jar, an "exit" pipe and a bucket. Individuals who have well-developed social skills may start chatting immediately after the task commences. Without being able to observe each other's screens, participants must identify that Student A must fill their jar at the container and place it under the "entry" pipe so that Student B can accept the oil from the "exit" pipe. Until this component of the problem is resolved, Student B cannot proceed with any significant actions within the task and is dependent on the actions of Student A. This design creates what Griffin et al., 2015 term an asymmetric problem-solving space in that each respondent has access to varying resources. Only when the resources are combined can the problem be solved.

Figure 2.8

View of the Olive Oil Task for Both Problem-solvers



Note. Copyright 2015 Springer Nature. Reprinted from Care, Griffin, Scoular, Awwal and Zoanetti (2015)

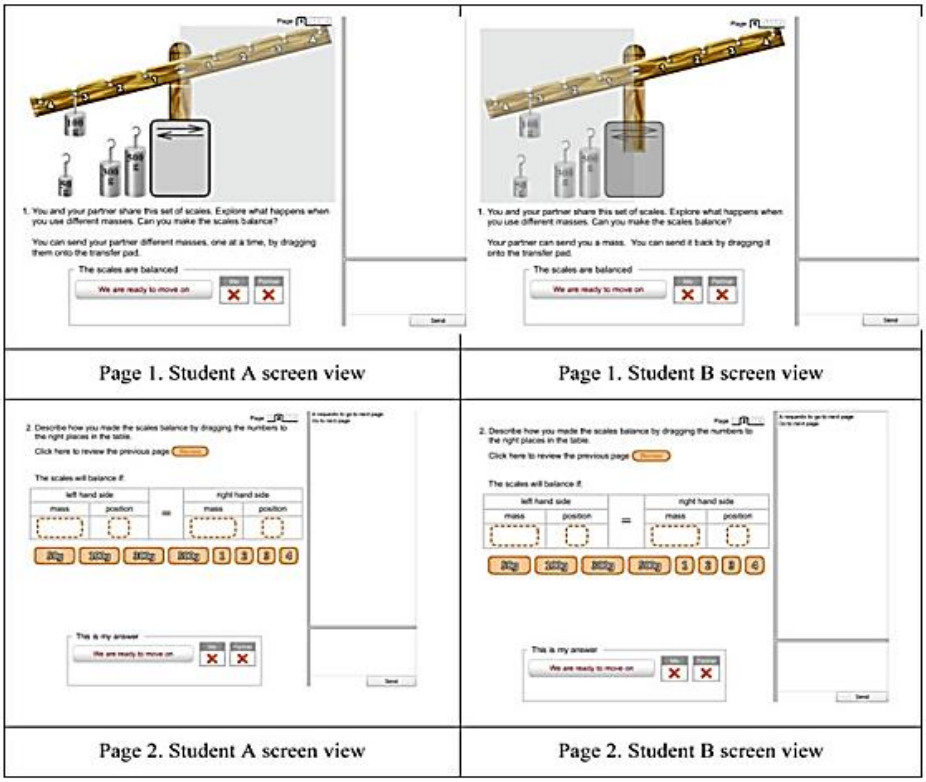
The Olive Oil Task is one of two content-free tasks used in the ATC21S assessments, meaning that it not require the problem-solvers to have background or preestablished subject knowledge in order to solve the task successfully (Griffin et al., 2015).

However, a basic level of reading and writing skills is required. On the other hand, content-dependent tasks require individuals to have particular knowledge and skills developed from school or curriculum. In the ATC21S project, two content-dependent tasks which required a basic level of mathematical and scientific knowledge were also designed. Figure 2.9 provides Pages 1 and 2 of the Balance Beam Task, which is content dependent as the participant should have a basic knowledge of physics. Group members must apply and test rules in order

to balance the beam, resulting in multiple correct solutions. Group members share a balance beam but each can interact with only one side of the beam. Participant A begins with four different masses, Student B has no masses, and does not know about Participant A's masses. First, students must pass the masses back and forth to balance their beams. Subsequent elements of the task require them to balance the beam in different ways (Griffin et al., 2015).

Figure 2.9

Balance Beam Task



Note. Copyright 2015 Springer Nature. Reprinted from Care, Griffin, Scoular, Awwal and Zoanetti (2015)

The adaptation of existing problem-solving tasks shows that it is possible to modify existing assessments to include a social skills assessment. If the task is carefully selected and defined,

skills of both collaboration and problem-solving can be observed and assessed simultaneously. These types of tasks can offer guidance to the present research.

2.6.2 Delivery of the Tasks

As the goal of the ATC21S project was to develop new assessment modalities for the digital age, assessment tasks were delivered through a virtual online environment. Following a log in, participants were presented with the task and the chat box with which they could communicate (Griffin et al., 2015). Each task was constructed so that students would be able to click, drag and drop objects using the mouse cursor, with no requirement to use the keyboard. Messages could be typed and sent to their collaborative partner in order to solve the problem presented in the tasks. Online assessment platforms have a number of practical benefits for both the participant and researcher (Ellis et al., 2020; Hao et al., 2020; Sun et al., 2020. Studies have also shown that online assessment platforms result in increased engagement and motivation amongst participants, particularly students in second or third level education (e.g., Alruwais et al., 2018; Ellis et al., 2020; OECD 2017). Much of the problem-solving work carried out in the world today is performed by teams in an increasingly globalised and computerised economy (OECD, 2017). The COVID-19 lockdown provided a unique context in which the shift to working-from-home meant that online digital collaboration was the most common context for people engaging in problem-solving (De et al., 2020; Ellis et al., 2020). Where once students may have met in person to problem-solve and collaborate, they now worked through online platforms. Thus, the use of a virtual assessment platform may help to represent the conditions in which individuals are meeting, working and problem-solving in today's world.

The ATC21S project used the Human-Human (H-H) approach to initiate collaboration on problem-solving tasks. That is, the participant collaborates to solve a problem with another

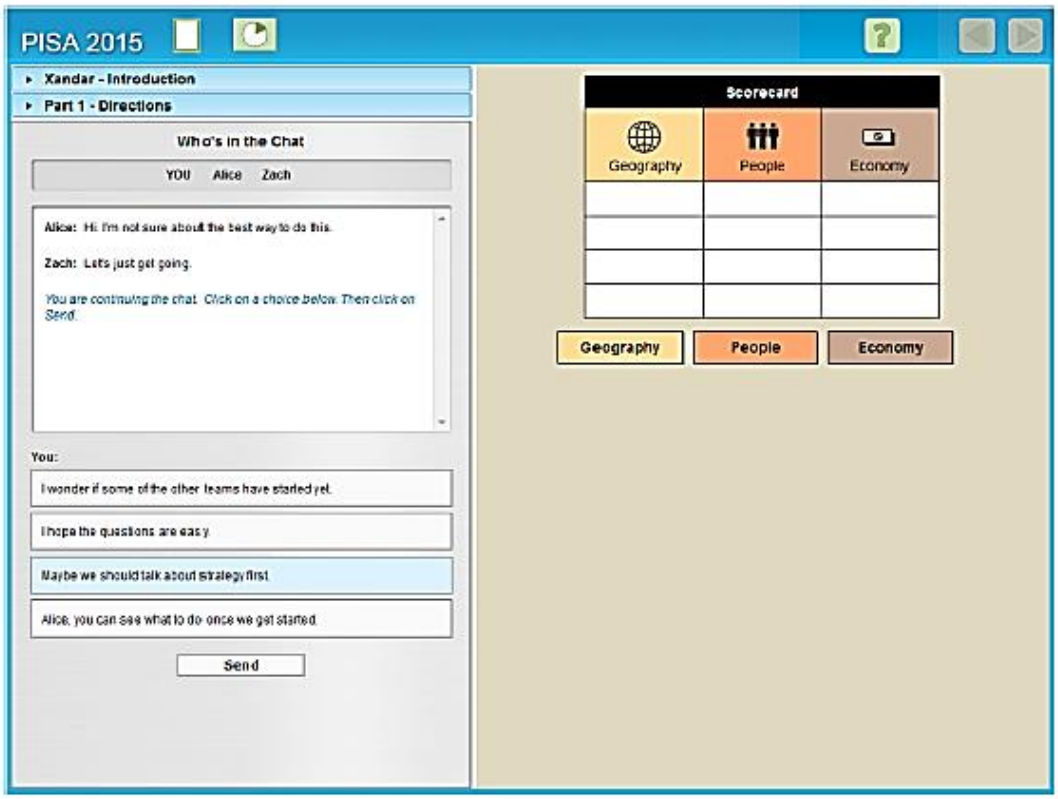
human participant (Graesser et al., 2017; Griffin et al., 2015). This creates a more authentic human-human interaction which is a familiar situation for participants. Additionally, the H-H context is closer to the CPS situations that people encounter in their personal, educational and professional lives. (Graesser et al., 2017; Rosen 2015). However, pairing can be problematic because of individual differences that can significantly affect the CPS process and outcomes. In the case of the ATC21S assessments, students were randomly paired with another student of a similar age and dyad composition was not pre-planned (Care et al., 2016; Hesse et al., 2015). To ensure an optimal measurement of individual CPS skills, each participant should be partnered with a person or indeed a selection of people who displays a range of CPS characteristics (Dingler, Davier & Hao, 2017; Graesser et al., 2017). This would permit a full and comprehensive assessment of CPS skills in various contexts and would also standardise the assessment (Dingler et al., 2017) However, this is logistically challenging and the case of the ATC21S project, it was beyond the feasibility of the researchers who had time-restricted access to certain schools who were participating in the project (Care et al., 2016). An alternative to the H-H approach is the Human-Agent (H-A) approach.

In the H-A approach, CPS skills are tested by pairing the human participant with a computer agent or agents, that can be programmed to act as group members with varying characteristics (Graesser et al., 2017; OECD, 2015). These agents can be developed with a full range of capabilities, such as facial actions, gestures and speech. For example, in 2015, the large-scale PISA assessment assessed CPS with virtual tasks requiring participants to collaborate with computer-simulated agents. Figure 2.9 illustrates a PISA tasks called Xandar, where along with their computer agent partners (Alice and Zach), they had to answer questions about a fictional country called Xandar. Students had to communicate with their team members by choosing a response from a pre-defined set of options. In this case, the participant wants to talk about the strategy first. This approach allows the standardisation of an assessment of

CPS and the participant has the opportunity to engage with agents who display a varied range of CPS skills (Hao et al., 2019; Scoular & Care, 2020) However, the H-A approach also has its drawbacks. Despite significant advancements in artificial intelligence in the last number of years, the dynamics of H-H interaction cannot yet be captured perfectly by programmed agents (Hao et al., 2019; Scoular & Care, 2020).

Figure 2.10

Sample Task from PISA



Note. Screenshot illustrates a typical predefined message selection scenario for communicating with the computer agents. Message 3 is scored as the correct message. Reprinted from OECD (2015) https://www.oecd.org/pisa/test/CPS-Xandar-scoring-guide.pdf

The delivery of the CPS tasks through an online interactive environment offers a number of advantages to researchers. However, advancements in technology have not progressed rapidly enough to fully replicate real world conditions (Chopade et al., 2018; Rosen et al., 2021;

Stoeffler et al., 2020). Significant cost and resources would need to be used before an artificially intelligent computer agent could truly simulate a human in a CPS context (Chopade et al., 2018; Rosen et al., 2021; Stoeffler et al., 2020). Chatting to another individual through a chat-box can be termed H-H communication but can only capture one aspect of human communication, the language used between two people in a contrived problem-solving environment (Stoeffler et al., 2020). Consequently, a substantial portion of process data, the data that is created from the interactions between participants is not evaluated or included in data analysis. This is a significant limitation of current CPS modalities and one which must also be taken into account in this research.

2.6.3 Scoring of Tasks: Process versus Product Data

The aim of ATC21S was to develop assessments that not only assessed whether individuals were effective at solving the tasks but also to create conclusions about how they solved the problems and how they collaborated with each other (Care et al., 2016; Griffin & Care, 2015). However, the data also needed to be generated automatedly and analysed quantitatively. Thus, collaboration was assessed in the ATC21S project through a combination of chat and actions used by the problem-solvers in the virtual environment. Each of these actions and chat was recorded automatically in files called 'session log files' from which data could be scored (Griffin & Awwal, 2018). Actions can be defined as any explicit act made by the individual that changes the state of the collaborative problem (Hesse et al., 2015). Examples of these actions in the ATC21S project included moving a puzzle piece into a certain setting, clicking on a button, moving a cursor on a display that the other participants can see, or editing a joint document. Each action could be mapped to measures of performance as it relates to either success (or failure) of solving the problem or to a skill contained within the framework. Each action was logged with a related timestamp which referred to the time at which an event was recorded by the network. This permitted a

combination of actions to be analysed (Griffin & Awwal, 2018). The concern however, with each one of these varieties of measures is that they overlook the cognitive processes involved and predominantly centre on output (Adams et al., 2015; Griffin & Awwal, 2018; Sun et al., 2020).

The other means by which collaboration was assessed was from analysis of the chat boxes through which the participants communicated. While these chats were often detailed and comprehensive, the content of the chat itself was not included in the analysis. Instead, it was presence/absence of chat, together with response time and action sequence data (i.e., when the chat happened in relation actions taken), that permitted a method to be used to deduce collaboration (Griffins & Care, 2015). Adams et al. (2015) argue that this method was advantageous as it simplified the data while recognising the complexity of the collaborative process. For example, the use of chat at the beginning of the Olive Oil task, coupled with an action by either individual was mapped onto the skill of participation, in that the participant was engaging from the beginning of the task with their collaborator. Certain combinations of chat-action-response time were derived as indicative of a higher degree of collaborative skills, while a lack of chat/action or a more sustained response time was deemed to be indicative of an individual with lower levels of collaborative skills. As reviewed by Adams et al. (2015), although the design and development of this assessment process was a complex one, it did successfully manage to create a system from which social skills could be automatically coded and analysed.

A list of some the cognitive and social skills that are assessed through the Olive Oil and Balance Beam Tasks is presented in Figure 2.11. It also highlights how the actions of the students are used as evidence of CPS. For example, the presence of chat when the students are still working on filling their individual containers is classified as testimony of perspective taking. Similarly, responding to the contributions of the other problem-solver is categorised

as evidence of perspective taking in the Balance Beam task. As Figure 2.11 summarises, both of these tasks assess a wider range of cognitive skills than social skills. This is consistent across all of the tasks included in the ATC21S project. Their ability to assess cognitive skills is broader than their ability to assess social skills. Care et al. (2016) argue that this does not mean that the tasks do not demand equivalent effort across the two areas of cognitive and social, or that equal use of skills across the areas does not occur. Substantial amounts of chat in the chat box were recorded between participants in all of the schools that used the assessments (Care et al., 2016).

Figure 2.11

Examples of Skills from Olive Oil and Balance Beam Task

Table 4.2 Example of skills observed in the olive oil task

Skill	Behaviour	An example of data captured for assessing
Interaction	Interacting with partner	Presence of chat during a specific set of actions and processes
Cause and effect	Identifies sequence of cause and effect	When A's 3 L contains only 1 L, A recognises that this must be transferred to B
Reflects and monitors	Adapts reasoning or course of action as information or circumstances change	Learning from redundant activities, such as A moving jar to bucket
Relationships	Identifies connections and patterns between and among elements of knowledge	Presence of chat exchanging information when A or B recognises significance of their jar containing only 1 L
Solution	Correct answer	Last action requires B's jar to contain 4 L of oil
Problem analysis	Identifies necessary sequence of subtasks	Exchange of important information during necessary sequence

Table 4.3 Example of skills observed in the balance beam task

Skill	Behaviour	An example of data captured for assessing
Action	Active in scaffolded environments	Student A passes B a mass
Task completion	Undertaking part of a task individually	Follows instructions, moves 100 g to position 4
Responsiveness	Responding to contributions of others	Realises that some masses cannot balance. If Student A resends 50 or 500, B returns it immediately
Sets goals	Sets goals for a task	Requests mass amounts
Systematicity	Implements possible solutions to a problem	Trial of different combinations of masses on different beam positions
Solution	Correct answer	Number of successful balances achieved (3 optimum)

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There are substantial compromises between the significant amount of information that can be collected in a CPS virtual environment and the amount that can be measured and analysed (Andrews-Todd & Forsyth, 2020; Graesser et al., 2017; Sun et al., 2020). Additionally, the assessment of social skills using action sequences and responses times, as in the ATC21S project, may provide a limited assessment of how the individual truly behaves in real-life

problem-solving contexts (Danby et al., 2018; Herborn et al., 2020. Similar to EI, social skills are traditionally assessed using self-report measures or assessed through observational data. Both have limitations in that they are subjective, may lack reliability and in the case of observations, are time-consuming, Specific tests of collaboration rely on the Situational Judgement Test approach in which individuals react to hypothetical role-relevant situations (Mumford et al., 2016; Patterson et al., 2016), or paper-based questionnaires, both of which provide researchers and participants with a final test score at the end of the assessment. Quantifying the proficiency of the social skills of collaboration is a therefore a relatively novel and complex process for which there is no clear solution (Andrews-Todd & Forsyth, 2020; Graesser et al., 2017; Sun et al., 2020)

There are some examples of studies that have used alternatives to the automatic scoring of social skills information in CPS assessments. For example, Poysa-Tarhonen et al. (2018) used the ATC21S assessment tasks to measure CPS skills in 20 Finnish undergraduate students. Additionally, they completed post-task interviews with each participant. The participant watched their recorded screen activity data from the problem-solving task and were asked to verbalise their thought processes underlying each action with their fellow problem-solver. This data was coded qualitatively and was therefore a time-consuming and laborious process. However, Poysa-Tarhonen et al. (2018) argued that this triangulation of more than one data source permitted a more comprehensive picture of the participants' thought processes as well as their CPS skills to emerge.

2.7 Implications for the Present Study

This section draws together the key issues that are discussed above and foregrounds their relevance to the present study. There is a significant volume of research that supports the assertion that AEI is an intelligence, similar to other well-established intelligences (Mayer et

al., 2016). However, it is not yet established where AEI can be positioned amidst other well-established intelligences (Mayer et al., 2016). In Mayer et al.'s latest update on the AEI model, they propose that AEI is one of a group of hot intelligences that are related to the processing of emotional, social and personal information, but this has not yet been supported by significant empirical research. A larger volume of studies have substantiated the predictive validity of the AEI model. Positive correlations have been reported between AEI measures and academic and job performance as well as a range of personal outcomes (Costa et al., 2015; Ivcevic & Brackett, 2014; MacCann et al., 2020; Rivers et al., 2012). These studies show that there is value in studying and assessing AEI.

As an intelligence, AEI is typically measured using performance tests that score items as either correct or incorrect, similar to an IQ test. There is only one omnibus performance test of AEI that measures all of the branches of the four-branch models concurrently. This test is called the MSCEIT (Mayer et al., 2002) and is the predominant test of AEI that is found in the literature. There are other alternatives that measure single branches of the four branch model. Two examples are the Situational Test of Emotion Understanding and the Situational Test of Emotion Management (MacCann & Roberts, 2008). Similar assessment modalities are available for children (Bunnett, 2021; Mayer et al., 2005). There are limitations to these types of assessments. The majority rely on static images and text-based items. Text-based items cannot capture emotion expressed through body language, voice or non-verbal cues, all of which are important parts of emotion processing. They do not assess how AEI is used with other types of transversal skills, which would better mirror the conditions of real life problems.

Collaborative Problem-Solving is included in this study as a model for a new AEI assessment type for two reasons. Firstly, many of the mental abilities of the four-branch model AEI can be subsumed under the broader social skills of collaboration included in CPS. The theoretical

model selected for this research was the one designed for the ATC21S project, an initiative developed to advance assessment modalities in education (Hesse et al., 2015). CPS is divided into broad domains in this model: cognitive and social. Cognitive represents the cognitive skills required for problem-solving and social represents the social skills required for collaboration. The three areas of participation, perspective taking and social regulation in the social domain are further partitioned into broad skills (Care et al., 2016). These broad skills incorporate many of the mental abilities of AEI. For some of these skills, there is empirical research to support the association between AEI and the skill. For example, negotiation is an important part of CPS. A relationship between negotiation skills and the use of AEI abilities has also been empirically supported (Kim et al., 2014; Mueller & Curhan, 2006; Pulido-Martos et al., 2013). For other skills of the CPS model, there is less empirical evidence demonstrating a link between the skill and AEI. Consequently, this literature review makes connections between specific mental abilities in AEI and the social skills of the CPS model, based on previous theoretical assumptions made by researchers and from a detailed examination of both models.

CPS is also included because of the advancements that have taken place in its assessment. CPS involves problem-solving and collaboration. Problem-solving is a well-researched area and there are many assessments of the construct available in the literature (Ahonen & Harding 2018; Scoular et al., 2018). Problem-solving primarily involves cognitive skills. Collaboration on the other hand, involves social skills. An assessment of CPS must therefore simultaneously assess the social skills of collaboration with the cognitive skills of problem-solving skills (Care et al., 2016). For the ATC21S project, existing assessments of problem-solving were adapted to include a collaborative element. Pairs of students were partnered in an online virtual assessment platform and completed tasks collaboratively. The tasks were designed so that they could not solve the problem alone and collaboration had to occur.

Participants could communicate through a chat box and could take various actions (clicking on an object, moving the cursor) to solve the problem. All of the data was automatically coded and scored with indicators of social skills being used to assess collaboration (Hesse et al., 2015). The disadvantage to this type of analysis is that it lends itself to the analysis of problem-solving, instead of the process data that is generated

The present research sought to explore if AEI abilities can be observed and assessed in CPS contexts. The collaborative environment in which two people interact means that there is potential for AEI to be assessed in a context which better represents real-life conditions as much of our AEI is engaged when we are interacting with others. This research drew on the research literature discussed above to identify how elements of CPS tasks can assist in the assessment of AEI.

Chapter Three: Methodology

3.1 Introduction

This study sought to explore whether Ability Emotional Intelligence (AEI) abilities could be observed and assessed within Collaborative Problem-Solving (CPS) tasks. The chapter is laid out in 12 sections which describe the methodology used to address the research problem of the study. Following a brief overview of the conceptual framework and research questions in Sections 3.2 and 3.3, the rationale for the choice of paradigm and research design is defended (see Section 3.4). An overview of the research design is noted in Section 3.5 and the steps taken to develop CPSs tasks are outlined in Section 3.6. Section 3.7 describes the iterative process of developing the AEI framework, while Section 3.8 details the research methods used. An overview of the piloting process is provided in Section 3.9 and the data collection timeline is set out in Section 3.10. The chapter concludes with a description of data analyses (Section 3.1) and an overview of validity in qualitative research (Section 3.12).

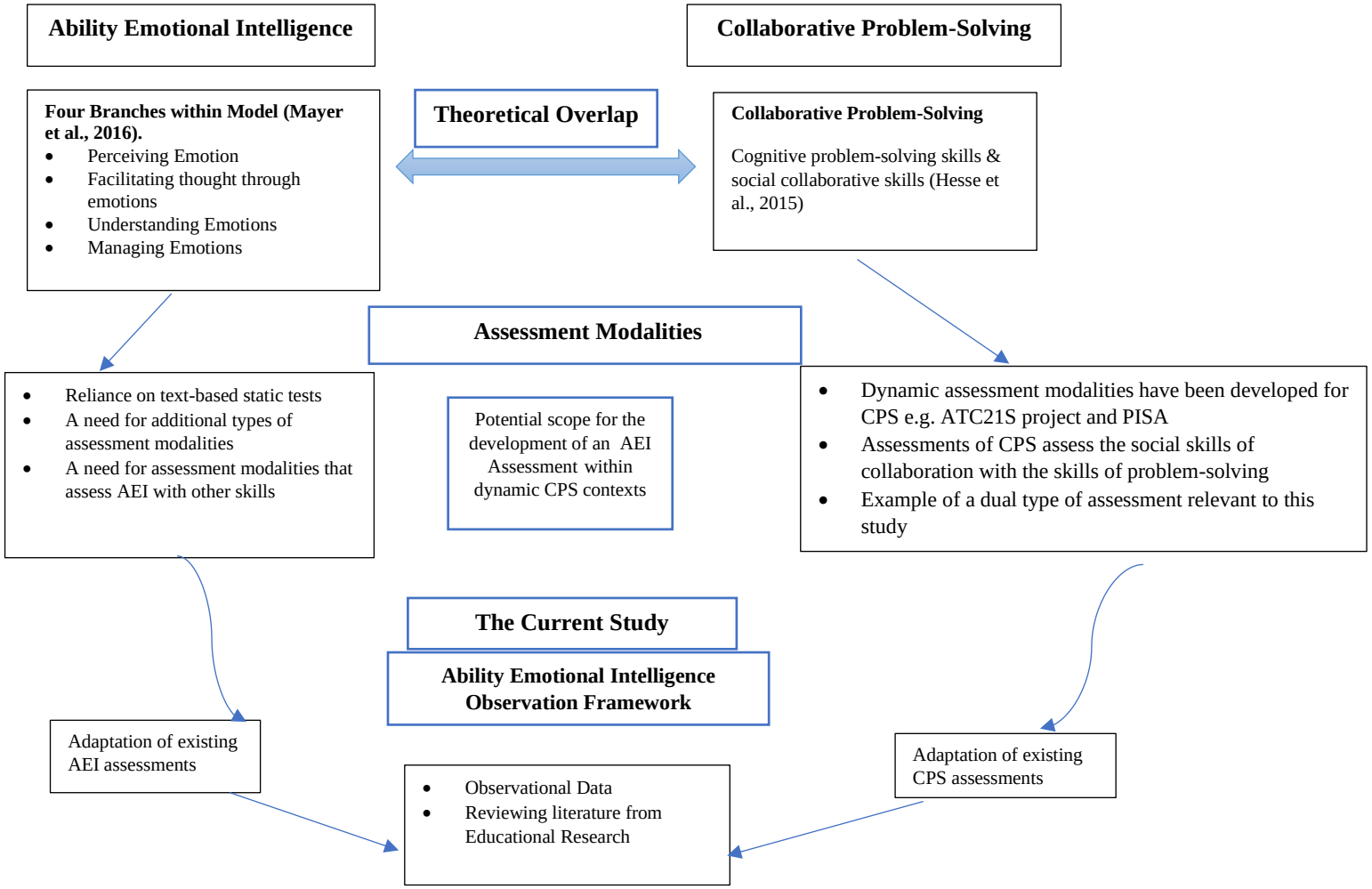
3.2 Conceptual Framework

The research problem as discussed in Chapter One and Two, underpinned the conceptual framework for this research. Creswell (2003) argues that a conceptual framework is of significant importance in an emergent research design as it cements the study in the relevant knowledge bases enabling the problem statement and research questions to emerge. The goal of the conceptual framework in this study is to categorise and describe concepts that are relevant to the study and to map relationships among them (Miles & Huberman, 1994; Jabereen, 2009).

As Figure 3.1 depicts, the conceptual framework was first designed to outline the theoretical relationship between AEI abilities and the social skills of CPS. Mayer et al.'s 2016 AEI theoretical model outlines four branches of emotional intelligence; perceiving emotion, facilitating thought through emotion, understanding emotions and managing emotions. These branches are further sub-divided into abilities which are used by individuals in their everyday interactions with others. The model of CPS that was selected for use in this study was derived from the ATC21S project (Hesse et al., 2015). This model distinguishes the social skills of collaboration from the problem-solving skills used within a CPS task. There are three areas of collaboration that are outlined as particularly pertinent in CPS contexts; participation, perspective taking and social regulation. Within these three areas are a range of social skills that individuals use when problem-solving collaboratively. As outlined in Chapter Two, there is significant theoretical convergence between the social skills of CPS and the mental abilities of AEI. This theoretical intersection means that CPS contexts were an optimal means by which new modalities in AEI assessment could be explored. Given the strong overlap between the two theories, CPS tasks would also be likely to elicit key AEI abilities.

Figure 3.1

Conceptual framework for the current study



The most common AEI assessment modalities are text-based tests which use static images and hypothetical scenarios (Mayer et al., 2002). As the conceptual framework describes, these tests have relevance in some assessment environments but they may not adequately address how AEI is used within real-life dynamic contexts. An individual may have a strong emotional knowledge, meaning that they score highly on an objective performance test. However, they may not exhibit these skills in work or social environments that they face outside of a structured test environment. Given the increased importance of AEI within workplace and educational settings, there is a growing need for a wider range of assessments modalities that address this gap in the literature.

As highlighted in the conceptual framework, CPS tasks assess both problem-solving and collaborative skills. Thus, CPS assessments are an exemplar of how different types of skillsets can be assessed simultaneously, which was of relevance to this study. Additionally, many different types of CPS assessment modalities have been developed due to the considerable international research interest in the area. Consequently, there are relatively consistent criteria or guidelines available for the design and creation of CPS tasks that are likely to elicit the skills of collaboration and problem-solving. As there is considerable intersection between the social skills of CPS and the mental abilities of AEI, it was anticipated that CPS tasks would also require group members to use emotional intelligence abilities. Thus, many of the criteria used for CPS task development guided the selection of Lego Spike Prime Education as the CPS tasks used in this study. Lego Spike Prime tasks combine Lego building with coding and includes challenges from the area of Science, Technology, Engineering and the Arts (STEAM). The comprehensive process which was used to select these tasks is described in Section 3.6.

In order to adequately observe AEI abilities within group contexts, an observational framework was designed for the study. The conceptual framework depicts how the

behavioural indicators developed for the mental abilities of AEI were primarily grounded in AEI theory. Theoretical concepts were also drawn from CPS theory, the area of functional behavioural analysis in education and from observational data. To undertake a thorough investigation of the framework, a case study design was conducted. The case selected was the researcher's own class of 28 5th class students, aged between 10 and 12 years of age. This design permitted the researcher to engage in sustained observation and analysis of the types of AEI abilities that the groups were using while carrying out CPS tasks. The interpretivist paradigm was derived from the view that the both the children and the researcher were socially constructing knowledge during the study and that they each brought their own experiences, views and backgrounds to each task.

3.3 From Research Problem to Research Questions

As discussed in the opening chapter, the research problem identified a dearth of assessment modalities for the assessment of AEI within real-life dynamic contexts. Additionally, the research funders, Prometric, expressed interest in the simultaneous assessment of AEI alongside other skillsets in dynamic performance assessments. Following on from a review of the relevant research literature, three overarching research questions were developed to guide the study:

- RQ1: To what degree can Emotional Intelligence Abilities be observed and assessed within Collaborative Problem-Solving Contexts?
- RQ2: What elements of CPS tasks elicit the use of AEI abilities in children working on Lego Spike Prime Tasks?
- RQ3: How beneficial is an AEI framework in supporting the observation and assessment of AEI abilities in CPS tasks?

When designing the study, particular consideration was given to the function of research paradigms, as well as the ontological, epistemological and methodological assumptions on which they are based. Given that a qualitative approach was employed, the use of an interpretive/constructivist paradigm was best suited for the research.

3.4 Research Paradigm

The term paradigm has been interpreted differently by various scholars. It originated with Kuhn (1970), who defined a paradigm as an epistemological position that ascertains the kinds of questions that are asked and subsequently understood in a research study. Subsequently, paradigms have been conceptualised in numerous ways, including as ideologies, perspectives held by researchers, shared opinions reputed by a group of scholars and epistemological stances (Atkins & Wallace, 2012; Creswell, 2014). Maxwell (2014) advises that the researcher make explicit the paradigm within which the study is positioned. These paradigm visions create a worldview and an understanding of how our place within this world is a human construction, a stance which accepts that no human can be "incontrovertibly right" about their perspective on the world (Guba & Lincoln, 1998, p. 202). Selecting a transparent paradigmatic view, however, eases the researcher's navigation through the research, informing decisions relating to design and methodology (Cresswell, 2014; Maxwell, 2005). Placing oneself within a paradigm is not, Maxwell (2014) warns, simply an issue of random selection. When undertaking research, an investigator has already made multiple assumptions about the world, the area that they plan to look into, the way it should be investigated, and how novel knowledge may be created. In this research, the term paradigm was interpreted as

the “basic belief system or worldview that guides the investigator” (Guba & Lincoln, 1998, p.195). As the research problem and design emerged, it became apparent that an interpretivist paradigm was where this study was situated. As outlined in Table 3.1, there were key ontological, epistemological and methodological beliefs that were aligned with this paradigm.

Epistemology is generally defined as beliefs about knowledge and knowing, and includes some or all of the following elements: beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides and how knowledge occurs (Guba & Lincoln, 1998; Hofer, 2001). As summarised in Table 3.1., the present research was guided by an epistemological stance that the knowledge constructed in the study was created through social interactions with others. When carrying out the Lego tasks with their peers, students perceived and created a reality that was observable by the researcher. Unlike the positivist paradigm, where knowledge is conceptualised as objective and distinct, it was construed as a flexible and ever-evolving entity in this study (Hofer, 2001). Knowledge evolved as the study progressed and was also constructed with the researcher. The participants had a well-established pre-existing relationship with the researcher as she was their teacher for the academic year. As Brannick & Coghlan (2014) discuss in their work, the researcher was also a ‘native’ within the school where the study took place, having worked there for several years before carrying out the research. This type of relationship was in line with the interpretive approach where the researcher does not stand above or outside the participants as in the positivist paradigm, but is a participant-observer who interprets the meanings of language and actions as they are expressed within particular social environments. In this case, the emotional abilities that were being used by the students were being interpreted and reported on from both direct and retrospective observations of children working in collaborative groups.

Unlike the positivist approach where reality is considered to be objective and quantifiable, the interpretive paradigm is situated in the ontological belief that reality is socially constructed through communication, consciousness and shared meanings (Creswell, 2013; Hofer, 2001). Each of the participants in the study had their own experiences, backgrounds and beliefs which impacted how they perceived the tasks and how they interacted with others. As presented by Krauss (2005), the categories that make up a participant's view of reality and with which actions are defined include culture, norms, understanding, social reality and definitions of the situation. The focus of this research was to determine if emotional abilities could be observed within CPS contexts. Therefore, the subjective and socially constructed experiences of participants in their groups was the primary interest. As this study was an exploratory study, there were no predefined and independent variables, but an emphasis on attempting to understand the complexity of human behaviour within particular situations. Although there is no one single research design that is aligned with interpretivism, the interpretivist researcher is most likely to use qualitative data collection methods as qualitative data allows the rich revelation of data and for an in-depth exploration to be carried out (Creswell, 2014).

Table 3.1

Key characteristics of Interpretivism and their Relevance for the Current Research

Feature	Description
Purpose of research	To explore if Emotional Intelligence abilities can be observed and assessed within Collaborative-Problem Solving contexts.
Ontology	Multiple realities which are constructed through interaction with others.
Epistemology	Both researcher and participants socially construct knowledge through their own experiences and perspectives
Methodology	Qualitative research methods are designed to help researchers understand people and the social contexts within which they live (Myers, 2009).

3.5 Research Design

At certain points in this research process, quantitative data (e.g. standardised test results, completion/non-completion of task) were used to enhance the validity of the qualitative interpretations of the researcher. However, the study was, in its essence, a qualitative case study design which was identified as conducive to the paradigm and research questions described above. As Chapter Two outlined, studies involving intelligence testing typically use quantitative research designs. However, following an iterative process in which a number

of research designs were considered, an exploratory qualitative research design was deemed most appropriate to address the research questions posed. As outlined by Creswell (2014), if a concept or a phenomenon needs to be understood because very little research has been completed on it, it typically merits a qualitative approach. Further, in light of the gaps in research identified in Chapter Two, and concerns that traditional AEI intelligence tests do not adequately address issues of emotional variability or subjectivity across different contexts in particular, qualitative design afforded opportunities to explore this topic in a manner that yielded thick rich descriptions of children's behaviours, perspectives and interactions for analysis. In particular, the potential afforded by a qualitative approach to engage and observe children as active research participants emerged strongly.

Adoption of an exploratory qualitative study was not without its challenges, however, not least in creating and refining an appropriate observation framework. Research methodologists such as Creswell (2014) highlight the need to undertake extensive statistical testing to address issues of validity and reliability adequately. It is noteworthy that statistical tests are not typically employed in qualitative analysis and, hence, the meanings attributed to the terms validity and reliability shifts to considerations of trustworthiness and the justifiability of inferences derived from qualitative data. How these issues were handled is detailed in Section 3.12.1.

Although case study is one of the most frequently used qualitative research methodologies, methodologists do not have a consensus on the design and implementation of case study, which makes it a contested area (Stake, 2013). The following sections describe why it was selected in this study and provides an overview of the chosen case.

3.5.1 Case Study Design

Three seminal authors, Robert K. Yin, Sharan Merriam and Robert E. Stake, are viewed as the foundational methodologists in the area of case study research. All provide guidelines on the theoretical premises and practical considerations that should be followed in case study design. Although the guidance of all three authors was referred to in the initial stages of research design, it was the work of Merriam (1998) that provided procedures that best suited the present research. Merriam acknowledged that the use of case study is often misunderstood by stating:

> *Those with little or no preparation in qualitative research often designate the case study as a sort of catch-all category for research that is not a survey or an experiment and is not statistical in nature. While case studies can be very quantitative and can test theory, in education they are more likely to be qualitative* (p. 19).

Merriam's definition of a case study is broader than that of Yin's and Stake's, which provides flexibility for an exploratory study like the present research. She defines qualitative case study as "an intensive, holistic, description and analysis of a bounded phenomenon such as a program, an institution, an person, a process or a social unit" (1998, p.xiii). Choosing the case is therefore the most significant task when selecting this method and a number of factors must guide the choice of case. Merriam (1998, p.27) refers to this as "fencing in the case" while Yin (2011, p.31) calls it "bounding the case". It is important therefore, that the features of a case study are clearly laid out and a rationale provided for its choice in research design.

The first justification for utilising a case study in this study was practicality. Initially, given Prometric's funding and interest in the topic, the goal of the study was to explore AEI within group problem-solving contexts using a post-primary or adult population, as outcomes from such a study would be more directly relevant to a workplace/organisational context and to the

assessment of AEI in adults. However, the COVID-19 pandemic meant that planning for data collection in this way was challenging.

Recruiting participants for in-person data collection was unlikely to be an option for the foreseeable future and alternative options had to be explored. When reflecting on the research questions, it became apparent that the best possible site for the study would be the researcher's school as there would be no obstacles to access beyond those related to standard ethical clearances. Additionally, it was more feasible to carry out research with one single class grouping in order to maintain consistency and continuity for both the school and the research. A further advantage was that by choosing an educational setting, the results of the study would be applicable to both educational and organisational contexts. Although the challenges of insider-researcher had to be addressed, the researcher's own class of 5th class primary school pupils was selected for the study. Thus, this study was classified as a single case study design. This is in contrast to multiple-case-study research, where data is collected from a variety of different sites (Merriam, 1998, Stake, 2013; Yin, 2011). From a Stakian viewpoint, a multiple-case-study design can often yield greater inter-subject reliability and generalisability (Stake, 2013). The generalisability of case study design can be limited. However, this study was exploratory in nature and a single case provided an initial lens from which future research could be developed.

The second justification for case study was that, as argued by Merriam (1998), single-case studies are well suited for exploratory research design. Exploratory research is defined as research used to investigate a problem which is not clearly defined. As outlined by Stebbins (2001) it is conducted to gain a better understanding of a particular phenomenon or problem, but it will not provide conclusive results. Flexibility is a key part of an exploratory study as

the focus, methods and design may be adapted as the research progresses. Merriam (1998) argues that case study supports the evolving nature of the study and the examination of real-life dynamics. An advantageous example of design flexibility in the present study was in the creation of an AEI observation framework for the CPS tasks. This framework was designed using theoretical content from the literature and from direct observation of children working on general classroom collaborative tasks. The researcher did not have to set a time limit or a set boundary for this initial observation period. It took place naturally within the existing parameters of curricular tasks that were planned within the school day. Without the flexibility of an exploratory case study design, the natural flow of the study would have been less fluid and adaptive in nature.

Lastly, a single case study design provided three unique attributes that could not be facilitated through other research designs (Merriam, 1998). Firstly, case study is particularistic, whereby it focuses on a particular situation or event (Merriam, 1998). In the case of this research, the particular focus was on collaborative groups and the use of AEI abilities within these contexts. Of critical importance is that a case study is descriptive whereby it generates a rich and thick description of the phenomenon under study. Given the gaps in the literature in this area, the repeated observation of the collaborative Lego tasks yielded a detailed narrative from the data. Lastly, Merriam (1998) argued that case study design should be heuristic and illuminate the reader's understanding of phenomenon under study. As the aim of this research was to provide a future 'proof of concept' for studies examining this growing area, this illumination and understanding of the phenomenon was important. With these considerations in mind, it was apparent that the optimal naturalistic setting to 'maximise what can be learned' about how AEI abilities are used within CPS contexts was the primary classroom context (Stake 2013, p.4).

3.5.2 Description of the Case and Ethical Considerations

The current case study was set within a suburban city primary school in which the researcher is the current 5th class teacher. It is a co-educational Catholic school and has a current enrolment of 116 boys and 128 girls. An administrative principal, nine mainstream class teachers and four Additional Education Teachers comprise the staff. The participating class encompassed 28 5th class students aged between 10 and 12 years of age, of which 15 were boys and 13 were girls. There were a wide range of abilities and interests within the class.

From an ethical perspective, children are considered vulnerable research participants (MacCabe & Pao, 2021). The American Psychological Association (APA, 2017) reviews and outlines a number of core ethical principles which should underpin research with human participants. It is argued that the core principles of beneficence (do good), nonmaleficence (do not harm), autonomy (control by the individual), and justice (fairness) should govern and guide all research endeavours (McCabe & Pao, 2021). Although these fundamental principles apply to adults and those under 18 years of age, there are also unique considerations which are involved in research with children. These considerations primarily stem from children's legal status in relation to consent and the need for additional protection from harm in research settings (McCabe & Pao, 2021). As reviewed by Harcourt and Sargeant (2011), researchers are often reluctant to include children as research participants because of these ethical concerns. However, given that Article 12 of the United Nations '*Convention on the Rights of the Child*' (UNCRC) (United Nations, 1989) emphasises the participatory rights of the child, there is a growing emphasis on the importance of high-quality ethical research in which children are active and agentic participants (Harcout & Sargeant, 2011; McCabe & Pao, 2021). In this research, recommendations from the cited literature above, as well as DCU's (2022) '*Keeping Children Safe, Policies and Procedures supporting Child Protection at*

DCU' and the Department of Children and Youth Affair's '*Guidance for developing ethical research projects involving children*' were adhered to throughout the project (see Appendix B Ethics Approval Letter).

Reflecting the best practice guidelines alluded to, research was designed with minimal risk to children. The collaborative problem-solving tasks (based on Lego Spike Prime) were embedded within the existing 5th class Maths, Science and SPHE (Social, Personal and Health Education) curriculum and were integrated into the school day, ensuring that children's access to learning experiences in other subject areas were not impeded or affected. Having worked as a primary school teacher for ten years, the researcher had substantial expertise with children of this age group. As the children's class teacher, she was aware of existing needs within the class and how dynamics might emerge in group tasks. Additionally, in prior research (MEd), she had previous experience of using child-participatory research methods in a school context. This professional expertise ensured that she had an in-depth awareness of how to anticipate and address, where necessary, the potential risks that may occur when carrying out research with vulnerable age groups.

Given the dual roles of research and teacher assumed, careful consideration was given to the potential for power imbalance between the researcher and the children and whether this might influence children's decisions to participate in the research. In response, a number of steps were taken. First, in both the Plain Language Statement (see Appendix E) and in subsequent discussions, children were assured that their involvement in the Lego tasks was not contingent on their participation in the study. Second, a range of research tools (including focus groups and whole class child reflections) were employed to optimise student voice. In the case of video recordings, the risk for this research was relatively minimal, as video

recordings were used for the purposes of completion of this research and would be not published elsewhere.

In designing the study, the researcher was cognisant of the importance of ensuring that participating children derived benefit from the experience. It was judged that engagement in the CPS tasks would serve to develop skills in the curricular areas of Science, Maths and Technology which encompass the broader areas of Science, Technology, Engineering, the Arts and Maths in STEAM. It put the school's Digital Learning Plan into practice and was in line with the Department of Education's Digital Learning Framework (2015).

Considerable attention was given to the ethical procedures that would ensure that informed consent and assent was provided by both parents and children respectively. Having received informed parental consent (Appendix C and D) students provided assent through a child-friendly assent form and were assured of confidentiality of data (Appendix E). However, in accordance with child protection legislation, children were explicitly informed that if an issue of a sensitive nature was shared, the researcher would have to inform other people, including the school principal of the incident. As the use of video as a research method meant that the personal data, which is any information about a person where that person is identified, was being captured, stringent GDPR measures were adhered to in the sharing and storage of the video data. Parents of children were informed of the legal limitations of data confidentiality through the Plain Language Statement. As a matter of course, all children were given access to both the Lego tasks and reflection process, irrespective of their involvement with the study. Of the 28 pupils in the class, one parent did not give consent to the video recordings. The pupil engaged in the Lego tasks but his group was not recorded. All of the children were informed that the camera would not always record their group interactions. Given that the

composition of the groups changed regularly, the issue of video recording did not become an issue for any child.

3.6 The Development of Research Tasks

This section provides an overview of the criteria that were used when selecting the tasks through which AEI abilities would be observed. It was important that the tasks used would elicit the use of a wide range of AEI abilities. As outlined previously in Chapter Two, collaborative problem-solving (CPS) is a complex construct with many definitions proposed by scholars in the field. In the present research, the ATC21S definition and model is the framework that has been chosen for a theoretical comparison of the overlap between the social skills of CPS and the abilities of AEI. An overview of how many of the social skills of CPS co-align with many of the AEI abilities used within the managing and understanding emotions branches was included in Chapter Two. Having established a link between the two constructs, it was important to create tasks that would be best suited to the elicitation of these types of skills and abilities in pupils.

A task is a specific problem scenario which consists of a number of turns between the participants of a team (OECD, 2013). Both ATC21S and PISA conceptualised similar guidelines or criteria for the development of CPS tasks which were used when selecting tasks for the current study. The following sub-sections outline how the problem scenario, the tasks characteristics, the task medium and team composition guided the selection of Lego Education Spike Prime as the medium through which AEI abilities would be observed and assessed.

3.6.1 Problem Scenario

The first element of task development that was attended to was the type of problem scenario. As outlined in Table 3.2., the problem scenario involved selecting a task type, discerning what type of setting would suit the task type (technology vs. non-technology based) and the domain content (e.g. Maths, Science, English). There are many different types of tasks that can elicit collaborative skills in group settings (Hesse et al., 2015; OECD, 2013). For example, in consensus building tasks, the group must make a decision after listening to the perspective and arguments of all group members. With regard to the nature of the task, ATC21S is of the position that the solution for the task should be vague in order to reflect real-life problem-solving contexts where a solution is often unclear. Hesse et al. (2015) define these as "ill-defined problems" in which there may be several solutions or several paths to the solution. An ill-defined problem requires an individual to draw on wide range of problem-solving and collaborative skills. In a slightly difference stance, PISA is of the position that the central unknown factor in CPS tasks is the path to reach a solution. The solution itself does not have to be unambiguous but the process of reaching the solution is not clear for group members. In the context of this study, it was important that the solutions to the tasks chosen were not clear-cut or transparent to pupils and that they were sufficiently 'ill-defined' to evoke key social skills. However, time pressure was also a factor due to the overloaded nature of the curriculum and the school day. The problem could not take longer than 45 minutes to one hour to solve within one session so as to ensure that other areas of curriculum would not suffer. As highlighted in Table 3.2, Lego Spike Prime Education provided a series of challenges or problems that had to be solved by the groups. The solution was never clear-cut and there were often multiple ways to find a solution to the challenges presented.

The setting of the task refers to where it takes place, either on a technological platform or in a real-life group context. As Table 3.2 summarises, many researchers have designed Technology-Based Assessments (TBAs) for CPS, including PISA and ATC21S. Whereas PISA asked students to complete a task by collaborating with an online agent, ATC21S asked two students to complete a task by communicating with each other through an online chat box. Both were advantageous in different ways, but it has been accepted that it is very difficult to truly capture the social process of CPS through many TBA tasks (Rosen, 2017). Originally, this research aimed to adapt the TBA used within the ATC21S assessment for the purposes of adding a type of AEI assessment. A number of key scholars were contacted by the researcher, including Dr Patrick Griffin[4] , Dr Johanna Pöysä-Tarhonen[5] and Professor Sandra Milligan[6]. An overview of the planned research design was provided by the researcher and feedback received relating to the adaptation of the ATC21S tasks served to guide the trajectory of the research in a number of ways. For example, having worked on a number of CPS projects, including ATC21S, Dr Pöysä-Tarhonen reported that the tasks were difficult to adapt and that the technology was becoming outdated quickly. This sentiment was echoed by Dr Griffin and Professor Gilligan, signalling that adaptation of these tasks would not be a workable concept. This consultation also assisted in adapting and directing the research design.

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[4]Executive director of the Assessment and Teaching of 21st Century Skills Project and the lead editor of the ATC21S series

[5]Senior researcher at the Finnish Institute for Educational Research (FIER), and lecturer at the University of Jyväskylä, Finland

[6]Executive Director of Melbourne Assessment at the Faculty of Education, University of Melbourne

Further, Dr Pöysä-Tarhonen suggested the use of the Cued Response technique as a means of encouraging participants to reflect on the thought processes behind collaborative social interactions. Based on a cue or cues of their performance, participants can be invited to verbalise their thought processes during the task retrospectively. This recommendation was subsequently incorporated into the design of the focus group interviews where children watched parts of their video recordings and discussed their thought processes behind particular interactions and decisions.

Given the substantial role that technology plays in many CPS tasks within both educational and organisational contexts today, it was important that it had some part of this study. Of equal importance was that the tasks chosen did not deprive the study of the opportunity to observe human-human group collaboration in a natural setting. The use of Lego robotics was the medium selected to ensure that technology played a part in the CPS tasks but did not detract from the real-life dynamics which were taking place between group members.

The domain content of the tasks used in PISA and ATC21S were designed to be of interest to post-primary students. In both studies, some of the tasks were content-dependent, while others were content-free (Hesse et al., 2015; Griffin & Care, 2015). Content-free-tasks do not require any prerequisite knowledge based on specific subject areas, but rely on the application of reasoning. Content-dependent tasks use skills and knowledge that are curriculum-based. Even when tasks were content-dependent, it was assumed that participating students had sufficient cognitive and social skills to successfully undertake the tasks without a requirement for expertise in a particular area (Hesse et al., 2015, OECD, 2013). The domain content of the tasks used in the present study were also specifically selected to be of interest to primary school children in that they were playful, hands-on and

did not require any subject specific knowledge. The content of Lego Spike Prime Education is varied but its main focus is on the development of knowledge and skills in the areas of STEAM (Science, Technology, Engineering, the Arts and Maths). Through the Lego Spike Prime App, students follow a series of problem-solving lessons in which they complete robotics design challenges. Typically, the lessons can be completed in approximately 45 minutes to an hour, but additional challenges can be provided to extend the tasks. After completing the build, groups must code their robot to complete some type of challenge. For example, one lesson requires the group to build a robotic arm. Subsequently, they must code the robotic arm so that it can pick up items of various size. In another lesson, students must build a break- dancing robot. They can add design elements to allow creativity and must then code the robot to dance in sync with one of their favourite songs. The coding element of Lego Spike is described by Lego Education as "intuitive" in that students do not require previous experience of coding to complete the lessons. Block coding is the most basic form of coding available on the app and can be used by all children. However, there is an option to use a more difficult form of programming language, Python, which ensures a challenge for those with a previous interest in the area.

3.6.3 Team Composition

It was not the final solution of problem-solving but the process of collaboration and interaction which was of interest in this study. Determining the correct number of children to place within a group to elicit maximum interaction was therefore a significant decision. It was guided by the pilot study, as well as groupwork guidelines from educational and psychological scholars. As highlighted in Table 3.2, in PISA and the ATC21S studies, only two participants were involved in each collaborative task. However, the ideal and typical group composition in classroom tasks is around 4 pupils (Frey, Fischer & Everlore, 2009; Kutnick & Blatchford, 2014; Vermette & Kiline, 2017). Having 4 pupils in a group

encourages individual accountability, participation and interaction with others. Having more than 4 pupils can lead to social loafing, in which one individual does not put in their full effort due to the effect of the group setting (Frey et al., 2009; Kutnick & Blatchford, 2014; Vermette & Kiline, 2017). Therefore, students in this study were allocated into groups of four for each of the tasks. In the beginning months of the study, because of COVID-19 procedures, this group had to be the 'pod' that they were sitting in within the class. In the later months of the study, these restrictions were lifted. If a student was absent, as was often the case, also due to Covid, the group carried on with the task with a smaller number. Mixed ability grouping was used in that each group typically had a mix of personalities, abilities and gender. Mixed-ability grouping is recommended for general classroom group tasks in a primary school context as it gives children an opportunity to learn from one another (Frey et al., 2009; Kutnick & Blatchford, 2014; Vermette & Kiline, 2017). In the case of this study, it was also more likely that mixed ability grouping would facilitate the use of AEI abilities as students negotiated roles and tasks within the CPS activity.

The second important element of team composition that was deliberated was the issue of symmetry of status and roles (OECD, 2013). In a problem with symmetrical roles and status, every group member has to opportunity to participate equally and equal status is assumed. In contrast, in a problem with asymmetrical roles, varying roles are assigned to different people, for example, one group member is asked to take notes while another is asked to control a laptop or a computer. Distributed status could also be used by appointing one person as a leader. The use of asymmetrical roles can frequently assist group productivity as group members have clearly defined tasks within the central problem (OECD, 2013). However, it was not suitable in this study. In the initial stages of research design, the use of asymmetrical roles was considered and trialled. Observations by the researcher recorded that the roles

resulted in a lack of fluidity of task development and a somewhat unnatural group environment. Students themselves expressed a desire to remove the roles as they were happy to take turns and ensure that everyone had equal access to the tasks by themselves. Therefore, equal symmetry of roles and status was put in place for data collection. Each group member had the same role in the problem-solving context and all could participate equally.

3.6.4 Task Characteristics

Problem-solving literature typically divides the process of problem-solving into sequential steps (D'zurilla & Goldfried, 1971; De Hoys, Grays & Simpson, 2004; He et al., 2017; OCED, 2013). The initial step involves exploring and understanding the problem. In CPS, this involves discovering the perspective and abilities of group members and taking some time to consider the problem (Griffin & Care, 2015; OECD, 2013). Secondly, group members must build a shared understanding and negotiate the meaning of the problem. This involves identifying and describing the tasks that would need to be completed as well as assigning roles or tasks to group members. The final two stages involve enacting the plans that are needed to solve the problem and monitoring and reflecting on the success of these actions. Feedback may have to be given to team members and roles may have to be re-assigned if the problem is not being solved successfully. As this study was creating a less structured context for participants than both ATC21S and PISA, these sequence of steps were not always followed accordingly. However, it was a prerequisite that the tasks should be designed so as to ensure that these four processes of problem-solving could take place in the students' groups. The structure of the Lego Spike Education lesson plans aided the facilitation of this sequence of steps. In the first steps of a lesson, students were faced with a problem, either building or coding a robot. They then had to decide how they would solve the problem as a team. The final steps involved reflecting on whether the robot was looking or acting as it

should. Often if unsuccessful, students then returned to the initial stages of problem-solving and the process of negotiating roles and actions began again.

Additional characteristics of the tasks that were important to consider was symmetry of information and resources in the tasks. In symmetrical tasks all of the information necessary for the solution is available from the start of the task, whereas in interactive tasks, individuals must work together to find information that is needed to reach the solution (OECD, 2013). As PISA assessments must be standardised across many different countries, the OECD's (2013) stance was that successful collaboration required symmetry with regard to the knowledge that individuals had access to in the task. In PISA's online tasks, all participants were provided with the same resources at the beginning of the task. They encountered the same stimuli and had the same opportunities to react as they worked to solve the online problem-solving situation (Scoular, Care & Hesse, 2017). ATC21S, on the contrary, placed a greater emphasis on the natural communication and interaction between group members, allowing them to chat through the medium of a chat box when completing online tasks. Standardisation was not a central focus of this qualitative study. It was not assumed that group members had symmetry of knowledge. In fact, the asymmetrical nature of the group was an important factor when deciding on group composition. Groups were designed so as to be of mixed gender, mixed abilities and a mix of different personality types, as is generally the case when creating groups in the primary school classroom. Some children had an interest in Lego outside of school and this may have given them a slight advantage when completing the tasks. Abilities in STEM varied and interest in the tasks often varied depending on its content and on the child's mood on the day.

Table 3.2

Task Development Considerations that lead to the selection of Lego Education Spike Prime

Context	Dimension	Examples	Characteristics of Lego Education Spike Prime
Problem Scenario	Task Type	e.g. Jigsaw, consensus building, negotiation	Collaborative STEAM Tasks
	Setting	e.g. Technology vs. non-technology	Technology based (children carry out coding in robotics) but in a real-life context, not an online platform
	Domain Content	e.g. Maths, Science, English	Not content specific (related to areas of STEAM but no expertise knowledge required)
Team Composition	Size of group	2 or more	Four students in each group
	Symmetry of status and roles	Symmetrical vs. asymmetrical	Equal status and roles allocated to all group members
Task Characteristics	Problem-Solving Sequence	Four steps	Lego Spike lessons are structured to elicit steps of problem-solving
	Symmetry of resources	Symmetrical vs. asymmetrical	Equal resources for all participants (1 iPad and 1 Lego spike prime kit)
	Symmetry of information	Symmetrical vs. asymmetrical	Equal access for all participants. Some participants may have background knowledge that influences task engagement/expertise

3.7 Development of the Observation Framework for Emotional Intelligence Abilities

The purpose of this research was to probe whether AEI abilities could be observed and assessed within CPS tasks. As described above, these tasks were designed to elicit social

skills, many of which overlap with the abilities of Mayer et al.'s 2016 AEI model. An observation framework provided a structure for the researcher's observations and could potentially be recommended for use in future research if successful. This design was an iterative process where the framework was designed, refined and adapted several times along the research process. The process for creating the analysis framework can be summarised as (1) reviewing existing AEI literature and existing CPS frameworks (2) collecting observational data of children using AEI abilities in the classroom (3) creating behavioural indicators of AEI abilities (4) refining the framework through the process of data collection and peer reflection.

3.7.1 Reviewing Existing AEI and CPS Literature; Refining the Branches

As described in Chapter Two, the most recent model of AEI was published by Mayer, Caruso and Salovey in 2016. There are four branches of AEI in this model; perceiving emotion, facilitating thought through emotion, understanding emotions and managing emotions (see Figure 3.2 for a visual summary of the model). Within each branch are a series of mental abilities that individuals use. The abilities are sequential in that they progress in difficulty. For example, the most basic ability within perceiving emotions is the ability to identify emotions in one's own physical states, feelings, and thoughts. The most difficult ability is the ability to recognise deception in another's emotions. While a young child may be able to perceive emotion in facial expression or voice, they would find it difficult understand if emotional expressions were not genuine. Initial attempts were made to design a framework that included the behavioural indicators of all four branches. While an extensive and comprehensive framework would have been produced, the process of observation or assessment would have been extremely time-consuming and laborious. Feasibility issues, therefore, informed the need to refine the framework.

A two-pronged approach was taken to refine the framework involving both researcher observation and a review of literature. The researcher engaged in an eight week observational period where she observed and reflected on the behaviours that children used while problem-solving collaboratively throughout the school day (see Section 3.7.3 for additional detail). The most frequently observed behaviours appeared to be related to the branches of managing and understanding emotions, and not the perceiving emotions or facilitating thought through emotions branches. In tandem with observations, relevant literature was reviewed to discern if certain branches of the AEI model were empirically linked with performance or behaviour in collaborative tasks. Few studies have focused on the relationships between distinct branches of AEI and team or group performance. Feyerherm and Rice (2002) investigated the relationship between 164 employees team performance (ratings of accuracy, productivity and general performance indicators) and scores on the Multifactor Emotional Intelligence Scale (Mayer, Caruso & Salovey, 1997). They found significant correlations between the understanding emotions and managing emotions branches with team performance, but not for the other branches. In a similar vein, Rozell and Scroggins (2009) reported that higher scores on the understanding and managing emotions branches were positively correlated with overall group satisfaction on a group work. Kren and Sellei (2020) also reported a significant correlation between the self-management of emotions and scores of organisational work performance (r = -0.656; p = 0.039). This limited body of literature suggested that the branches of understanding and managing emotions are particularly significant when working with others. Drawing together these reflections and findings, it was therefore decided that from a practical and theoretical perspective, the branches of understanding and managing emotions would be included in the framework.

As Figure 3.2 outlines, there are eight mental abilities within the managing emotions branch. The bottom, most basic ability, is the ability to *label emotions and to recognise relations among them.* The top, most developed ability, is the ability to *recognise cultural differences in the evaluation of emotions.* In between, there are six other abilities that help an individual to understand emotions in order to solve problems in their everyday lives. The managing emotions branch has six abilities. The first, most basic ability within this branch is acknowledging *both pleasant and unpleasant feelings and the information that they convey.* The most complex ability within this branch is *effectively managing other's emotions to achieve a desired outcome.* Although not all were included in the final prototype, these 14 abilities guided the design of the framework.

Figure 3.2

The Most Recent Model of Ability Emotional Intelligence

The Four Branches	Types of Reasoning
Manging Emotions	• Effectively manage others' emotions to achieve a desired outcome[b] • Effectively manage one's own emotions to achieve a desired outcome[b] • Evaluate strategies to maintain, reduce, or intensify an emotional response[b] • Monitor emotional reactions to determine their reasonableness • Engage with emotions if they are helpful; disengage if not • Stay open to pleasant and unpleasant feelings, as needed, and to the information they convey
Understanding Emotions	• Recognize cultural differences in the evaluation of emotions[c] • Understand how a person might feel in the future or under certain conditions (affective forecasting)[c] • Recognize likely transitions among emotions such as from anger to satisfaction • Understand complex and mixed emotions • Differentiate between moods and emotions[c] • Appraise the situations that are likely to elicit emotions[c] • Determine the antecedents, meanings, and consequences of emotions • Label emotions and recognize relations among them
Facilitating Thought Through Emotion	• Select problems based on how one's ongoing emotional state might facilitate cognition • Leverage mood swings to generate different cognitive perspectives • Prioritize thinking by directing attention according to present feeling • Generate emotions as a means to relate to experiences of another person[c] • Generate emotions as an aid to judgment and memory
Perceiving Emotion	• Identify deceptive or dishonest emotional expressions[b] • Discriminate accurate vs. inaccurate emotional expressions[b] • Understand how emotions are displayed depending on context and culture[c] • Express emotions accurately when desired • Perceive emotional content in the environment, visual arts, and music[b] • Perceive emotions in other people through their vocal cues, facial expression, language, and behavior[b] • Identify emotions in one's own physical states, feelings, and thoughts

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The AEI assessment tools that are currently available in the literature were also examined in the theoretical review. As previously described in Chapter Two, Mayer, Salovey and Caruso (2002) released the youth version of the Mayer-Salovey-Caruso Emotional Intelligence Test. Designed to assess the four branches of Ability EI in youths aged 10-18 years of age, it uses a total of 101 items, of which 97 are scored. In more recent years, the Swinburne University Emotional Intelligence Test – Early Years (SUEIT-EY) has been developed, originally by Lloyd (2012) and later revised by Bunnett (2021). Unusually for an AEI measure, the SUEIT-EY combines self-report and performance-based measurements to assess AEI. The self-report

statements were helpful in designing the AEI framework in this study as they could be adapted to develop behavioural indicators.

Existing CPS assessment frameworks were also analysed to determine which skills and processes related to collaboration were similar to the mental abilities included in the AEI model. These included the framework used in the Assessment and Teaching of 21st Century Skills Project (Hesse et al., 2015) and the PISA CPS framework (OECD, 2013). For example, the social skill of 'negotiation' included within the ATC21S model overlaps with the abilities described in the managing and understanding emotions branches. When negotiating with others, one must recognise the antecedents of emotions, the relationships between emotions and how to manage one's own and other's emotions to achieve success. Therefore, some of the behavioural indicators used within CPS frameworks became relevant when designing and adapting the AEI framework for the present study.

3.7.2 The Education Research Literature

As this research was centred in a classroom context, guidance was drawn from the area of socio-emotional learning and the assessment tools used within this area in schools. Socio-emotional learning refers to the educational provision of strategies and methodologies that develop key social and emotional competences in students (Al-Yagon & Mikulincer, 2004; Mondi, Giovanelli & Reynolds, 2021; Poole et al., 2018). The key pillars of socio-emotional learning co-align with the key abilities outlined in AEI theory, such as, emotional awareness and social skills. A substantial number of studies have documented that children who struggle with socio-emotional learning are more likely to exhibit challenging behaviours in the classroom (e.g. Allen et al., 2020; Bacherini et al., 2021; Conners et al., 2021). Children struggling in the area of socio-emotional development can benefit great from the use of functional behavioural checklists or screening tools (Allday, Nelson & Russel, 2011; Bessette

& Wills, 2007; Repp, 1994). These checklists and tools can help to identify how frequently a behaviour occurs, the level of its intensity and its antecedents. These types of behavioural checklists are designed to be easy to use for teachers and to be effective in analysing behaviour. Some elements of these checklists and tools were adapted for use in this study.

3.7.3 Observational Data

Over a period of 8 weeks, students were observed by the teacher in their everyday classroom practice and interactions. The researcher was particularly perceptive to the types of social behaviours and language that the students used when they were solving problems or working in groups. CPS was of particular interest, whereby children were required to share resources, assign roles or solve conflict with others. Having observed the task in an informal manner, the researcher compiled active memos and notes that were subsequently used to inform the AEI framework.

3.7.4 Creating the Framework

During the literature review and the classroom observations, a number of different behaviours associated with the use of AEI were identified. For example, conflict between group members was likely to elicit the ability to self-regulate one's own emotions. Managing other's emotions in order to maintain group cohesiveness and group focus were also apparent during conflict situations. Similar abilities were observed when groups were distributing roles or tasks. Some children found it difficult not to become angry or reserved, while others worked hard to maintain their composure if they were not satisfied with the jobs that they had been assigned by other members. The self-report questions from the Swinburne University Emotional Intelligence Test – Early Years (Bunnett, 2021; Lloyd, 2012) and the behavioural indicators used for the social skills of CPS in the ATC21S project (Hesse et al., 2015) were also referred to and adapted to suit the context of this study.

The first design of the AEI framework can be viewed in Figure 3.3. The branches of Understanding and Managing Emotions are further divided into emotional abilities. Not all of the emotional abilities within these two branches were included. Instead, the abilities that appeared to be most frequently noted during the observation period and those that were chosen as most relevant to group work from the theoretical review were included. Three abilities; *labelling emotions and recognising relations among them, determining the antecedents, meanings, and consequences of emotions* and the ability to *appraise the situations that are likely to elicit emotions* were included.

Figure 3.3

Draft One of Observation Framework

Branch of AEI Model (Mayer et al., 2016)	Emotional Abilities According to Mayer et al., (2016)	Corresponding Behavioural Indicators Relevant to Successful Problem-Solving in Lego STEAM Tasks	Child A Frequency	Child A Intensity	Child B Frequency	Child B Intensity
Understanding Emotions (in oneself and others)	Label emotions and recognize relations among them	Makes reference to their own and other's emotions throughout the task	✓✓✓			
	Determine the antecedents, meanings, and consequences of emotions	Discusses potential emotions that may occur in the next component of the task with group members.				
		Listens to other's opinions and asks questions				
		Displays empathy verbally or with body language				
	Appraise the situations that are likely to elicit emotions	Offering assistance to other group members encountering difficulty (preventing frustration/maintaining group cohesiveness)				
Managing Emotions (MG) (in oneself and others)	Effectively manage one's own emotions to achieve a desired outcome (self-regulation of emotion)	Accepts making mistakes/handles being corrected by others				
		Consistently focused on task (not distracted by off-task behaviour like chatting/other groups working)				
		Persists even when encountering challenges				
		Uses self-regulation abilities to manage frustration/negative emotions				
		Disagrees without having an argument				
	Effectively manage other's emotions to achieve a desired outcome	Use of positive language and encouragement in order to maintain group cohesiveness to achieve task (e.g. This is hard but let's try again).				
		Divides workload/negotiates roles (prevents conflict and frustration in others)				

In keeping with the approach adopted for the understanding emotions branch, two main abilities were included from the managing emotions branch, the ability to *effectively manage one's own emotions to achieve a desired outcome* and the ability to *effectively manage other's emotions to achieve a desired outcome*. Given the predominant role that managing conflict has in team literature, and the potential negative impact that disagreement or conflict can have on interpersonal relations, these two abilities were judged to be of particular relevance and worthy of inclusion. The abilities are organised sequentially from the most basic to the more complex, as in the AEI model developed by Mayer et al. (2016). Corresponding behavioural indicators that are relevant to successful problem-solving in groups are outlined next to the relevant ability. For example, accepting being corrected by others is an important part of managing one's own emotions. Talking and making reference to one's one and other's emotions throughout the task is related to the ability to label emotions and recognise relations amongst them. The final columns in the framework are a means of tracking the behaviours of children in the group. These were derived from the area of functional behavioural analysis mentioned above. Firstly, the frequency of the corresponding behaviour is recorded using a tick. Three levels of intensity for behaviours were included, red, yellow and green. A red symbol indicated that the student was not engaged with this behaviour, a yellow that they were somewhat engaged in this behaviour and a green symbol indicated that they were fully engaged with the behaviour.

3.7.5 Refining and Adapting the Framework

After the first draft of the framework was created, it was tested in the pilot phase of the study and the following adaptations were made:

- The framework template was used to assess one child, rather than two or three groups together

- Common phrase or language indicators were added
- Duration of behaviour was added
- Researcher triangulation was used to verify lack of researcher bias

Figure 3.4 highlights the final framework that was adapted for use. Firstly, its usability as an instrument was checked, which resulted in iterating the rubric. In its original form, the behaviour of all four group members was recorded within the one framework. However, this meant that the framework lacked clarity as there was not enough room for all of the behaviours to be recorded. Hence, it was altered to assess one pupil within one framework and a new template was created for each group member.

Recommendations for adaptation were also made by the supervisors of this project. The type of language used by the children was a central indicator of the types of emotional abilities that they were using. Therefore, common phrases used by the children were added to the framework as the study progressed. For example, phrases used to indicate a positive emotional state included “This is really fun” and “This is really cool” while phrases used to indicate a negative emotional state included “Why is this so hard?” or “I don’t want to do this anymore”.

Additionally, it was suggested that the duration of behaviours could be added to the draft. Including the duration of a particular behaviour could provide greater insight into the use of AEI abilities. As can be viewed in Figure 3.4 one star was used to indicate if the behaviour lasted less than 30 seconds, two for behaviour that lasted between 30 seconds and one minute and three for behaviour that lasted greater than one minute.

Figure 3.4

Final Observation Framework

Branch of AEI Model (Mayer et al., 2016)	Emotional Abilities arranged from the simplest to the most complex (Mayer et al., 2016)	Corresponding Behavioural Indicators Relevant to Successful Problem-Solving in Lego STEAM Tasks	Common Language Indicators to indicate use of AEI ability	Student I.D. Code: Frequency	Intensity	Duration
Understanding Emotions (in oneself and others)	i. Label emotions and recognize relations among them	**Makes reference to their own and other's emotions throughout the task**	**Positive emotional state** • This is actually fun. • This is really cool • I'm so glad our group got to do it today **Negative emotional state** • This is so hard/annoying • This isn't working. Why isn't it working?	✓	•	
	ii. Determine the antecedents, meanings, and consequences of emotions	• **Listens to others opinions, asks questions and talks through the process of problem-solving.**	• Ok here's what we need to do next... • Should we do this now? • What did you say we should do?			
		• **Displays empathy verbally or with body language** **Body Language Indicators used** • Smiles • Laughing with the person when they make mistakes • Fist pumps, high fives/hugs/arm around the person • Sympathetic facial expression	• No that was good. • Keep going. • Well it was really hard, don't worry about it • Sorry, I didn't know what you meant			
		Discusses potential emotions that may occur in the next components of the task with group members	• This looks really hard • We might not be able to do this • The next bit will be fun for us			
	iii. Appraise the situations that are likely to elicit emotions	• **Maintains group cohesiveness by offering assistance to other group members encountering difficulty manages conflict**	• Do you need help? • Let her have a turn.. • Let's try it another way. Can I have a go?			

Managing Emotions (MG) **(in oneself and others)**	v.	Effectively manage one's own emotions to achieve a desired outcome (self-regulation of emotion)	• **Accepts making mistakes/handles being corrected by others**			
			• **Consistently focused on task (not distracted by off-task behaviour like chatting/other groups working**			
			• **Persists even when encountering challenges and tries new methods to solve problem**			
			• **Uses self-regulation abilities to manage conflict/negative emotions/disagrees without having an argument (reaches compromises/is patient with others)**			
	v.	Effectively manage other's emotions to achieve a desired outcome	• **Uses positive language and encouragement to ensure others remain focused and motivated to complete task**	• Well done! • We did it! • Keep trying! I think you are going to get it!		
			• **Divides workload and negotiates roles (prevents conflict and frustration in others)**			

Key

Frequency:	Duration:	Intensity
✓ every time behaviour is displayed	< 30 seconds = * 30 seconds - 1 minute = ** >1 minutes ***	Not engaged with this ability Somewhat engaged in ability e.g. listens but can get distracted Fully engaged in use of ability

Researcher triangulation was used to verify the credibility of the template and to address the issue of researcher bias. It was possible that as the creator of the framework, the researcher would be more likely to observe the behaviours that she wished to see in the children. In order to address this issue and identify the level of inter-rater reliability between researchers, a colleague of the researcher completed observation frameworks for three children. This is described in more detail in the findings section.

3.8 Research Methods

There were two primary research methods used in the present study; video-based fieldwork and focus groups. The focus group structure and questions was informed by the video-based fieldwork component of the study.

3.8.2 Using Video-Based Observation

The current section describes how the use of video-based observation (VBO) aligned with the research questions of the present study and how the common pitfalls of video-based fieldwork were tackled. In the past number of years, due to developments in technology, video as a research tool has become more popular and accessible to researchers (Clarke & Chan, 2018; Hannula et al., 2021). There are a number of different ways that video can be used in research. For instance, Jewitt (2012) defines a participatory video approach as a process in which research participants are given access to video recording equipment and training to ensure that they can use it successfully to document as element of their lives. Video-based reflections are another way to prompt discussion or to stimulate reflection in a study. Typically, participants record reflections on an event or an experience through the medium of video.

For the present study, it was critical that the natural interactions and discussions of pupils could be observed and analysed. In-person observations could permit some notes and memos to be recorded. However, retrospective analysis of video provided ample opportunity for the communication between group members to be deciphered and described. In this study, VBO was selected as a primary research method. VBO involves the collection of "naturally occurring data using video cameras" (Jewitt 2012, p. 5) and it is the most established use of video for data collection within the social science. VBO involves recording the continual interaction of individuals within a certain environment and allows for an in-depth exploration of human behaviour. Even though video allows 'naturally occurring data' to be processed, there are other variables which affect how the data is captured, including the type and number of cameras, the length of recording and the placement of the camera (Clarke & Chan, 2018; Hannula et al., 2021; Jewitt, 2012). These issues were addressed in this study through the process of piloting.

As highlighted by Jacobs, Hollingsworth, & Givvin, (2007), VBO is advantageous as a research method as it can provide a comprehensive record of an interaction and capture facial expressions, posture, gestures and language. It allows the process of research to be recorded, rather than just the product (Hannula et al., 2021). Video can be viewed as a window to observe group contexts in which much of the communication is non-verbal in nature. Analysing the social structure of body language, gestures and 'non-dialogue' provides a rich and detailed narrative of the types of interactions between participants in a study. Thus, video is a multimodal, fine-grained documentation in which talk is recorded in context and interactions are captured sequentially (Hannula et al., 2021; Whiting et al., 2018).

A significant further advantage of video data is that it can be meticulously and thoroughly scrutinised so further meaning can be deciphered. Other types of recordings cannot capture these kinds of social interactions. It is also a durable and adaptable record that can be repeatedly watched and altered to be viewed in slow or fast motion, freeze-frame or without sound or image. As noted by Jacobs et al. (2007), this process permits the researcher to revisit the data many times as a greater understanding of codes and themes emerges. Lemke (2009) suggests that slowing and speeding up video can assist in providing analytical distance and reflexivity by denaturalising it. This assists in the avoidance of bias in interpreting social situations, a common threat to validity in qualitative research. The present research required a process of iterative data analysis in that each video was watched multiple times by the researcher when completing the observation frameworks for a group. In each round of observation, the focus was on one child and their use of AEI abilities when completing the task. Without video, the researcher would have been reliant on reflections rather than data that was captured in real-time.

According to Savin-Baden and Tombs (2017), there is an extensive range of video cameras that can be used to gather data and the research design of the study should guide the choice of camera. Larger cameras fixed on tripods tend to be used to video record interactions between individuals within a certain field of vision over long periods of time (Savin-Baden & Tombs, 2017). Fixed cameras, like those positioned in wall or ceilings are commonly availed of in experimental or laboratory settings (Jewitt, 2012). Many studies with child participants use small hand-held cameras which allow children to record some of the data themselves (Blikstad-Balas, 2017). An additional decision is whether the video camera will be fixed or roaming. Fixed and ‘unmanned’ cameras typically use a wide angle lens and advantageously capture ‘raw footage’. The recording produced is of the same scene, using the same lens and

without any distortion or alteration. In contrast, roaming cameras are cameras that are moving, either assisted by an individual or by technological equipment. These types of cameras can allow many different types of shots to be recorded, for example, zooming in on a particular action or interaction that is happening between group participants. The disadvantage of this type of camera is that there is less of a natural representation of the context that is being video recorded, in that selection and choices are being made by the researcher about what to video and about who to focus on (Blikstad-Balas, 2017, Jewitt, 2012). As highlighted by Goldman (2007), some researchers also use multiple cameras in an attempt to deal with the risk of bias in video and to allow the collection of multiple perspectives. For example, multiple cameras are often used in classroom settings where there are many 'scenes' taking place at the same time. One camera might capture the teacher's talk and actions, whereas other cameras might record the actions and talk of children in different groups within the classroom. However, multiple cameras are not always necessary and depend on the context in which the research is being carried out (Blikstad-Balas, 2017, Jewitt, 2012).

Different types of cameras were considered for this study. Given that the research was taking place within the context of a busy school and classroom, the video camera had to be mobile and relatively small. Easy and fast set up of the camera was important within the time-constrained nature of the school day. The researcher contacted several local education centres to enquire about renting audio-visual equipment given that education-based research often stems from education centres. However, all of the education centres no longer retained audio-visual equipment. They reported that teacher-researchers now commonly use their phones or other digital devices that were available in schools. With this consideration in mind, it was decided to trial the use of the school iPads that were available in the researcher's school as

the video camera and recording device. The iPads could be easily accessed, were small and easy to move and could produce videos which were of relatively high video quality. The decision of where to position the iPad or camera was made with the goal of capturing the maximum level of interaction between the groups. While there is no standard 'right' position for the video camera in video-based research, there is general consensus across social researchers for the need to locate it where the pertinent action is, to frame it and to disturb it as little as possible (Jewitt, 2012). An iPad tripod stand was purchased and placed in front of the group that were completing the Lego task. There were a number of instances in the pilot phase of the study where students were cut out of shot as they moved around the table working on the robotics challenges. Therefore, the camera had to be moved further away to capture a wide angle shot of all of the group members and provide some scope for movement within this recording space. Issues of sound quality had to be addressed with the purchase of an additional microphone that would produce superior audio. It was decided that one video recording device would be sufficient for data collection as the wide pan shot would capture natural interactions and would be more feasible for set-up and post-data analysis. Using more than one camera may also create an additional sense of scrutiny for the students in question. There were also a number of other considerations about the impact that the video would have on the children.

Using video recordings in educational research with children has generated some debate. Of primary concern is the ethical concerns that are associated with the use of video. Videos capture personal data of children's faces, voices and locations. The publication of video in any type of public forum opens up the potential for resharing online, regardless of the security features used (Hannula et al., 2022; Peters et al., 2021). As addressed in Section 3.4.2, stringent ethical procedures were put in place for the current research. Children's

anonymity was protected as direct videos will not be published in any forum in the future. With this issue addressed, the focus moves to the effect that the recording equipment would have on the participants being observed and subsequently, the data collected. On one side of this debate raised by academics (e.g., Buchwald, Schantz-Laursen & Delmar, 2009; Haggerty 2020) is the argument that the recording equipment acts as a disruption and that children will ultimately perform for the camera. In this regard, children may 'play up' for the camera and the video will not capture their true interactions and behaviours but a type of performance, ultimately undermining the quality of the study. On the other hand, there are researchers like Peters et al. (2021) who argue that this reactivity to the video camera is frequently exaggerated.

Indeed, there are many studies where qualitative researchers have reported little or no effects from the recording device on children's behaviour. Heath et al. (2010) carried out a longitudinal study of a group of children using video cameras. They reported that the camera was unobtrusive and that children quickly forgot about its presence. Similarly, in a more recent study, Haggerty (2020) used video in an ethnographical study of children in the classroom, reporting that the children in her research did not react to the camera and were comfortable in its presence. In a number of studies on new initiatives in Maths education, Hannula et al. (2022) asked post-primary students how they reacted or experienced the video recording device in their Maths lessons. These recordings were being captured in their classroom and were over a significant period time. None of the students reported that the equipment or the presence of researchers affected their participation or learning in significant manner. An additional argument is that children in today's society are very familiar and comfortable with the use of video in their own lives. As highlighted by Peters et al. (2021), never has the visual been more prominent in society. Children are increasingly documenting

their own lives through video and sharing this content online. There is an argument therefore that video now has less of an impact on children within research as it is not perceived as something beyond the norm of their everyday lives.

When considering the impact of video on children in this study, it is possible that it did 'compromise some aspects of the naturalness of the classroom', particularly at the beginning of the study (Peters et al., 2021). When analysing data, children sometimes glanced at the camera when they were not completely focused on the task. There were times when the children felt that certain content was not 'suitable' for the camera and they discussed this with their group. For example, if a child began to discuss their weekend or how much homework they were getting today, they would sometimes be 'shushed' or lightly reprimanded by their peers for not keeping the content relevant for the video. Others used the camera to check how much time had passed since they had begun the task. However, there were other factors which meant that children were more likely to act naturally in front of the camera. Unlike other video-based studies, children did not carry out the study in a new setting. They completed the Lego tasks within their classroom or in a shared resource area that was just outside their classroom door. Additionally, as the study progressed students became more familiar with the process of data collection and generally proceeded without looking at the camera. Interestingly, there were also indications that children felt ownership of the video recordings and that they were in fact engaging in participatory research, even though this was not the explicit design put in place. The class had been told in their plain language statement and by the researcher that the videos may be shown to her supervisors in DCU. When some groups were particularly proud of a robot that they had built, they would speak to the camera and show off what it could do. Therefore, while it was accepted that the

camera had some influence on different children in this study, it was not a central concern to validity.

Common limitations of VBO cited in the literature generally focus on what happens after data collection take place (Paulus, Lester & Dempster, 2015). A well-mentioned limitation is that it can result in the acquisition of huge amounts of data (Nassauer & Legewie, 2019). In the present study, there were hundreds of interactions, conversations and utterances within each video that was recorded. This can be overwhelming and required the use of a rigorous selection process to refine data analysis. Reflexivity also plays a huge role in data analysis of video and it is vital that the role of the researcher in video research is acknowledged (Knoblauch & Schnettler, 2012). It has been frequently stressed that in spite of its seeming objectivity, video-based research is not always a true and accurate representation of reality. A fear amongst some academics is that researchers make subjective judgements about what to select from the raw data and create interpretations of meaning that may not be authentic to the participants experiences of the situation (e.g., Paulus, Lester & Dempster, 2015; Nassauer & Legewie, 2019). The transcription and coding of video must be transparently documented for the purposes of ensuring rigor in video-based research. These factors are discerned in greater detail in the later sub-sections related to data analysis.

3.8.3 Research Methods: Class Reflections and Focus Group Interviews

As discussed in Section 3.5.2, a central aim of this research was that children would be active participants in the research process. One way that this was achieved was through the use of class reflections and focus group interviews. Additionally, given that AEI is a latent construct, it was important for triangulation purposes that this study did not rely solely on video observation data and the researcher's interpretations of same. Whole class child

reflections were used therefore to afford children the opportunity to reflect on their participation and engagement in the CPS tasks. Each group of children participated in four different tasks from the Lego Spike Prime Education Kit: Hopper Race, Driver Race, Breakdancer Challenge and Super Clean-Up Challenge. Each task involved children working collaboratively to problem-solve and work through a particular challenge or question. When all groups had completed one of the tasks, the researcher held a reflection session in the classroom where she encouraged children to sit together in their groups and discuss their reflections on the task. These reflections were less structured than the focus group interviews used, although guiding questions were used (see Appendix J).

Focus groups are used to produce qualitative data that provides insights into the attitudes, perceptions, motivations, concerns and opinions of participants (Gibson, 2007; Stewart & Shamdasani, 2014). Stewart & Shamdensi (2014) define a focus group as a strategically planned discussion that is designed to gather perceptions on a particular subject of interest in a permissive, non-threatening context. Using focus groups as a research method with children is becoming increasingly popular as it allows children's voices to be heard in the research process (Adler, Salanterä, & Zumstein-Shaha, 2019; Gibson, 2007). In this study, focus group interviews were selected as a way for children to tell their own stories, express their opinions and to cognitively debrief on the process of working collaboratively on Lego STEAM tasks. Adler et al. (2019) argue that focus groups are particularly successful with children who are aged 10 and over and that their use can create a safe peer environment which counteracts the power imbalance that often exists between the researcher and the participants. During the ages of 10 and 12, children make expansive cognitive and social development and are generally skilled at conveying their thoughts and feelings to one another (DeHart et al., 2004). They are also able to understand what other children are thinking and conversations

typically start to show more ‘give and take’ as children learn how to respond to one another (DeHart et al., 2004). Many of the children in this study had turned 12 years of age by the time in which the focus groups were held. At 12 years of age, children typically develop greater abstract reasoning, greater language and memory capabilities and their awareness of self becomes heightened (Fledman, 2011). Thus, the children in 5th class in this study were deemed of a suitable age and developmental stage to fully articulate their thoughts within a group context.

When preparing for a focus group, several issues have to be addressed. Firstly, participants have to be chosen. Purposive sampling was used in the selection of participants for the focus groups in this study. A whole-class pilot phase was held prior to the conduction of the focus groups. The concept of De Bono’s Six Thinking Hats was used to elicit discussion and lateral thinking on participation in the Lego Tasks (Gill-Simmen, 2020; Kivunja, 2015). Pupils who were able to articulate their feelings, opinions and perspectives clearly during the whole class activity were noted by the researcher. Focus group participants were also selected from the first stages of data analysis from the video recordings. Groups in which the researcher had found strong evidence of the use of AEI abilities were chosen, in order to ascertain how the participants felt and thought during these processes. Groups in which some participants struggled with the use of AEI were also selected, in order to determine how students perceived these kinds of less successful situations. This purposive selection allowed for a comprehensive picture of the tasks to emerge through the perceptions of children in the class.

Determining which questions and strategies to use for focus groups with children depends on the research questions and the overall aims of the study. In general, as described by Gibson (2007), the advice is that concrete questions should be framed to avoid confusion and to

ensure that children understand exactly what they are being asked. Participatory techniques are often recommended to elicit discussion and to make children feel comfortable (Morgan et al., 2002). In this study, the use of cued retrospective reporting, the CRR, assisted in encouraging children to reflect on the processes of the Lego tasks. It also assisted in keeping children on task throughout the focus group and to discuss issues which were of relevance to the study. Poysa-Tarhonen et al. (2018) describe CRR as a verbal reporting procedure, in which, based on a cue or cues of their performance, participants are invited to verbalise their thought processes during the task performance retrospectively. CRR has previously been used in problem-solving and CPS studies in which researchers attempted to verbalise the thought procedures behind these concepts. During the focus group interview, the researcher paused the video at several points and asked the children to verbalise how they felt or thought during the process of building or coding the Lego robot. The timing of this technique was important as children can become distracted after short periods of time which can affect the quality of data that is collected, a consideration that was highlighted by Adler et al., (2019). Thus, the researcher had carefully selected key points of the hour long videos in which to pause and discuss. This meant that each focus group lasted approximately forty minutes. At this point, saturation had usually been met, in that the repetition of themes had started to begin and no new real information was being provided by the students (Prior & Van Herwegen, 2016).

The role of the interviewer in focus group interviews with children is a significant one. Ronzoni, O'Reilly & Dorga (2013) argue that as there is typically an asymmetrical dynamic between the researcher and children, children can often be reluctant to speak with unfamiliar adults and can be hesitant about what to share. This was not a central issue in the current study as there was a pre-established relationship between the researcher and the students. They were familiar with the process of answering questions and giving their opinions in class

discussions. Additionally, they were very comfortable with each other and did not tend to refrain from sharing contributions. Despite this familiarity, the researcher was aware that there was a power imbalance between teacher/researcher and student. It was stressed to students that this was not an evaluative exercise, but an opportunity for them to express their views and experiences. If children did not wish to answer or appeared uncomfortable commenting, they were not forced or asked to contribute. The ethical procedures described in Section 3.6.2 were stringently adhered to and all children provided assent before beginning the focus group.

3.9 The Pilot Study

There are two types of pilot studies commonly conceptualised within the research literature. The first, called feasibility studies, are designed to determine if and how the practicalities of a study will work and often includes an appraisal of resources, such as time and costs, before the collection of data in the main study (Gudmundsdottir & Brock-Utne, 2010). The second, typically called pilot studies, are usually used to pre-test a certain research instrument (Malmqvist et al., 2019). One of the main goals when conducting a pilot study is to increase research quality, as it offers the opportunity to modify research instruments in order to gather rich data (Malmqvist et al., 2019). As an exploratory research design, the pilot study was important to determine if this study was feasible and to pre-test if the research instruments were appropriate in the context of the research questions. Chenail (2011) identifies additional significant issues which may arise in the course of piloting qualitative methods by accentuating a number of challenges for researchers related to the management of bias and the role of the researcher within the qualitative research space. It was unknown how the students participating in this study would react to the teacher observing them in a new way.

As a teacher there is often continual engagement with groups during collaborative tasks. Children like to share their observations and feelings as they complete tasks. However, in this case, the researcher was interested in making concrete observations while the tasks were taking place. The pilot helped to discern if this role could work in the study. The main areas that were piloted were the overall feasibility of the study, the Lego tasks, video as a research method, the analysis framework and the role of the researcher within each of these aspects.

3.9.1 Feasibility

It was important to determine if the research design was feasible for the researcher-teacher within the constraints of a busy school day and an overloaded curriculum. The first stage of piloting used a whole-class setting. In this stage, all of the children were divided into groups and were working on Lego Spike tasks simultaneously. A small number of cameras were set up to explore audio and video quality within this context. It became apparent almost immediately that this would not be a feasible way of collecting data. The classroom was too small for all of the children to be able to move around comfortably and build and code the robots. Additionally, the level of background noise on the videos meant that it was impossible to clearly discern what the children were saying in post-task analysis, even with the addition of external microphones. Therefore, this design was quickly abandoned.

In the second piloting stage, one group completed the Lego Spike tasks in a communal learning area next to their classroom. This provided a calmer, quieter and larger space for the children to move around, talk, build and code. The audio and video quality also improved substantially. The researcher was able to move between the Lego task group and the rest of the class with the support of another teacher in the school. This design proved feasible for the study, the school and the children.

3.9.2 Lego Education Spike Prime: Piloting of Tasks

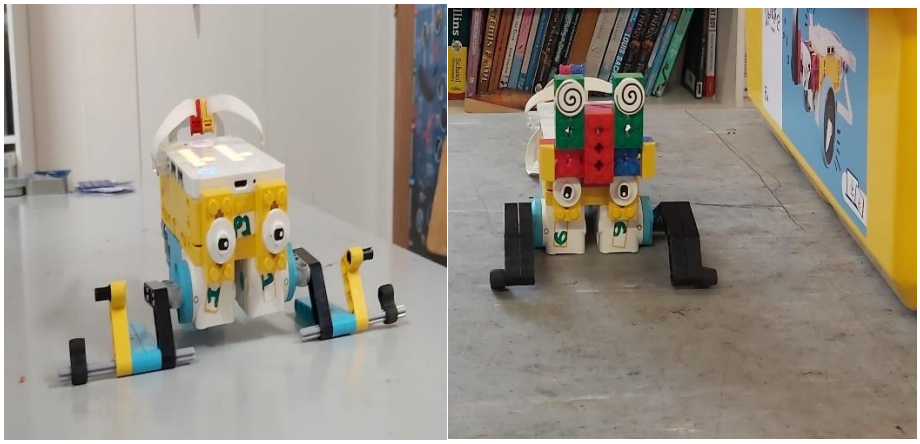
Lego Education's Spike Prime is specifically aimed at children aged 10 and over and supports the development of STEAM skills in a fun and playful manner. The lessons, and the tasks within these lessons are aligned with the common core standard used in the American curriculum. Common Core, is an educational initiative from 2010 that details what K–12 students throughout the United States should know in English language arts and mathematics at the conclusion of each school grade (National Governor's Association, 2010). A thorough theoretical analysis of the Spike Prime tasks had been undertaken by the researcher to ensure that they met the criteria for CPS tasks. On a practical level, the pilot was essential to determine how this group of children would engage with the tasks. Initially, it was difficult to establish if building and coding the robot would challenge students adequately. If the tasks were too easy, children may not require the use of a range of AEI abilities or collaborative skills. If the tasks were too difficult, children may become disheartened and give up (Allal & Ducrey, 2000). In the pilot, children became familiar with the names and the different functions of the parts of the Lego kit in a whole class setting. They also navigated the Lego Spike App on the iPad, and became comfortable finding the lesson plans and the building section of the app.

Following this induction process, two groups of children worked on the 'Hopper Race' task individually and they were recorded. The goal of this lesson was to design a prototype to find the most effective way to move a robot without wheels. Following each group's completion of all of their prototypes a race was held between all of the hoppers. The students had to code their robot to move in a straight and quick manner for 2 metres for the race. This was a complex process of deciphering the correct balance between the speed of the different movement motors were attached to the hopper. Figure 3.5 displays the hopper prototypes that

were built by the two groups in the pilot to participate in the whole class race. This pilot was successful in establishing that these tasks would be adequately difficult and engaging for this group of children.

Figure 3.5

Pilot Prototypes of Robot Hoppers.



3.9.3 The Role of the Researcher

The purpose of the pilot was to establish how the role of the researcher would be conceptualised by the children in the class and to allow issues of reflexivity or bias to be reflected upon. The design of the study included the use of running record observations which would be taken by the researcher during task completion. The researcher would do this subtly by explaining that she was recording how they were solving the task but was not evaluating any pupil. These notes could then be triangulated with the post-task analysis of video recordings. The collection of observations could have been difficult if the students wished to continually engage with the teacher about issues like what do next or to check if they were completing the task correctly. In reality, the students did not frequently engage or talk to the teacher when she was observing them anecdotally. They were engaged with the task and if they came across a challenge, they discussed it amongst themselves instead of asking for help. When they achieved a particular goal, the teacher would praise the children

or use positive language of encouragement. The pilot study therefore enabled the researcher to develop consistent procedures for recording observations and validated the role that she would play in the research process.

3.9.4 Piloting of Video as a Method of Observation for AEI abilities

As mentioned above, the video quality of the recordings gathered from the first stage of piloting was not adequate. Therefore, the second phase of piloting focused on recording an individual group completing the tasks. The impact of the video camera on the two groups of four children who participated in the pilot study was minimal. The non-evaluative aspect of the study was emphasised to students, and they were aware that the videos were only being used for the purposes of this study. At times, in the initial stages, they looked at the camera or discussed it informally with each other. However, as the task progressed, they became more engaged with the process of problem-solving and the video being recording was of little interest to them. Issues like the location and the position of the iPad and tripod were also fine-tuned during this pilot process (Jewitt, 2012). Eventually as the study moved on, the children would set up the camera and the tripod themselves, at an angle that would pick up all of their discussions and interactions. In this way, the tasks and the video recordings became a part of everyday classroom practice. Having established the technical procedures that were more suitable, the next factor to consider was if the data produced could be analysed successfully to answer the research questions.

3.9.5 Piloting the Analysis AEI Framework

As discussed in Section 3.6, an initial analysis framework of AEI abilities was developed for the study. The first stage of piloting allowed the analysis framework to be tested. Initially, a number of adaptations were made to it before commencing the second phase of piloting. The second phase of piloting allowed the final framework to be adapted and put in place for the remainder of the research. Figure 3.6 provides an example of one of the initial analyses completed by the researcher during the second stage of piloting. As the figure demonstrates, the language indicators that the child used throughout the task were also recorded. The running-record observations taken by the researcher during group completion were also noted on the framework during post-task analysis.

Figure 3.6

Analysis Framework for Student from Phase 2 of Pilot Study

Branch of AEI Model (Mayer et al., 2016)	Emotional Abilities arranged from the simplest to the most complex (Mayer et al., 2016)	Corresponding Behavioural Indicators Relevant to Successful Problem-Solving in Lego STEAM Tasks		Student I.D. Code: CO2 Frequency	Intensity	Duration
Understanding Emotions (in oneself and others)	i. Label emotions and recognize relations among them	**Makes reference to their own and other's emotions throughout the task**	**Phrases used to indicate positive emotional state** This is actually fun. **Phrases use to indicate negative emotional state** • This is so hard/annoying • This isn't working. Why isn't it working?	✓ ✓ ✓	▪▪ ▪▪ ▪▪	
	ii. Determine the antecedents, meanings, and consequences of emotions	• **Listens to others opinions, asks questions and talks through the process of problem-solving.**		✓ ✓✓✓✓ ✓✓✓	▪▪▪ (x 8)	
		• **Displays empathy verbally or with body language** **Body Language Indicators used** • Smiles • Laughing with the person when they make mistakes • Fist pumps, high fives/hugs/arm around the person	**Common phrases to display empathy** • No that was good. • Keep going. • Well it was really hard, don't worry about it • Sorry I didn't know what you meant	✓ ✓	▪▪ ▪▪	

		• Sympathetic facial expression				
		• **Discusses potential emotions that may occur in the next components of the task with group members** **Phrases that indicate what emotional state may occur later** • This looks really hard	• We might not be able to do this • The next bit will be fun for us			
	iii. Appraise the situations that are likely to elicit emotions	• **Maintains group cohesiveness by offering assistance to other group members encountering difficulty** • **Manages conflict**		✓ ✓ ✓ ✓	▪▪ ▪▪ ▪▪▪ ▪▪▪	
Managing Emotions (MG) **(in oneself and others)**	iv. Effectively manage one's own emotions to achieve a desired outcome (self-regulation of	• **Accepts making mistakes/handles being corrected by others**		✓✓✓ ✓	▪▪ (x 4)	
		• **Consistently focused on task (not distracted by off-task behaviour like chatting/other groups working**		✓ ✓✓	▪▪▪ (x 3)	
		• **Persists even when encountering challenges and tries new methods to solve problem**		✓✓✓✓	▪▪▪ (x4)	

	emotion)	• **Uses self-regulation abilities to manage conflict/negative emotions/disagrees without having an argument (reaches compromises/is patient with others**	✓✓ ✓ ✓ ✓	*** (x5)	
	v. Effectively manage other's emotions to achieve a desired outcome	• **Uses positive language and encouragement to ensure others remain focused and motivated to complete task**	✓ (keeps situation calm) ✓ ✓	*** ** (x 2)	
		• **Divides workload and negotiates roles (prevents conflict and frustration in others)**	✓ (tries to divide workload even when other child is resisting) ✓ (you guys can do this bit)	** **	

Frequency:	Duration:	Intensity
✓ every time behaviour is displayed	< 30 seconds = * 30 seconds - 1 minute = ** >1 minutes ***	Not engaged with this ability Somewhat engaged in ability e.g. listens but can get distracted Fully engaged in use of ability

Key

3.10 Data Collection and Data Sources

Data collection took place over a period of six months from January 2022 to June 2022. Table 3.3 outlines the qualitative and quantitative data sources that were used in this research. The left column outlines the data source, while the right column outlines the quantity.

Table 3.3

Sources of Data collected from January 2022- June 2022

Qualitative Data Source	**Quantity**
1. Video Recording of group working on Lego Spike Prime Task	16
2. Running Record Observation of group working on task	16
3. Child Classroom Reflections on each Lego Spike Prime task	4
4. Focus Group Interviews with Children	3
5. Critical Friend Interview on Observation Framework	1
Quantitative Data Source	**Quantity**
1. Likert Scale Agreement between group members	16
1. Observation Schedule for Presence of off-task behaviour in group	16
2. Record of task duration	16
3. Norm-referenced standardised Test Results	26

As highlighted in Table 3.3, the first two qualitative data sources were linked. Over the course of five months (Jan 2022 - June 2022) groups of three/four children collaborated on four different CPS tasks from the Lego Spike Prime Education Kit, which resulted in 16 video recordings. Concurrently, the researcher completed running record observations of each group while they were working on each task, which allowed for direct observation of behaviours in real time (see Appendix I for template). Child classroom reflections were held after each of the four Lego Spike Prime tasks had been completed by the participating groups. In a whole class setting, children discussed their participation in the task and the researcher recorded her observations on their discussions (see Appendix J for template). Having piloted the format of a focus group interview in a whole class setting in late May, three focus groups, were carried out in June in a shared collaborative area between two classrooms. Group composition for the focus groups was the same as used for the tasks and the focus groups were held during the school day. During the focus group, participants were shown portions of their last video recording and asked to reflect on their participation and interactions. The final qualitative data source was an interview with the critical friend where she reflected on the usability of the AEI observation framework as a potential observation and assessment tool.

Although this study was, in its essence, a qualitative case study, several quantitative data sources were used. As Table 3.3 details, there were four sources of quantitative data. Three of these data sources were drawn from the video recordings discussed above. A Likert observation scale was used to identify the level of agreement between group members during the task (see Appendix G). An observation schedule was used to record the presence of off-task behaviour in the video recording (see Appendix G) while time spent on the task (task duration) was also documented. The group member's most recent norm-referenced

standardised tests results for Maths and English (from June 2021) provided an additional lens on the types of group dynamics which emerged.

3.11 Data Analysis

This section outlines the data analysis procedures that were used to allow the researcher to address each of the three research questions:

> RQ1: To what degree can Emotional Intelligence Abilities be observed and assessed within Collaborative Problem-Solving Contexts?
>
> RQ2: What elements of CPS tasks elicit the use of AEI abilities in children working on Lego Spike Prime Tasks?

These two questions were addressed using qualitative data from six video recordings, analysed using thematic analysis. The analyses procedures are outlined in Sections 3.11.1 and 3.11.2.

> RQ3: How beneficial is an AEI framework in supporting the observation and assessment of AEI abilities in CPS tasks?

Qualitative analysis of the researcher and critical friend's reflections and quantitative analysis of the inter-rater reliability of the observations were used to address RQ3. The analyses procedures are outlined in Section 3.11.3.

3.11.1 RQ1 and RQ2: Selection of Video Recordings for Thematic Analysis

It was not feasible to engage in thematic analysis of all 16 video recordings that were collected in this research. For this reason, a selection process was employed to justify the use of specific data sets for more in-depth thematic analysis. On completion of data collection, a review of the video recordings was carried out by the researcher. Quantitative analysis

indicated that there was a disparity in relation to the levels of agreement and engagement between the groups. Groups varied on the time taken to complete the task, the rating of agreement between group members (see Appendix F for Likert Scale measure), the presence of minor/significant off-task behaviour (see Appendix F for observation schedule) and on their classification as a highly successful or moderately successful group (see Appendix F for classification criteria). Of the 16 videos, seven groups were classified as highly successful groups while 10 were classified as moderately successful. Appendix G provides a detailed description of the group profiling stage completed by the researcher, as well as two tables which document the recorded quantitative descriptors (including standardised test results) of each group.

In tandem, the researcher engaged in the 'familiarisation' stage of data analysis for the running record observations, the focus group interviews and the child classroom reflections on the task (Braun & Clarke, 2006). The purpose of this observational data was to triangulate the quantitative data in order to inform the selection and refinement process. Some initial deductive codes which were informed by literature in the area of AEI, were also identified by the researcher at this stage. Table 3.3 provides an example of the initial hand-coding that was completed for a running record observation of Group 8 (Task 3) and for the child classroom reflections recorded by the researcher for Group Eight in this initial stage of data collection (see Appendices H and I for the original templates used by the researcher during data collection).

Table 3.4

Sample of Coding from Running Record and Child Classroom Reflections

Data Source	Written reflection by researcher	Initial codes applied
Sample of Running Record for Group Eight on Breakdancer challenge (Task 3)	The group are taking a long time to progress through the initial stages of problem-solving. Jane is leading the group's progress for the most part. Trying to motivate others, keep the group on task. Using strong tone of voice to give instructions but positive in encouragement. Aoife is supporting her and trying to remain focused. Coming up with ideas, reaffirming what she says to the group. Speaks about her own lack of experience using Lego, not confident in her coding abilities. Emma is very distracted at this stage. Speaking about off-task topics that are of interest to her…Lily is frequently speaking back to her but also making some effort to complete elements of the task. Most distracted group member I have seen so far. Seems disinterested- having a strong impact on the group's success and dynamics.	Issues early in task Leadership Role Behaviours linked to AEI? Supportive Role Distracted group member New group dynamic
Child Class Reflection on Task 3- Breakdancer Challenge Portion of reflection recorded for Group 8	Whole class spoke about how much they liked this task. Really motivated, liked the music element. Group Eight: Jane joked that it was very hard for them to get task complete. Coding was difficult, distracting conversations going on about Harry Potter etc. Didn't reference any one group member. Aoife said that they "weren't very good at it. We were probably the worst group". Asked why, said we found it hard and we talked a lot. Emma did not comment on her behaviour during task but said she enjoyed it. Lily: Commented on time pressure, could be have more of a team, talked a lot, Jane really wanted to get it done and the rest of us were not like her.	Challenge of Task completion due to issues in group Difficulty of Task Significant disparity between group member

This qualitative analysis complimented the disparities which were found in the quantitative analysis, whereby children and the researcher reported significant contrasts in the ways that

the groups interacted with one another. For example, the above Group Eight were highlighted as a group of interest in both the quantitative and qualitative analysis. This was due to the high level of off-task discussion displayed by some group members. They were also one of the only groups to report significant difficultly with a task. As a group with unique dynamics, they were selected for further review. On the basis of this review, six video recordings were selected for further thematic analysis: three highly successful groups and three moderately successful groups. It was judged more valuable to compare highly successful and moderately successful groups as the optimal way of analysing and describing the data in relation RQ1 and RQ2.

A cross-group comparative analysis was also included whereby one group member's behaviours across a number of group contexts was analysed using thematic analysis. This addressed the issue of whether children's behaviours varied according to the group context or task. One child was selected because they were a group member in two or more of the six selected video recordings for thematic analysis. Secondly, their behaviours were highlighted in the running record observations and child classroom reflections.

The triangulation of data sources in the selection of groups and subsequently individuals for comparative analysis enhanced the validity or 'trustworthiness' of this process as the selection was not based on the researcher's interpretations of the video recordings alone (Elo et al., 2014).

3.11.2 RQ1 and RQ2: Thematic Analysis of Video Recordings and Focus Group Interviews

Following the selection process, the six video recordings were transcribed and analysed using the principals of thematic analysis (TA). TA is a "method for identifying, analysing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p.79). TA allows the researcher to "search across a data set… to find repeated patterns of meaning" (p.86), rather than trying to understand the meaning of one piece of data (such as a single video recording). There are many different ways in which thematic analysis can be approached (e.g. Alhojailan, 2012; Boyatzis,1998; Javadi & Zarea, 2016). In this research, Braun and Clarke's (2006) six-step model guided the data analysis process, each of which are described in detail. Analysis was not conducted in a sequential manner as the researcher moved back and forth through the various steps, a process which is often essential in qualitative analysis (Braun & Clarke, 2006).

1. *Familiarisation:* As mentioned in Section 3.11.1, this process began in the initial review of both qualitative and quantitative data. When the six video recordings had been selected, the researcher then transcribed them directly into NVivo (207 minutes of video). Appendix I provides a detailed overview of the transcription procedures which were employed for video data in this research.

2. *Coding:* The data were then read methodically on a line-by-line basis, with each relevant 'chunk' of data assigned a particular code. Using NVivo software, the researcher was watch the video and read the transcript simultaneously. This allowed for a more authentic representation of the context to be observed and coded. Both deductive and inductive approaches were used in the coding of data (Braun & Clarke, 2006). In the first round of coding, the strategy was deductive because it was

informed by the literature in the area of AEI and how these abilities may be observed in an individual. At this initial stage of data analysis, many of the codes identified were latent, in that they were largely related to the "explicit meaning" of the data. However, as the researcher revisited the data in the second and third round of coding, she identified new codes that would not have been anticipated, therefore, using an inductive approach. The following is an example of a coded transcript (Video Recording 6 Group 2 00.00-00.54) in the second round of coding

Table 3.5

Sample of Coding from Video Recording

Transcript	**Initial codes**
H: Ok C is this one…D is this one	Talks through process of problem solving
R: Guys if we move the box it will be much easier.	Gives opinion
H: Let's see if this one…(turns on robot). It has to be on this one.	Talks through process of problem solving
J: It's going. It's going. No! that's gone off the table we'll stop it.	Expresses emotion – annoyance
(Harry starts the robot again)	
J: Oh shoot why is it going?	Expresses emotion – annoyance
K: It doesn't matter.	Gives opinion
J: Just put it down. We're trying to figure out…	Gives instructions
K: It's on the wrong way.	Gives opinion
J: You know what we need to do...get the tape and put it in between..	Discussion about next step of process
H: In between what?	
J to R: Wait can I have that? (asks for masking tape)	
R: My mask is the coolest here. It's got blue tack on it.	Off-task behaviour
H: Guys come on we've only got ten minutes we need to get it done.	

3. *Theme Search:* In the six video recordings, 55 codes were identified in the coding stage. Using an iterative process, the codes were then organised into broader themes. As Braun & Clarke (2006) explain, there are no hard and fast rules about what makes a theme. A theme is characterised by its significance in the research. In this case, many of the codes related to a similar broader theme (relevant to addressing RQ1 & 2) that was identified by the researcher and they were grouped together to form a theme. An example of theme development for Group Two, Task 2, is described below.

Theme Label: Effective Communication

Example codes:

Encourages others: "*Well we're going to win this one! Well we're going to be the fastest at that!" (GR2K* V8 Pg4 L18-19)

Positive Language: "*Don't worry. We've got this!*" (**GR2J** V8 Pg4 L101-102). *"This is actually working! We're doing it quite fast!"* (**GR2H** V8 Pg6 L145-146)

Happiness/Satisfaction: *"Yes, that's brilliant!"* **(GR2J** V8 Pg11 L360), *"Yes let's go wahoo"* (**GR2H** V8 Pg11, L361

Worry/Anxiety: "*Are you sure we shouldn't put it at 60 instead? I think it mightn't be fast enough*" (*GR2K* V8 Pg.13, L436). "*Oh no I'm worried it's not going to work"*, (**GR2J** V8 Pg12 L417)

Frustration: "*He's not turning enough that's why he's not going around the boxes"* (**GR2J** V8 Pg6 L182)

Theme description: This theme described how the group members effectively communicated with each other to solve the problem. They expressed emotion clearly to one another as documented by the above codes. They also used praise and encouragement to support their peers in persevering with the task.

The same process of theme development was used for the individual comparative analyses. The researcher analysed the codes for each individual child and then identified a relevant theme.

4. *Theme Review:* During this phase, initial themes are reviewed, modified and developed to assess how well they reflected the complexity of the data. After this review, the researcher chose to identify sub-themes within the larger themes. The larger themes were relatively broad and there was enough data to support the presentation of sub-themes in the findings section. For example, the above sub-theme "Effective Communication" was divided into two smaller sub-themes of "Encouragement and Motivational Statements" and "Reference to Emotional State".

5. *Theme Definition:* The themes were defined by referencing the relevant literature and based on the codes which supported the themes. A detailed description of the themes and sub-themes can be found in Chapter Four.

6. *Write-Up:* The findings of this analysis are presented in Chapter 4.

3.11.3 RQ3: Data Analysis Procedures

The aim of the third research question was to determine how beneficial the use of an AEI observation framework was in supporting the observation and assessment of AEI abilities in CPS tasks. The usability of the framework was first considered. As described in Section 3.11.1, six groups were selected for in-depth thematic analysis following an initial review of data. Initially, the researcher had aimed to complete observation frameworks for the 24

children in these six groups. However, data saturation was felt to be reached after the third group, whereby the research question above could be addressed with the frameworks that had been completed (Braun & Clarke, 2021). Therefore, an AEI observation framework was completed for the 12 children in Groups Two, Six and Eight by the primary researcher. In order to reduce potential bias in the interpretation of behaviours, the critical friend also participated in this stage of data analysis. The critical friend was a teacher who also had an undergraduate degree in Psychology. She read three key pieces of literature from AEI theorists Mayer, Salovey and Caruso (2002; 2003; 2016) before completion of the frameworks. She selected three names randomly from a list of pseudonyms, watched each video recording once and completed a framework for each child. An interview was held where she discussed her ability to understand terms, use and score all of the dimensions to reach consensus, and whether the framework adequately represented her understanding of AEI abilities.

The second component of data analysis focused on the validity and reliability of the framework. In order to address the level of inter-rater reliability (IRR), the percent agreement statistic was used. This simple calculation allowed for an identification of the level of consensus between the researchers on the types of behaviours that they observed and recorded in the framework. The level of per cent agreement was calculated by totalling the number of agreements and dividing it by the total number of possible agreements. As noted by Gwet (2014), a figure of less than 0.75 is deemed unacceptable. Results of this phase of analysis can be found in Section 4.8 of the following chapter.

3.12 Validity, Reliability and Generalisability

Evaluating the quality of research is an essential part of the research process. Presenting evidence pertaining to the concepts of validity, reliability and generalisability is key to

ensuring that all research, including qualitative research, is high quality. Validity refers to the extent to which good decisions can be made on the basis of data collected in a study. Validity is concerned with ensuring that the inferences made on the basis of measurement instruments are accurate and trustworthy. Reliability and generalisability, respectively, are defined as the extent to which results are consistent over time and are an accurate representation of the population being studied (Golafshani, 2003; Morse, 2015; 2018). Replication is a key component of reliability. If the study is replicated in the same manner, and the results can be reproduced using a similar methodology, then the research instrument is generally deemed to be reliable. In the positivist tradition, reliability involves accounting for personal biases that may have influenced the findings.

Scholars generally agree that traditional definitions of validity, reliability and generalisability used in the quantitative paradigm are not well suited to qualitative research (Golafshani, 2003; Morse, 2015; 2018). In the 1980's, Guba and Lincoln (1985; 1989) transformed the area of qualitative research by developing criteria to verify rigor, which they termed trustworthiness. These criteria were credibility, transferability, dependability, confirmability and the reflexivity of the final research. Within these criteria are particular strategies that have been used widely for ensuring rigor. While these criteria have remained the same over time, the strategies for attaining each have been adapted by researchers throughout the years (Creswell, 2012). As highlighted by Morse (2015), it is not clear whether Guba and Lincoln expected all strategies to be operationalised within a study. Creswell (2012) recommends that researchers should apply at least two and that the strategy choice should reflect the research paradigm and design. As argued below, during this study, every effort was made to ensure these criteria were applied in a way that ensured high quality outcomes for the research.

3.12.1 Methodological Rigour in the Present Study

The first criteria, credibility, addresses the "fit" between the experiences of the participants and the researcher's presentations of them. It is linked to the truth worthiness of the study, in that there should be alignment between the theory, research question, data collection, analysis and results (Guba & Lincoln, 1989). The sampling approach, the breadth and quantity of the data and the analytical approach used appropriately align with the planned research design and paradigm (Morse, 2015). To ensure research credibility, Guba and Lincoln (1985) suggest a range of techniques, such as prolonged engagement, persistent observation, triangulation, peer debriefing and member checking. In this study, there was prolonged and persistent observation of the participants. Before beginning the study, the researcher had spent four months as the children's' classroom teacher. She was aware of their cognitive and social skills, their friendship groups and their backgrounds. Becoming a teacher-researcher added an additional element to the relationship. Even when the students were not explicitly participating in the study, the researcher was in the fortunate position to observe their everyday interactions. With increased trust and intimacy comes better, richer data (Morse, 2015). She did not have to work to "get in" to the fieldwork setting and establish trust. There was ample time and ease from which a relationship between the students and the researcher could be established.

Triangulation plays a significant role in ensuring the credibility of qualitative research. As highlighted by Patton (2015, p.674), "triangulation in whatever form increases credibility and quality by counteracting the concern that a study's findings are simply an artifact of a single method, a single source or a single investigator's blinders" In this study, the primary method of data collection was video-based observation. However, this research method was complemented by running record observations and chid class reflections recorded by the

researcher as well as focus group interviews with the children. Investigator triangulation was used in that another researcher was involved in using the observation framework. This allowed for the evidence to be cross-checked and reduced the risk of researcher bias in data analysis. Data triangulation was implemented through the collection of data over an extensive period of time using a wide variety of group compositions from the class of 5th class students. This process of triangulation helped to ensure that the data was both dependable and trustworthy (Guba & Lincoln, 1989).

The dependability and confirmability of research in this study was also aided by a strong audit trail of data collection. An audit trail provides a transparent description and account of the research direction that has been taken, as well as a clear rationale for the decisions that have been made in an investigation (Guba & Lincoln, 1989). The steps taken when considering key elements such as research design, sampling, research methods and transcription have all been outlined in detail in the above sections. The procedures used to design and adapt the research instruments have been illustrated comprehensively. Access to the raw data in the form of video recordings and anecdotal notes will be included with the final thesis. The process of data reduction (transcription) has been clearly described and samples are available. Similarly, the process of data analysis will be thorough and clearly laid out. Rich and thick descriptions of the findings will be incorporated into the final work. This audit trail will ensure that the study could be replicated within another similar setting, that the findings are trustworthy and can be interpreted as genuine.

An additional criteria for trustworthiness put forward by Guba and Lincoln (1989) is transferability. As reviewed by Shenton (2004) transferability refers to the generalisability of inquiry. From a positivist perspective, the goal of empirical research is to present the results

of a study as applicable to the wider population. However, as the results of qualitative research are often specific to a small number of participants or a particular setting, it is difficult to demonstrate that these findings and conclusions are directly applicable to other contexts or representative of other populations (Shenton, 2004). Polit and Beck (2010) highlight that there are differing views amongst academic researchers about the degree to which the findings of qualitative research can be transferred. Bassey (1981) and Stake (1995) argue that although each qualitative context is unique, it is an example within a broader group, and as a consequence, findings may be applicable to other contexts. In line with this thinking, Guba and Lincoln (1989) argued that it is the responsibility of the researcher to provide sufficient background and contextual information about the study in order to ensure that the reader to draw conclusions about the possibility of transfer. They recommended that the researcher outline a thick description of the phenomenon under investigation, as well as sufficient detail around the contextual factors of the study. Hence, a detailed and descriptive audit trail has been provided in this work. Considerable care has been taken to ensure that information include about the participants, research methods and timeframes is adequately "thick" to provide the reader with a comprehensive understanding of the study. Rich and descriptions of the data analysis process, and the findings and conclusions generated from this process is presented in Chapter Four. Consequently, it is possible for the reader to reflect on the data and determine the transferability of the findings to other research contexts.

One of the key indicators of methodological rigour used by Guba and Lincoln (1989) was reflexivity. Reflexivity encourages the researcher to be aware of their biases and to clarify any potential consequences that these biases may have on the credibility of the study (Orange, 2016). Reflexive journals provide a way for researchers to document the methodological decisions that they make throughout the study and serve as the beginning of

data interpretation (Guba and Lincoln, 2015). Although reflexive journals are recommended throughout qualitative literature, there is very little explicit guidance on how they should be structured or formatted (Ortlipp, 2008). From the beginning of the present study, reflexivity was considered in the context of the researcher's role as an insider-researcher within the case study setting. Earlier in Chapter Three, the positive aspects of insider-researcher were described, including easier access and greater rapport with the participants (Mercer, 2007). However, it was also accepted that this role is a like wielding a double-edged sword (Mercer, 2007). As described by Hawkins (1990, p.417), the " extensive and intimate knowledge of the culture and taken-for-granted understandings of the actors" may be lost in terms of their myopia and their inability to make the familiar strange".

The reflexive notes in this study were a combination of a number of different reflection types. Firstly, the observational notes taken from the Lego tasks included a reflexive reflection on the impact of the researcher on the task and how her role as a teacher was affecting the children's behaviours and place within a group setting. Reflexivity played an important role in data analysis given the subjective nature of the data. Throughout data analysis, researcher was aware of potential preconceptions that were influencing the emergence of themes and to try to look at the data from a number of different angles.

3.13 Chapter Summary

This chapter provided an overview of the methodological approach used in this study. The philosophical underpinnings of interpretivism guided the exploratory case-study design which was governed by the research questions. In-depth descriptions of the research methods were provided, as well as the stages of piloting and data collection. Considerations relating to

ethics, validity and reliability were also included. Outcomes from the empirical study are presented in the chapter to follow.

Chapter Four: Findings

4.1. Introduction

At the heart of this thesis lies a classroom-based empirical study which focused on the observation and assessment of Ability Emotional Intelligence (AEI) through Collaborative Problem-Solving (CPS). Although of interest to the researcher, CPS contexts were not the primary focus of the research, and were used as a vehicle to explore the extent to which AEI can be assessed. In the context of the case study employed, three research questions were outlined as follows:

> RQ1: To what degree can Emotional Intelligence Abilities be observed and assessed within Collaborative Problem-Solving Contexts?
>
> RQ2: What elements of CPS tasks elicit the use of AEI abilities in children working on Lego Spike Prime Tasks?
>
> RQ3: How beneficial is an AEI framework in supporting the observation and assessment of AEI abilities in CPS tasks?

This chapter presents an analysis of findings in relation to the research questions and relevant literature.

4.2 Organisation of the Chapter

Mining of the voluminous data collected was not a straightforward process and required repeated attempts to ensure that the data were used as efficiently and effectively as possible. The current structure represents the optimal way of presenting the data in order to address the research questions in an engaging and coherent manner.

- Section 4.3 reminds the reader of the main data sources used in this research.

- Section 4.4 provides an overview of the data analysis procedures that were used and the themes and sub-themes that were identified in each comparative analysis.
- RQ1 and RQ2 are addressed together in Sections 4.5, 4.6 and 4.7. Section 4.5 details a thematic analysis of Group Two, a highly successful group and Group Five, a moderately successful group. Following a pen picture description of the group, the themes and sub-themes for each group are then discussed with interpretation and contextualisation of the data by the researcher. Finally, a comparative analysis highlights how AEI behaviours were observed differently in both groups and the implications of this for RQ1 and RQ2.
- Following the same structure, Section 4.6 outlines a comparative analysis for Group Eight and Group Four.
- Section 4.7 details a thematic analysis of one child's behaviours over three different group contexts. It begins with a pen picture description of pupil Rose, followed by a presentation of the theme and sub-themes which were identified in the data. Section 4.7 ends with a conclusion of how these findings relate to RQ1 and RQ2.
- The third research question is addressed in Section 4.8. Two sub-sections are included which address firstly, the usability of the framework as an observation tool when assessing AEI abilities during CPS tasks, and secondly, the suitability of the framework as an assessment tool in the future.

4.3. Data Sources in this Research

In Chapter Three, the process of data collection was described. The primary method of data collection was video-based observations, where groups of children working collaboratively on Lego tasks were recorded. In tandem, the researcher maintained running record

observations for each group while completing the task (see Appendix I). Additionally, the researcher recorded her observations on whole class reflections, during which children discussed their engagement with the collaborative process (see Appendix J for template). Three CPS groups also participated in focus group interviews where they discussed their participation in a specific Lego task. Finally, an unstructured interview was held with the critical friend in order to gather her perspective on the usability of the AEI observation framework.

There were four sources of quantitative data. A Likert observation scale assisted in proving a numerical indicator of the level of agreement between group members during the task (see Appendix G), while an observation schedule recorded the presence of off-task behaviour (see Appendix G). Other quantitative descriptors used to describe the groups were the time spent on the task (task duration) and the group member's norm-referenced standardised tests results for Maths and English. As discussed in Chapter Three, the use of multiple data approaches provided opportunities for triangulation in this research. This was beneficial in providing confirmation of findings, more comprehensive data, and understanding of the studied phenomenon (Flick, 2006). As there are multiple qualitative data sources referred to in these findings, Table 4.1 provides an overview of how each data source is referenced and abbreviated.

Table 4.1

Abbreviations of data sources used in this chapter

Data Source	Referenced in Chapter	Abbreviated Form
Quote from Video Recording	Video Recording 8, Pg.7, Lines 20-25	VR8 Pg7 L20-25
Running Record Observation	Running Record, Group 2, Task 2, Pg.4, Lines 12-13	RR Gr2 T2, Pg4 L12-13
Child Classroom Reflection	Child Classroom Reflection, Task 2, Pg.1, L12-13	CCR T2, Pg1 L12-13
Focus Group Interview	Focus Group 1, Pg.2, L10-14	FG1, Pg2, L10-14

The pseudonym and Group ID are referenced for each child at the beginning of each sub-section. Following this initial reference, the Group ID is used to identify the child when using quotations from the transcript. The pseudonym is used to identify the child when the researcher is describing their behaviours throughout the text.

4.4 RQ1 and RQ2: Data Analysis

As outlined by Braun & Clarke (2013), there are many forms of data analysis available in qualitative research and there are multiple ways in which data can be presented. In Chapter Three, the data analysis procedures that allowed the researcher to address each of the three research questions were described. As Table 4.2 details, quantitative analysis of the video recordings indicated that there were substantial contrasts in relation to the levels of agreement, the presence of off-task behaviour and task completion (see Appendix G). Using these criteria, nine groups were classified as moderately successful while seven were categorised as highly successful (see Appendix G for classification criteria).

Table 4.2

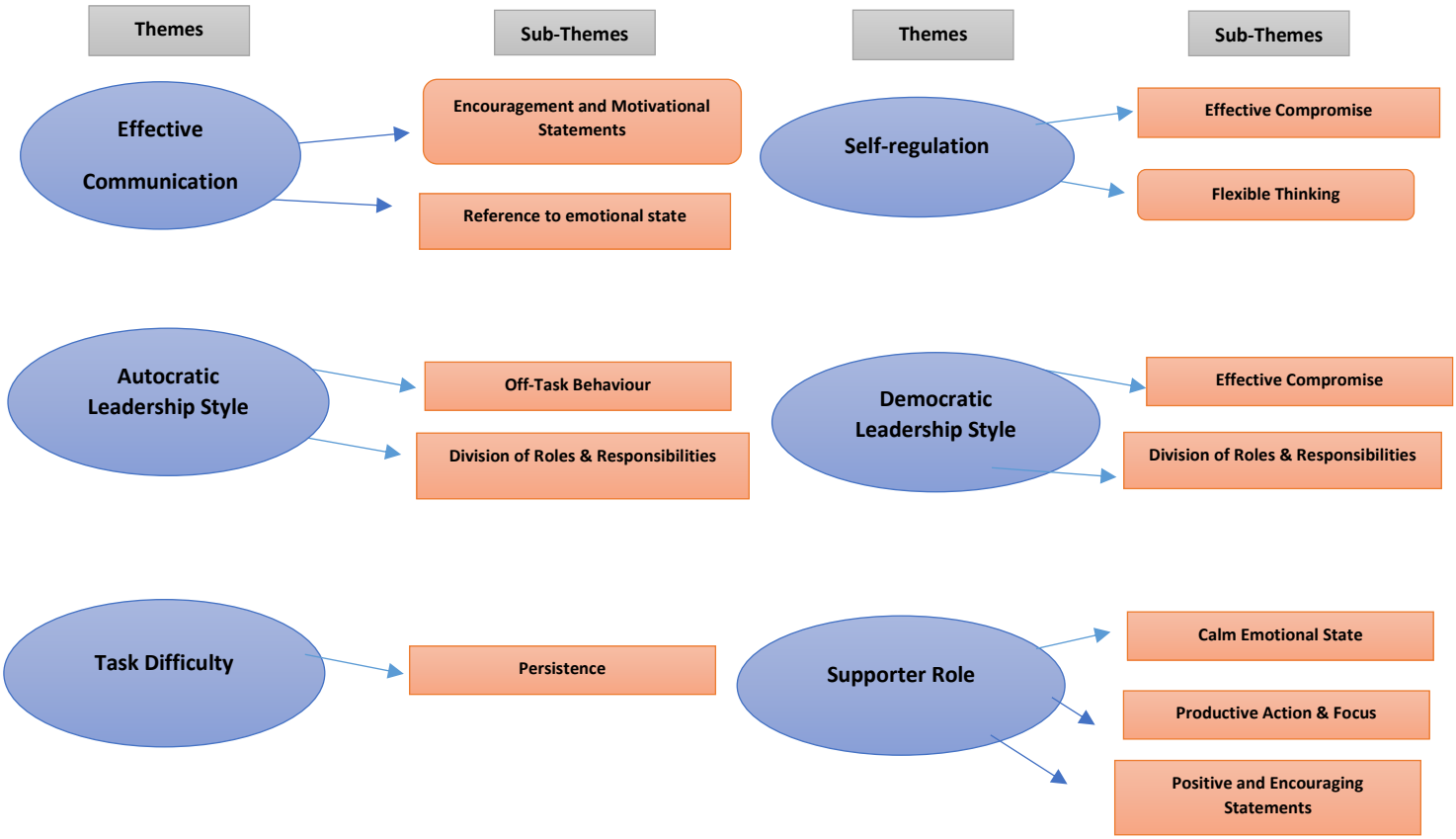
Task and Group Profiles

Task	Group ID	Task completed in time allocated	Duration of task	Rating of agreement between group members (5- high agreement, 1- low agreement)	Off task behaviour present during task		Group classification for working collaboratively on problem-solving task:	
					Minor	Significant	Highly successful	Moderately successful
Hopper Challenge	1	Y	30.39	3	✓			✓
Time Allocated: 40 minutes	2	Y	35.00	4	✓		✓	
	3	Y	20.54	3	✓			✓
	4	Y	25.28	4	✓		✓	
Driver Challenge	1	Y	26.33	3	✓			✓
Time allocated: 40 minutes	2	Y	25.77	4	✓		✓	
	3	Y	26.35	3	✓			✓
	4	Y	31.53	4	✓		✓	
	5	N	35.00	2		✓		✓
Break-dancer Challenge	6	Y	34.41	3	✓			✓
Time allocated: 35 minutes	7	Y	26.12	4	✓		✓	
	8	Y	34.08	3	✓			✓
Super clean- up Challenge	9	N	45.09	4	✓		✓	
Time allocated: 45 minutes	10	Y	23.59	4		✓		✓
	11	Y	33.15	4	✓		✓	
	12	N	42.32	3	✓			✓

These quantitative findings were triangulated with qualitative analysis of the running record observations, focus group interviews and the classroom child reflections on the tasks. These findings complimented the contrasts between the groups which were found in the quantitative analysis. As a result of this process, six video recordings were chosen for further thematic analysis: three highly successful groups and three moderately successful groups. As outlined in Chapter Three, the qualitative analysis of the six video recordings followed Braun and Clarke's (2006) six step model of thematic analysis. Having transcribed the recordings directly into NVivo, the data was read systematically on a line by line basis with each relevant 'chunk' of data assigned a particular code. There were both semantic and latent codes identified in the data because at times a child's behaviour or language was observed as indicative of the potential use of AEI, rather than being concerned with the "explicit meaning" of their interactions (Terry et al., 2017, p.11). 55 codes were organised into several themes and sub-themes. An overview of these themes can be found in Figure 4.1 below and all are described in detail in Sections 4.5, 4.6 and 4.7. Each theme is colour coded in blue, while orange is used to signify a sub-theme.

Figure 4.1

Themes and Sub-Themes



The content of these themes address RQ1 and RQ2 by addressing which types of AEI behaviours can be observed and assessed in CPS contexts.

4.5 Comparative Analysis 1: Group Two and Group Five

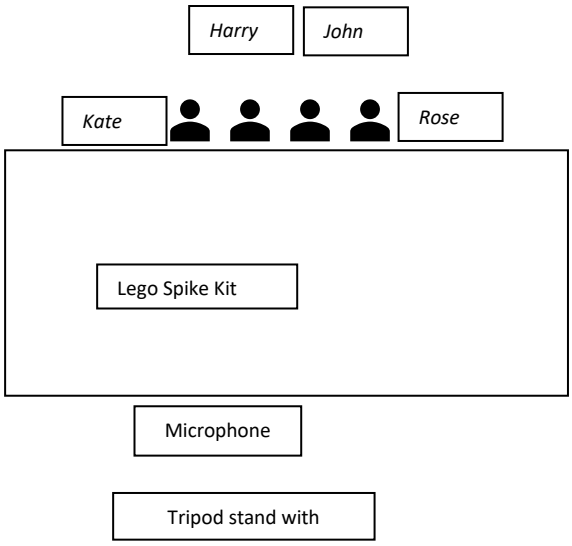
4.5.1. Pen Picture of Group Two (Driver Challenge)

The goal of the Driver Challenge was to code a Lego robot to move successfully around a table, taking into account obstacles that were laid out (boxes that the robot had to move around). As Figure 4.2 details, Group Two was composed of four individuals: Harry

(**GR2H**), John (**GR2J)**, Kate (*GR2K)* and Rose (*GR2R)* who were working on a large table with the Lego Spike Kit, a microphone and an iPad. The group's standardised test results varied from low to well above average (see Appendix G for overview of group profiles). Group members Kate, a high performing student (as characterised by most recent standardised test results) and Rose, a lower performing student, offered ideas, opinions and assistance during the task. However, the key decisions were made by two group members, Harry and John, both high performing students. These two group members generated the highest number of ideas and potential solutions to solve the problem that the group faced.

Figure 4.2

Pen Picture of Group Two



4.5.2 Thematic Analysis of Group Two

In the initial quantitative analysis, Group Two emerged as a highly successful group because of high levels of agreement between group members, a low frequency of off-task behaviour and their completion of the task within the allocated time (see Table 4.2). During the initial manual coding of the running record observations, behaviours which could be related to the

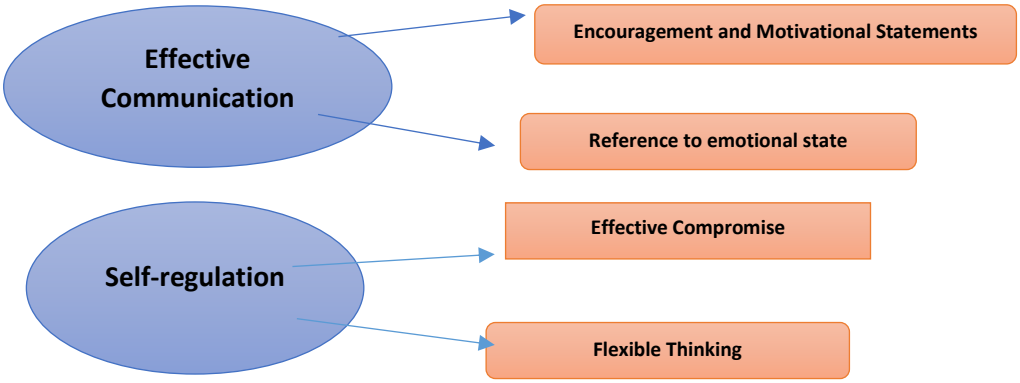
use of AEI abilities were identified. They were also noted as one of the most motivated and enthusiastic groups who participated in the study. In the child classroom reflections, the group attributed their success to good teamwork, persistence and communication. The strong indication that the group used behaviours related to AEI meant that they were chosen for further thematic analysis of the video recording.

Following the process of thematic analysis previously described in Section 3.8.1 and 3.8.2, two main themes were identified. The first theme *Effective Communication* referred to the ways in which the group members effectively communicated to collaborate and problem-solve simultaneously. As Figure 4.3 details, there were two sub-themes related to the larger theme of *Effective Communication*: *Encouragement and Motivational Statement*s and *Explicit Reference to Emotional State*. Both sub-themes were equally significant in the data.

The second theme *Self-Regulation* referred to how group members managed their behaviours, emotions and interactions when working on the task. Two sub-themes were identified for this theme: *Effective Compromise* and *Flexible Thinking*. Both of these sub-themes were equally dominant. These two central themes are discussed in detail below.

Figure 4.3

Thematic Analysis of Group Two

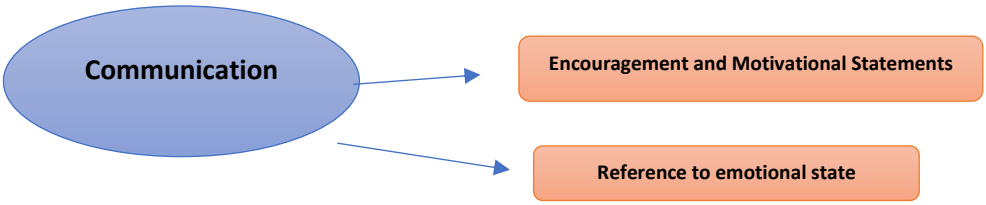


4.5.3 Effective Communication

Communication is a central component of effective collaborative problem-solving (Lai & Wong, 2022). In the case of Group Two, there were particular elements of communication which related to the use of AEI when working on the collaborative task.

Figure 4.4

Theme 1: Effective Communication



4.5.3.1 Encouragement and Motivational Statements

This sub-theme relates to the use of reassurance and encouragement between group members. This type of dynamic was observed frequently by the researcher in both the running records and the video recording of Group Two as they consistently motivated one another through positive affirmations and positive language. Additionally, in the child classroom reflection, it was noted by the group members as one of the reasons why they were successful at working together. In the video recording, there were 41 points over the 25 minute task where verbal encouragement or reassurance was offered to another group member. During the initial stages of problem-solving, a group must identify and analyse the problem before they decide on an appropriate course of action. An illustrative example of the use of encouragement in this early stage was provided in the first three minutes of Group Two's task, when group member

Harry (**GR2H)** expressed concern at four points. Firstly, he compared this experience to a previous task where his group struggled to get their robot to drive in a straight line.

> Oh no! We came dead last. It didn't even go straight. Oh no, it turned around and said bye. Literally, it spun around and went the opposite way. I really hope that this goes better for us.
>
> **GR2H,** V6 Pg2 L4-9

As the other three group members began to build and attach Lego pieces, his tone of voice and facial expression changed. He expressed concern about the difficulty of the task and the group's ability to solve it as effectively as other who had discussed their success in the classroom:

> I hope that we get it done because __'s group. They told me that they're nearly done. And that would really annoy me if we had to tell them we didn't'
>
> **GR2H,** V8 Pg4 L12-15

As observed in the running record observations, two of the other group members John (**GR2J)** and Kate (*GR2K)* assumed the role of the 'reassurer'. For example, Kate said, "Well we're going to win this one. We're going to be the fastest" *(GR2K* V6 Pg4 L18-19) and John stated "Don't worry. We've got this*!"* (**GR2J,** V6Pg4 L20-21). When asked about the use of encouragement in the post-task whole-class reflection, Kate said that she was "trying to keep everyone happy and I was feeling happy" (CCR T2, Pg3 L4). It is interesting that this student referenced keeping other's happy as this suggests that she felt like she had some control over how the other children in the group experienced the task.

As the task progressed, the dynamics shifted again, whereby other group members queried decisions that the group made. An illustrative example was found in the final ten minutes of

the task where Kate questioned whether they had selected the right speed and direction five times, “Are you sure we shouldn’t put it at 60 instead? I think it mightn’t be fast enough” (*GR2K,* V6 Pg13 L14-16). She used a concerned tone of voice, looked around at her group members and made direct eye contact when questioning the group’s decisions. In this case, the other three group members reassured her by confirming that the speed and direction were working well, “No it’s fine, don’t worry, we have this” (**GR2J,** V6 Pg.13 L17-19). They smiled and used a calm tone of voice when responding to Kate’s query. In the running record observations, the researcher observed this as a *“an important way that this group is remaining cohesive”* (RR GR2 T2, Pg1 L9). The frequent use of motivational statements and encouragement was noted as a factor in the maintenance of high levels of agreement and collaboration in the group. When reflecting on the task in the whole-class discussion, three of the group members, Harry, John and Kate felt that the use of praise and encouragement helped them to finish the task successfully. The researcher noted a discussion on how encouragement “kept them motivated and made them a good team” (CCR T2, Pg5 L12-19.) In this way, the students linked praise and reassurance to productive collaboration and problem-solving.

In Mayer, Caruso and Salovey’s AEI model (2016), managing emotions is one of the four main branches that indicate an individual’s overall ability in the use of EI. The qualitative evidence drawn from this analysis could be interpreted to infer that children *effectively managed others’ emotions to achieve a desired outcome* (managing emotions branch) and suggest that AEI abilities can be observed within CPS tasks, addressing RQ1.

4.5.3.2 Explicit reference to emotional state

Direct and specific reference to emotions were made by Group Two when problem-solving. In Group Two’s video recording, 30 references were made by the participants to either

positive or negative emotions throughout the task. 24 of these were when the group was experiencing success at an element of the task. Examples of emotional expression included phrases like "Yes, that's brilliant! "**(GR2J,** V6 Pg 11, L10), "Yes let's go wahoo" (**GR2H,** V6 Pg 11 L16) and "Yay this is so fun, I'm so happy we got to do it today" *(GR2K* V8 Pg5 L14). Each of these utterances was accompanied by a smile by the child. At three of these points, two of the children 'high-fived' each other and jumped up and down. In the running record, the researcher observed that Group 2 "make their emotions clear to one another, particularly Kate, John and Harry. They are communicating well throughout the task, including about how they are feeling" (RR GR2 T2, Pg1 L15-16).

Although there was a higher number of direct references to positive emotions, there were also times when Group Two's members expressed worry, frustration or anxiety. There were eight 'negative' emotional references recorded by the researcher. These occurred when the group was experiencing a challenge in the task or when they were required to come to a decision about which step to take next. Phrases which illustrated these emotions at portions of the task included "Oh no I'm worried it's not going to work", (**GR2J**, V6 Pg12 L25) "I'm a bit stressed, this isn't fitting in" (*GR2K*, V6 Pg6 L1-2). This language was used to indicate a child's emotional state and other children often responded accordingly. When a participant clearly stated an emotion, there was a demonstrable example of the ability to label emotions in oneself or others.

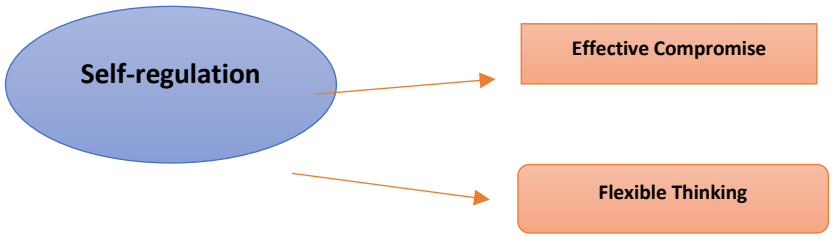
In the AEI model, an individual's ability to label emotions (*label emotions and recognize relations among them*) is seen as an indicator of an overall ability to understand emotions in oneself and others (Mayer et al., 2016). These data suggest that AEI was evident when children expressed emotions. A direct reference to emotions in a collaborative task could be used as an indicator of the use of abilities related to the understanding emotions branch.

4.5.4 Self-Regulation

This theme describes the different ways that Group Two managed their behaviours, emotions and interactions in the collaborative task. As outlined in Figure 4.5, there were two sub-themes relating to the larger theme of self-regulation: *Effective Compromise Scenarios* and *Flexible Thinking*.

Figure 4.5

Theme 2: Self-Regulation



4.5.4.1 Effective Compromise Scenarios

As Sun et al. (2020) describe, disagreement is a common part of collaborative problem-solving as group members must negotiate through various problem-solving stages. Although disagreement between the members of Group Two occurred at several points throughout the problem-solving process, they reached effective compromises when decision making. When making decisions about how best to proceed with the next step of the task, there were two dominant decision-makers, Harry (**GR2H**) and John (**GR2J**). Kate (*GR2K)* made suggestions and was involved in the process of decision-making, but John and Harry guided the course of problem-solving throughout the 26 minutes. Their verbal contributions were the greatest and they dominated the use of the iPad and the Lego pieces. Rose (*GR2R)* was a non-dominant member because she did not directly influence any course of action, but was involved in the

problem-solving process in other ways, a factor which is unpacked in the intra-group comparative analysis in Section 4.7.

From the beginning of the task, Harry and John listened to one another and took each other's advice on board. However, as the task moved into challenging phases of decision-making, their strong opinions resulted in a disagreement. One example of this was when they clashed about the correct measurements that were needed to ensure that the robot drove in the correct direction around the obstacle course. The researcher observed that all four group members had concerned facial expressions, had higher tones of voice when speaking, suggesting anxiety or worry, and that the atmosphere changed from one of relaxed productivity to one of slight stress (RR GR2 T2). The following dialogue between John and Harry illustrates how a compromise was reached. By the end of this section of the video recording, John and Harry's tones of voice had become more relaxed:

J: 0.7 it would go off the table.

H: It won't. Just let me try 0.7.

J: I think it will but ok try it so.

They turn on the robot again.

H: Go…go…spin…go.

Robot works

H: What did I tell you? 0.7!

J: Yes (cheers).

H: 0.7 what did I tell you?

J: So then we have to go here, here and here.

H: No it's this way.

J: No it's not a circle. It's a figure of 8.

K: Yeah, yeah.

J: Yeah it is.

H: Oh you're right you're right.

V8 Pg13 L12-24

At this point in the video, they had already discussed the measurements for the previous two minutes. John believed that the robot would drive off the table if they set it to the measurement of 0.7. However, he accepted Harry's suggestion that they should attempt it. Harry laughed and smiled when he said "What did I tell you?" when he had the correct answer and John celebrated in the success by cheering and shouting "Yes". Later in the discussion, John disagreed with Harry's statement that the robot must drive in a circular fashion, stating that it should move in a figure of eight, a statement which is verified by Kate. Harry admitted his mistake, with a facial expression that was interpreted as apologetic by the researcher. In this way, the two dominant group members reach an effective compromise.

The management of one's own and others' emotions during disagreements can be challenging. In the most recent AEI model (Mayer et al., 2016), there are a number of abilities included under the larger branch of emotional management. These include the ability to *effectively manage one's own and other's emotions to achieve a desired outcome* and the ability to *engage with emotions if they are helpful or disengage if not.* In the case of Group Two, the above example of effective compromise between John and Harry could be observed as an external indicator of both boys managing their own and other's emotions. They appeared to disengage from unhelpful emotions in order to compromise successfully with one another. These findings address RQ1 as they signify that AEI abilities linked to emotional management are observable and can be assessed through the use of CPS tasks.

4.5.4.2 Flexible Thinking

An additional sub-theme of the main theme 'self-regulation' was flexible thinking. Put simply, flexible thinking refers to the ability to think about things in a new or different way (Parsafar et al., 2019). The qualitative data drawn from the video recordings, running record observations and child class reflections indicated that the members of Group Two demonstrated consistent flexible thinking towards the task and towards their group members. One illustrative example from the video recording was when group members were open to trying things a different way. The following one minute conversation was in relation to the correct measurement that they should include in the robot's code. As the discussion details, Harry suggested 36cm, John counteracted with a suggestion of 52cm while Kate suggested a compromise of 50cm. They compromised on 52cm:

H: So thirty (measuring) thirty what would you say?

J: 56..I think that's better.

H: No it would fall of the table.

K: It would fall off the table. Try 50.

J comes to look at the measurements with H.

J: Now I could be wrong….but I think somewhere around 50 might work.

H: So that's thirty, that's 52. Do you want to try 52 and have someone ready to catch it?

R: I will.

H: Thanks ok let's do it so. That's good.

K: Let's try 52. We can always go back and try 40 or 30.

J: I think that's a good idea. Let's try it.

The running record observed that all of the group members were enthusiastic and engaged with the task at this point, using calm tones of voice when speaking to each other. They moved around and looked at the iPad, the robot and the table (RR GR2 T2, Pg2 L5-6). As the conversation illustrates, they were happy to return to Harry's suggestion of 40cm if the measurement of 52cm did not work. Rose's offer to catch the robot table seemed to help Harry to agree to the other's suggestions. In this way, the collective group were flexible in their approach to the task and to the opinions of their group members. In the classroom reflection, the researcher documented when children made reference to listening to one another and taking on board each other's ideas as important factors in collaboration (CCR T2, Pg2 L25-29). Being open to trying things a different way was important for the group's success because it meant that they explored multiple pathways to the solution. Additionally, it minimised the time that was spent discussing or reflecting on the potential success of a proposed method by a group member. In the case of Group Two, no longer than two minutes was spent discussing a potential idea. Although group members sometimes disagreed, they were consistently open to trying something and subsequently returning to a different plan if it failed to work.

Flexible thinking also meant that group members acknowledged that they were not always correct in their own thinking and that it was acceptable to make mistakes. Their cognition was flexible in that they were aware that they were not always correct about what the next step in the task was. However, they had the confidence to express an opinion regardless. Analysis of the video recording data indicated that a number of different behaviours were used to suggest that they were comfortable about 'being wrong' or in making mistakes. Common strategies that appeared in the data were the use of humour and positive statements.

For example, group member Harry laughed and said “I could have messed it up there but it’s good now” (**GR2H,** V6 Pg9 L4) when he made an incorrect suggestion to the group and they decide to take a different course of action. Similarly, John said “It didn’t quite work there but I think it might next time if we change it” (**GR2J,** V6 Pg10 L16) when his plan of action doesn’t work out as anticipated. The way in which group members responded to others assisted the ease at which Group Two could admit that they had a made a mistake or proposed an incorrect solution. Throughout the video recording, all of the group members used “we” when they were conversing with each other about the task. They asked questions like “What did we do wrong?” (*GR2K,* V6 Pg10 L7), or “What should we do differently next time”? (*GR2R,* V6 Pg10 L8). This type of discussion indicates that they were thinking as part of a group rather than an individual.

Flexibility in our cognition is an important part of emotional intelligence (Mayer et al., 2016), and can be linked to a number of abilities from the understanding and managing emotions branches. For example, in the managing emotions branch, the ability to *engage with emotions if they are helpful; disengage if not* requires flexibility from the individual. The ability to adjust one’s emotions and behaviour to adapting contexts and conditions impacts how we cope in group situations. In the case of this analysis, Group Two’s verbal and non-verbal behaviours indicated that they were adept at handling change throughout the task. The relationship to AEI is considered in more depth in the summary below.

4.5.5 Synopsis of Thematic Analysis for Group Two

Two central themes emerged from the qualitative analysis of Group Two, the highly successful group. These themes address RQ1 which was focused on the observation and assessment of AEI in CPS tasks. One main way that the emotional abilities of group members

could be observed was through effective communication between children. For example, when children referred to an explicit emotional state of themselves of others in the group, they demonstrated an ability to label emotions in themselves and others. This was often when they celebrated success at an element of the task or when they expressed frustration at how the task was progressing. The ability to *label emotions and recognise the relations among them* is one of the abilities of the Understanding Emotions branch (Mayer et al. 2016).

Another behavioural pattern which indicated that children were using AEI was the frequent use of encouragement and motivational statements. The data indicated that this was often used in response to another group member's expression of frustration, confusion or worry. In this way, group members tried to support one another and manage the emotional state of the group as a whole and individual members. *Managing the emotion of others to achieve a desired outcome* is one of the abilities of the emotional management branch. As outlined by Mayer et al. (2016) the emotional management and emotional understanding are often latent internal process. However, in this case, the ability to understand and manage other's emotions could be observed through group member's interactions with one another.

An additional way in which emotional abilities were revealed in qualitative analysis was through behaviours related to self-regulation. Self-regulation refers to the way that at individual exercises control over their thoughts, feelings and behaviours (Pandey et al., 2018). In this case, the behaviours which were of interest were those related to the management and control of emotions. One illustrative example of well-developed emotional management abilities was when disagreement was handled effectively through compromise. Compromise requires individuals to find a 'middle ground' in decision making. The second sub-theme of self-regulation was flexible thinking which is also a significant component of

emotional management. Adjusting one's feelings to a new situation or idea requires an individual to self-manage and understand their emotions. Group Two exhibited behaviours that suggested they were flexible in their thinking towards the task and their peers. When they were consistently open to other's opinions and suggestions, as well as being open to making mistakes, they appeared to display flexible thinking.

In relation to RQ2, there were particular elements of the task that elicited the use of these behaviours described above. As the tasks were collaborative in nature, group members had to communicate with each throughout the problem-solving process. This meant that children were continually conversing and using body language that could be interpreted as indicative of their AEI abilities. Additionally, the open-ended nature of the tasks meant that frequent decision making was required. This group frequently created new prototypes and shared ideas about the next step in the process. Making decisions in open-ended tasks is complex because it requires individuals to use the behaviours described above, like effective compromise and flexible thinking (Li et al., 2022).The focus now shifts to the thematic analysis of Group Five who were determined to be a moderately successful group.

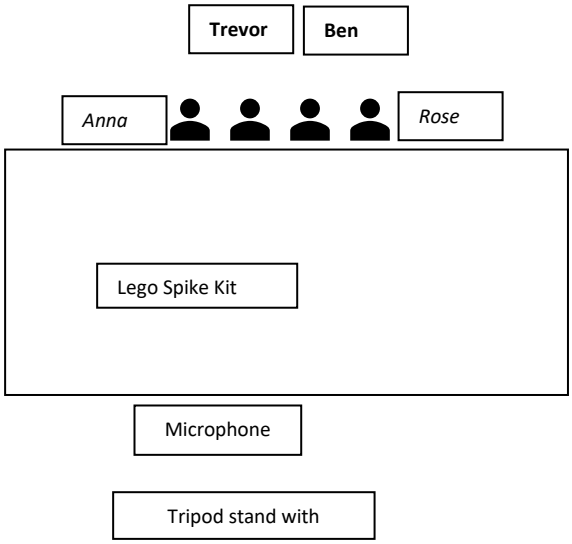
4.5.6 Description of Group Five

Group Five was composed of four individuals: Trevor (**GR5T**), Ben (**GR5B)**, Anna (*GR5A)* and Rose (*GR5R)*. There were a variety of temperaments and personalities in the group. As described for Group Two above, they were working around a table, using a Lego kit and iPad. Ben was typically quiet and focused in the classroom. He liked to work independently and often requested to complete projects alone instead of in a pair or a group. Rose was also a more reserved individual who took on a supporter role in group contexts. Both Anna and Ben were sociable, vocal and confident individuals. In this task, they disagreed about turn-taking,

how to proceed with the task and with each other's opinions at several points in the task. Consequently, more time was spent making decisions than in other more successful groups.

Figure 4.6

Pen Picture of Group Five



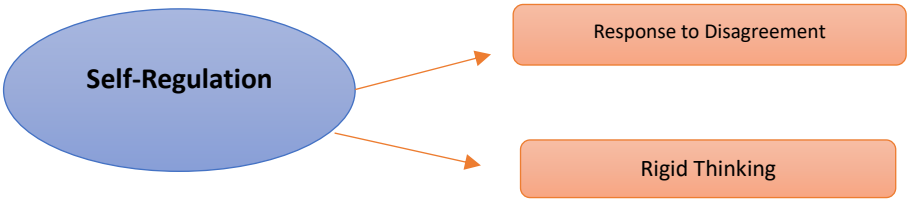
4.5.7 Thematic Analysis of Group Five

Quantitative analysis of Group Five's video recording identified them as a moderately successful group (see Table 4.2 for full overview of behavioural indicators) with high levels of disagreement when decision making. Running record observations also identified interactions which were dominated by criticism and disagreement between group members Trevor and Anna. Although minor disagreements occurred in many groups, this disagreement was interpreted by the researcher as the most disruptive to group productivity as a whole. These data were triangulated with the class child reflection, where group members identified this disagreement as one of the factors which inhibited their success as a team and on the

task. This motivated the selection of Group Five's video recording on Task Three for further thematic analysis. One main theme was identified as most dominant in the data and as most relevant to the research questions of this study. This theme Self-Regulation, referred to the way in which group members displayed behaviours, facial expressions and body language that related to the self-regulation of emotion. Figure 4.7 outlines the two sub-themes were identified in the data as equally significant: *Response to Disagreement* and *Rigid Thinking.*

Figure 4.7

Theme 2: Self-regulation



4.5.7.1 Response to Disagreement

A large proportion of Group Five's time was spent involved in, observing or managing a disagreement between others. The way in which group members responded to disagreement could be related to their use of AEI in collaborative settings, a sub-theme which is unpacked and discussed in relation to the research questions below. As mentioned previously, Group Five's first fifteen minutes of the task were dominated by a conflict between two pupils, *Anna (GR5A)* and **Trevor (GR5T).** The disagreement began when Anna told Trevor that he had inserted the Lego piece incorrectly. Her tone was interpreted as critical and Trevor responded with a critical comment and an angry facial expression:

Anna: You're turning it the wrong way!

T: Stop you can't do anything for your life!

A: Yes I can. I'm actually doing it right!

T: Where am I putting it? You can't see.

A: I can I know what to do. (She takes the piece)

T: Of course you know what to do

V9 Pg1 L6-12

The two other group members Rose (*GR5R)* and Ben (**GR5B)** handled the disagreement between Anna and Trevor in a similar manner, whereby they appeared to ignore the conflict and maintained a calm emotional state. Having taken the Lego pieces from Trevor without his permission, Anna talked through how she was going to correct his previous mistakes. Rose joined in the conversation and praised her efforts, which Trevor responded to with a comment, a question and an angry facial expression.

A: You're going to put it in this way.

R: Well done Anna.

T: What do mean well done Anna? Are you sure it's even working?

A: You need to put it on this way.

V9 Pg1 L14-18

Rose did not respond to Trevor's question. She continued to read the instructions that were on the iPad and looked away with was interpreted by the researcher as a calm facial expression. Over the course of the next three minutes, Anna and Trevor each made four critical comments to one another, where they disagreed about how the robot should be put together. Both Ben and Rose continued to build other parts of the robot, without making eye contact with their other two group members. However, Ben made one response to Trevor when he queried a previously established agreement about turn-taking:

T: Well done you're doing a great job of taking my go so I'm getting more gos.

B: You only get two gos. That's what we all agreed.

T: But you're all doing my go.

B: That's what we agreed.

V9 Pg1 L22-26

In a running record observation of the task, the researcher observed that "Ben remained very calm in the face of Trevor's frustration and anger" (RR GR5 T3, Pg1 L10). As outlined in the description of the group above, Ben and Rose's temperaments were generally calm in the classroom. Therefore, their behaviours in this group setting were consistent with what the researcher had observed as their teacher over the course of the year. As one of the groups included in the focus group interviews, some insight was also provided by the children themselves. When they spoke about their reactions to the disagreement between Anna and Trevor. Rose said that "I didn't want to get involved because I knew it wouldn't help anyone…it was a bit annoying but I find it easy to stay calm" (FG2, Pg2 L35) while Ben said m"Yeah I found it annoying but I just wanted us to move on. I knew that they would get over it if we kept going" (FG2, Pg2 L40). Together, these behaviours and comments might be interpreted as suggesting that both Ben and Rose were using abilities from the managing emotions and understanding emotions branches in a purposeful and thought-out manner, including the ability to *effectively manage one's own emotions to achieve a desired outcomes* (managing emotions) and the ability to *appraise situations that are likely to elicit emotions.*

As the most vocal and confident individuals in the group, Anna and Trevor's behaviours often appeared spontaneous and uninhibited. However, their successful management of the conflict later in the task signifies that like Rose and Ben, they engaged in the use of abilities

related to emotional management in order to refocus their attention on the task. In the later sections of the task, Trevor stopped criticising Anna and tried to encourage the group to work together to get the task done. In minute sixteen he asked them to "Stop fighting and just go with the flow" and tells them to "Forget the go's! Everyone just help out with everything" (V9 PG4 L11). Reflecting on these positive comments in the focus group Trevor said "I really wanted us to get it done and I knew we couldn't keep fighting the way we were" (FG2, Pg 3 Line 50). This reflection could suggest that he made a conscious effort to manage and understand his emotions before proceeding with the next element of the task.

Anna's behaviour also changed in the final components of the task as she was happy to compromise on a number of elements of the decision-making. For example, over the course of three minutes (VR9, 10:03- 13:31) Anna and Trevor disagreed about the type of song that they should pick for the dancing robot. However, in this case, they reached a compromise:

T: What music should we do?

A: Like a funny song

T: No no. I don't think so

A: Ok what about a dance song?

T: Like a dance song yeah but not a Tik Tok one?

R: A fun song

A: Aw I love the Tik Tok ones but yeah ok a good dance one.

V9 Pg5 L125- 132

When Trevor disagreed with Anna about the selection of a 'funny song', she made another suggestion of selecting a 'dance song'. He agreed but stipulated that they should not choose a song from Tik Tok. Although she said that she would like to select one from this social media platform, she accepted his opinion and they agreed to choose a 'good dance one'. In the running record observations, the researcher recorded this as a "significant change in the way decisions had been made previously" (RR GR2 T3, Pg2). The de-escalation of the disagreement between Trevor and Anna may have been assisted by Rose and Ben maintenance of a calm emotional state and by Trevor and Anna's willingness to adapt to the circumstances and move on from the conflict. In this way, the reactions of the group members to disagreement led to the observation of behaviours which could be attributed to the use of AEI abilities from both the managing and understanding emotions branches in collaborative contexts. These findings address RQ1, demonstrating that CPS tasks can be used as a vehicle to explore the assessment and observation of AEI.

4.5.7.2 Rigid Thinking

In Group Five, three of the group members, Ben (**GR5B),** Trevor (**GR5T)** and Anna (*GR5A)* were consistently rigid in their thinking. This had an impact on how the task progressed and how they collaborated with their group members. As the verbal contributions of the final group member Rose (*GR5R)* were less frequent, it was more challenging to identify these indicators from her behaviours. Firstly, qualitative analysis of the video recordings and the running record observations indicated that these three group members were more rigid in their thinking about the nature of the task and the steps needed to solve the problem. If they had an idea that they felt was correct, they were reluctant to take on board the ideas of others or to listen to each other's opinions. Examples of comments made over the course of the 40 minutes included, "We shouldn't try that…I know it won't work" (*GR5A,* V9 Pg3 L92), "No,

don't try that, that's stupid" (**GR5T,** V9 Pg4 L132). "Why would we do that?..". and "It's not supposed to be done that way" (**GR5B**, V9 Pg 5 L158). The researcher commented on "the lack of openness to new ideas" as a prevalent pattern in the interactions between the group members (RR GR5 T3, Pg2).

The group members also tended to have fixed ideas about making mistakes. They did not console one another but often criticised if a proposed solution did not work out as planned. Comments included "That's wrong, you messed up" (**GR5B,** V9 Pg6 L189) and "You probably broke it now. Why would you put it in there?" (*GR5A,* V9 Pg3 L100). The researcher observed that both of these remarks were made with a critical tone and a negative facial expression to the other group members. When one or two members dominate a group and demonstrate inflexible thinking, it can have an impact on the on the group's success as a whole. This is because they don't engage in discussion about potential solutions and some group members may be reluctant to share ideas due to a fear of criticism or retributions.

An additional pattern was that Anna and Trevor often gave instructions without consulting others in the group. In one instance, Anna used the phrase "You have to" or "You should" ten times over a period of 15 minutes (V9 Pgs1-4) when another group member was completing a component of the task. Additionally, in the 40 minute task, she did not respond positively to any idea proposed by another group member. An illustration of this was in the 20th minute of the task where Ben, Trevor and Rose each proposed ideas to progress at the task:

A: Ok we need to get the legs to move.

Ben takes iPad to look at code

T: We should put these pieces on his arms so he's like Megatron.

A: We're not doing that. No way.

B: I have it. Let’s put the arms on this way.

Turns on robot

A: No stop! He's going way too fast.

R: That's good though? Have a look at this picture? They look like this (points)

A: No we need it to move to go with upbeat dancing.

A: Play some music B. B's like I'm a genius.

V9 Pg6 L200-208

The above example demonstrated how Anna’s thinking was often inflexible in how she approached the task. In this part of the process, her tone of voice was raised and she was interpreted as showing a frustrated facial expression. She frequently grabbed at items on the table and did not ask permission from her group members to take a piece of Lego or the iPad to look at. The researcher observed that Anna was “often the dominant decision maker, did not like when others wanted to try different things and made critical comments when others made mistakes” (RR GR5 T3). In the post-task focus group, the group was asked how they felt they worked together. Anna initially reported that “some people were messing and some people were taking control” (Fg2, Pg1 L11) but did not discuss her own approach to the task. However, later in the focus group, they reflected on a portion of the video recording at which point Anna said “I feel like I was taking control a bit here. Maybe I shouldn’t have” (FG2, Pg3 L47-48). It would appear that Anna had some awareness of her dominance in the group and how this may have impacted others when working on the task.

Flexibility in our cognition is an important part of emotional intelligence. The ability to adjust one's emotions and behaviour to adapting contexts and conditions impacts how we cope in group situations. In the case of this thematic analysis, Group Five consistently displayed rigidity in their thinking, which was reflected in their non-verbal and verbal behaviours. It is possible that these group members were less adept at using the ability to *engage with emotions if they are helpful and disengage if not* (understanding emotions). The link between rigid and pupil's use of their AEI in this collaborative context is explored in the synopsis below.

4.5.8 Synopsis of Thematic Analysis of Group Five

The main theme of *Self-Regulation* and the two sub-themes of *Response to Disagreement* and *Rigid Thinking* relate to both RQ1 and RQ2. RQ1 focused on the degree to which AEI abilities could be observed and assessed in CPS contexts. The variation in children's responses to disagreement facilitated this observation and assessment process. Rose and Ben remained calm, did not get involved or respond and focused on completion of the task. Their comments from the focus group suggested that these actions were not spontaneous but thought-out to some degree. It is possible to discern from the data that both children self-managed their own emotions in response to the disagreement of others. In contrast, Anna and Trevor were often uninhibited in their responses, used raised voices and made critical comments using facial expressions of frustration. These data suggest that these were spontaneous actions rather than well-thought out interactions, which could illustrate that these participants had less well- developed AEI, particularly in the branch of managing emotions. However, at certain points in the task, both altered their behaviours towards each other and towards the other two group members. They suggested compromises and listened, which, in turn, shifted the dynamic of the group as a whole. In these instances, both Trevor and Anna were observed as engaged in emotional management of their own and others emotions in

order to successfully complete the task. The behaviours and observations discussed in the findings thus far were largely related to positive use of AEI abilities. However, in this case, the emergence of disagreement between group members resulted in a wide array of behaviours and interactions, some of which may be associated with 'lower' or less developed AEI. These findings add further clarification around RQ1 as they indicate that a wide range of AEI abilities can be observed and assessed within CPS contexts, not solely positive use of these abilities.

Another external indicator of an individuals' emotional abilities was linked to flexibility of cognition. In this group, members often displayed rigidity in their thinking towards others. Two group members had particularly fixed ideas about how the task should proceed, even when an idea that they had proposed wasn't working. This type of behaviour pattern was interpreted as indicative of the use of emotional understanding and management abilities. Addressing RQ1, these findings illustrate that AEI abilities can be observed and assessed to a strong degree in CPS contexts. Individuals who have well-developed AEI adapt their emotions and behaviours in order to succeed in particular contexts. The behaviour of some of these group members suggests that they were unable or unwilling to take on the opinions or ideas of others or to adapt and change their own emotional state for the sake of the group's success.

This theme also has implications for RQ2 and the types of tasks that appear to elicit AEI abilities. Given that this task was open-ended with multiple pathways to solutions, it particularly highlighted the rigidity of thinking that was apparent in some members of Group Five. A task which allows individuals to share ideas, trial multiple methods and express creativity was successful in eliciting AEI behaviours such as the one described in this thematic analysis.

4.5.9 Comparative Analysis of Group Five and Group Two

As discussed, there were different ways in which behaviours connected to AEI were observed in Group Five and Group Two, each of which relates to RQ1 regarding the observation and assessment of AEI through the use of CPS tasks. Effective communication was a factor in Group Two's success at CPS. It also assisted the researcher's observation of behaviours related to emotional management and emotional understanding. When Group Two made explicit references to both positive and negative emotions throughout the task, this was interpreted as indicative of the ability to label emotions in oneself and others (Mayer et al., 2016). In contrast, Group Five did not reference their own or others the emotions during the task. This meant that emotional state had to be inferred by the assessor, through the child's tone of voice, their facial expression or from the reactions of other group members. Consequently, it was difficult to observe this ability of the understanding emotions branch of the AEI model from the running record and video recording observations.

Group Two and Group Five also differed in their use of positive statements and encouragement. In Group Five, members frequently used encouragement in response to an expression of worry or anxiety by another child. This pattern of behaviour suggested that children were aware of the emotions of their group members and responded accordingly. These data indicate that this pattern was linked to the use of AEI, particularly the area of emotional management of others. Hence, the researcher interpreted this behaviour as a visible indicator of the ability to manage other's emotions. In contrast, Group Five did not frequently use reassurance or positive statements towards one another and often criticised one another in their efforts. This suggests that they were less adept at managing their own and other's emotions. However, it is also possible that there were other latent factors which influenced

their behaviour in the group. For example, the significant influence of an individual's personality on their behaviours cannot be ignored when considering the impact of emotional intelligence, a factor which is discussed in greater detail in Chapter 5. The observation and assessment of behaviours linked to AEI is not a straightforward process as there are many factors which can influence behaviour in CPS tasks.

Behaviours related to AEI in Group Five were more visible when they related to the self-regulation of emotion in disagreement scenarios. Both Group Two and Group Five had to manage disagreement between group members. However, the means by which they handled disagreement varied. Two members of Group Five (Ben and Rose) remained calm and did not get involved in disagreements. Comments from the focus group data aligned with the researcher's observations that this could be indicative of well-developed emotional management and emotional understanding abilities. In contrast, two members of Group Five (Trevor and Anna) responded in different ways to disagreement throughout the task. At first they offered responses like critical comments and negative facial expressions. However, this changed and they began to compromise as the task progressed. Effective compromises were also a common way that disagreements were resolved in Group Two, particularly between the two dominant decision makers, Harry and John. These behaviours could be interpreted as indicative of a number of abilities of the understanding and managing emotions branches (Mayer et al., 2016). Reaching a compromise with others requires an individual to *engage with emotions if they are helpful and disengage if no*t. Although it is difficult to observe this directly, children did alter their emotional state to manage the disagreement effectively with others. It could also be indicative of the ability to *effectively manage one's own and others emotions to achieve a desired outcome*. In this case, students managed their emotions in order to successfully complete the task and to avoid conflict in the group. Finally, it could be

indicative of a child's ability to *apprise the situations that are likely to elicit emotions*. When pupils compromised, they had to determine how their own emotions would influence others and the types of emotions that others would experience if they carried out a particular course of action.

Group Five and Group Two also differed in their openness to new ideas and the opinions of others. In the highly successful Group Two, all four group members were open to trying out new methods to solve the problem. They encouraged one another when mistakes were made. In contrast, Group Five's members often displayed rigid thinking about the CPS task. They did not want to take on board other's ideas and remained resistant to change. These behaviours could be suggestive of well-developed or less-developed AEI in the areas of emotional management and understanding, particularly those related to the self-management of emotion and self-understanding of emotion. Individuals who have well developed AEI solve problems with a flexible emotional range (Mayer et al., 2016). They adapt their emotions to the context and do not remain fixed in one emotional state.

Overall, in addressing RQ1, the findings show that Group Five and Group Two displayed a range of behaviours which could be seen as indicative of the use of both well-developed and less developed AEI abilities, implying that AEI abilities can be observed and potentially assessed in CPS contexts (RQ1). In the highly successful group, the researcher observed a higher number of positive behavioural strategies which were related to emotional understanding and management. This was because children made reference to emotions and often used praise and encouragement as a strategy to assist other's emotional state. However, in the moderately successful group, there was more scope for understanding how the individuals handled their emotions to deal with a conflict or disagreement scenario.

Relating to RQ2, thematic analysis also helped to identify the features of CPS tasks that evoke the use of these behaviours. Firstly, the challenging and open-ended nature of the tasks appeared to elicit the use of AEI abilities in children. What was typically challenging about these problems was that they could be solved in multiple ways. This type of open-ended task required greater collaboration from group members than a well-defined problem. Consequently, there were more instances where children were required to use decision-making and negotiation skills. Secondly, the tasks were collaborative in nature and could not have been completed by one individual within the allocated time frame. Thus, children were reliant on each other's input into the task. The sharing of knowledge, ideas and skills was important to task success, as is typical in CPS tasks (Li et al., 2022). This collaborative element required children to communicate, to make decisions and to share ideas. These were all elements which also led to the use of AEI abilities in the group me

4.6 Comparative Analysis 2: Group Eight and Group Four

4.6.1 Pen Picture of Group Eight (Breakdancer Challenge)

There were four children in Group Eight: Emma (*GR8E*), Aoife (*GR8A*), Jane (*GR8J*) and Lily (*GR8L*). Group member, Jane, a student with above average standardised test results, took on the role of group leader. She allocated roles and tasks, attempted to motivate other group members to stay on track and organised the distribution of Lego pieces and the iPad. Lily, also a high ability student (interpreted from both classroom assessments, and standardised test results) frequently talked through the process of problem-solving and took on the role of building and coding the robot. However, she was often distracted by Emma, who initiated multiple off-task conversations with her group, a factor which caused some

frustration for Jane. Group member Aoife offered a supportive role in that she provided positive words of encouragement and support to her group members. However, she often offered her turn to others and reported that she was "bad" at Lego.

4.6.2 Thematic Analysis of Group Eight

The rationale for the selection of Group Eight's video recording was guided by the triangulation of data sources. Initial quantitative analysis indicated that the group did not complete the task in the time provided and had significant off-task behaviour (see Table 4.2). In the running record observations, the researcher noted that the use of a dominant leadership style by group member Jane appeared to elicit behaviours in others which could be indicative of emotional understanding and management abilities. This leadership style was also noted by group members Emma and Lily in the child class reflection, where they joked about Jane's "bossy style" and concluded that this impacted their ability to participate fully in the task (CCR T3, Pg2, L42). In contrast, Jane and Aoife joked about how the off-task behaviour shown by Emma impacted their ability to complete the task. Moreover, this group was highlighted as unique because they were the only group who reported that the task was too difficult for them to complete. The group members' most recent standardised test results ranged from average to well above average in English and Maths, which meant that their academic abilities could not account for this difficulty (see Appendix G for full overview of standardised test results). This unique leadership style, combined with a significant amount of off-task behaviour and the dissatisfaction around the task difficulty meant that this group were selected for further thematic analysis.

Following the procedures described in Section 3.8.1 and 3.8.2, two themes *Autocratic Leadership Style* and *Task Difficulty* were identified in the data. Two sub-themes were identified from this main theme: the *Distribution of Roles and Responsibilities* and *Off-task*

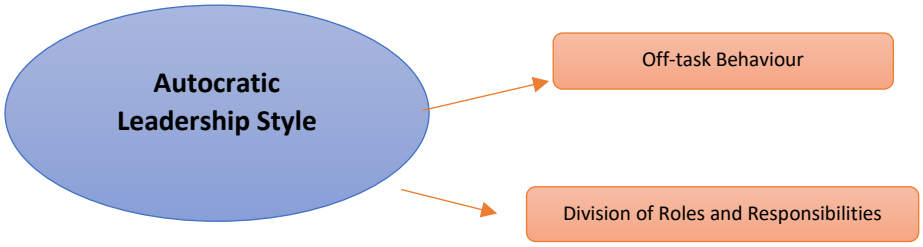
Behaviour. These were related to the leadership style but distinct concepts that could be explored. The second theme *Response to Task Difficulty* refers to the ways that the group members responded to the perceived difficulty of the task. The sub-theme of *Persistence* refers to the pursuit of a course of action, despite encountering an obstacle or opposition.

4.6.3 Theme 1: Autocratic Leadership Style

There are multiple interpretations of the autocratic leadership style, many of which are negative. In this particular thematic analysis, it refers to a leadership style where the leader prioritises command and control over the project or team members in order to accomplish a task (Van Vugt et al., 2004). The data analysis indicated that Jane used a dominant leadership style whereby she made decisions on turn-taking and steps on the task. Two sub-themes were identified from this main theme: the *Distribution of Roles and Responsibilities* and *Off-task Behaviour*.

Figure 4.8

Theme 1: Autocratic Leadership Style



4.6.3.1 Division of Roles and Responsibilities

This group followed a system of turn-taking which was guided by group member Jane. At the beginning of the task, she suggested that they each take a turn and rotate, a system which was agreed to by the rest of the group. Although there were four points in the video recording where this arrangement was not adhered to because a group member requested assistance

from others, it was in place for the remainder of task completion and was maintained with 14 verbal reminders from Jane to the other group members. When a component of the task was completed, she would typically make a comment like “Ok, it’s your go now Lily. Take over” (V13 Pg4 L55). The manner by which other children responded to this division of roles could be indicative of the use of behaviours related to AEI. As the following conversation details, Emma and Lily firstly expressed dissatisfaction and boredom at the components of the task they were allocated by Jane:

Jane: Emma. It’s your turn.

Emma: Oh another turn where I just have to find a piece in a box.

J: No I found it. You can do a step after this too.

E: It's the exact same step.

Lily: This is a bit boring.

VR13 Pg3 L55-60

In the subsequent two minutes, Emma and Lily expressed dissatisfaction with the system because they felt that it was being used unfairly by Aoife and Jane:

L: Hey, it was my turn next.

J: It wasn't.

E: You guys get two gos (turns) for our every one. It's fine though.

M: No it's not.

J: Well it's fine for Elsa.

Emma laughs.

E: I don't know how to stand up for myself.

VR13 Pg3 L74-8-13)

These two conversations illustrate a number of behaviours which were indicative of the use of AEI when undertaking a CPS task. Firstly, both Lily and Emma made reference to their emotions by expressing boredom and dissatisfaction at their system of turn-taking. The ability *to label emotions in oneself or others* is part of the understanding emotions branch of Mayer et al.'s (2016) model. In the second conversation, Emma appeared to express dissatisfaction at the unequal distribution of tasks but then laughed and said "It's fine though". She then added that she didn't know how "to stand up for myself". This data was complimented by a comment made by the researcher who observed "some frustrated facial expressions at the turn-taking system, even though Emma laughed it off" (RR GR8 T3, Pg3 L47). Additionally, in the child reflection, Lily and Emma were observed as "joking about Jane's bossiness in the task…They felt that she sometimes took over" (CCR T3, Pg2 L47). These data suggest that this system of roles was an issue of concern for Emma and Lily. However, no other reference was made to turn-taking following this conversation which occurred in the 6th minute of the video recording. It is possible that Emma may have wanted to avoid a conflict with Jane or the other group members. As Emma managed her own and other's emotions through her de-escalation of the issue, this could be interpreted as a behaviour indicative of the branch of emotional management. The consequence of this decision was that Julia continued to allocate turns as she wished. In this way, group cohesiveness was maintained. However, as the following sub-theme addresses, Emma engaged in significant off-task behaviour, which could be linked to this group dynamic.

4.6.3.2 Off-Task Behaviour

Off-task behaviour primarily presented as conversations about topics that were not relevant to the problem-solving process which were most frequently instigated by group member Emma.

The manner in which Emma behaved and the ways in which other group members responded to her behaviour permitted the observation of behavioural indicators relevant to AEI abilities in the CPS task. Over the course of the 34 minute task, Emma initiated ten conversations not related to the problem. She asked open-ended questions that sought her group members' opinions on topics that were of interest to her. Examples from the video recording included "Do you think some day that there will be a magical war between humans and fairies?" (VR13 Pg8 L183), "Are you happy with the Harry Potter house you got in the quiz?" (VR13 Pg7 L171) and "Do you guys keep your wardrobes open all of the time?" (VR13 P.6 L168). The researcher also observed that she "was not focused on the task…didn't generate ideas or offer help. (RR GR8 T3, Pg3 L49).

There are a number of reasons why Emma may have lacked focus on the task. Firstly, she may not have had interest or been motivated by its content. However, she made several comments which suggested that she was interested in its completion. She asked the group not to complete the music coding component without her "But please don't do the music part without me. I won't be here tomorrow" (VR 13 Pg6 L161) and expressed excitement at the prospect of dancing with the robot "Guys we all have to do the dance with the robot when we code it" (VR13 Pg6 L172). Her comments in the class reflection suggested that her behaviour was linked to the management of boredom. When asked about turn-taking, she was recorded as noting that she was "sometimes bored waiting for her turn but the Lego itself was fun" (CCR T3, Pg2 L48). While it was typical in this and other groups that children remained focused and offered help while others were directly working on building or coding, Emma did not do this and got distracted. This could also have been due to the turn-taking system that was initiated by Jane and led to each child working individually on an element of the task.

The management of boredom on academic tasks requires an individual to exert control over their own behaviours and emotions (MacCann et al., 2020). It is possible that Emma's behaviours indicate that she found it difficult to manage her own emotions to achieve the overall goal of task completion. The construction of shared knowledge through the sharing of ideas and experiences is an important component of CPS (Sun et al., 2020). Without Emma's input, the other group members were at a disadvantage when decision making on how to proceed with the task. However, it could also be discerned that for her own enjoyment of the context, her use of off-task behaviour was a successful strategy because it often initiated a response form others, which then alleviated her potential 'negative emotion' of boredom. In this way, Emma's response could be indicative of the ability to *effectively manage one's own emotions to achieve a desired outcome* (managing emotions branch). The desired outcome, however, could be interpreted in different ways. If the outcome was to alleviate boredom, Emma was successful. However, if the outcome of task completion and successful collaboration is considered, Emma's behaviours were less successful.

The group members varied in their responses to Emma's off-task prompts. Using a positive and friendly tone of voice, group member Lily provided short responses to five of the open-ended questions posed by Emma, including "I'm not sure" (VR13 Pg5 L131), "You're so funny" (VR13 Pg6 L163) and a smile. At these points in the video recording, she was building a component of the robot. Lily's responses appeared to be mindful of Emma's emotions in that she smiled and responded positively to each of her comments but remained focused on the task. In this way, her behaviour could be characterised as successfully managing the emotions of others as she maintains positive interactions with Emma, while also continuing with the process of problem-solving. However, later in the task, she did respond to the other five questions posed by Emma, resulting in off-topic conversations. These responses occurred when she was not directly involved in the building or coding

process. This had an impact on the group's success as a whole because both Lily and Emma then tried to involve the others in a discussion. In this way, Lily did not put the success of the group ahead of her own interest in the conversation or attempt to manage her own boredom when not working on the robot.

Jane's responses to off-task behaviour varied from comments on others behaviour to direct requests for assistance. These included "We can't concentrate". You two are over there messing" (VR13 Pg1 L12), "You're not concentrating, come on" (VR13 Pg2 L37) and "Please guys, come on" (VR13 Pg 6 L125), which were all accompanied by what was interpreted as a frustrated tone of voice by the researcher. Four requests for assistance were noted. These included "Will you join in now? We have the head done. You can do the body" (VR13 Pg4 L96) and "You can apply this brick here. You'd be good at this?" (VR13 P4 L108). When discussing the task in the class reflection, Jane spoke about "being slowed down by talking" and felt that the group should have achieved more within the time allocated (CCR T3, Pg2 L52). Although she did not directly reference emotions of anger or frustration at her group members, her tone of voice, facial expression and language suggested that she was unhappy or dissatisfied with their participation. It is possible that these requests for assistance were indicative of emotional management relating to the emotions that she was experiencing around her group members.

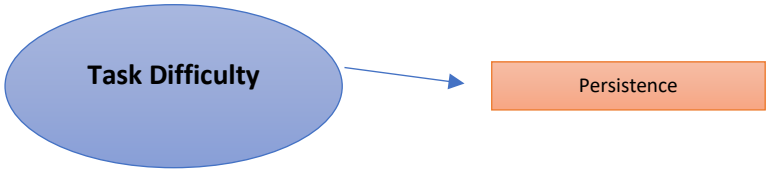
Group member Aoife's behaviours towards the off-task behaviour differed to that of her peers. When Lily and Emma were engaged in five off-task conversations, she largely ignored their distraction and continued to work on the task or watch Jane undertake the task. However, she did make five comments which suggested that she would have preferred if all four group members worked together throughout the task. As observed by the researcher, these comments were accompanied by a "joking" tone and a smile. She asked the two girls to "Shush, come on" at one point (VR13 Pg3 L54) and joked "Would you two ever stop and

come on?" (VR13 Pg4, L86). It could be argued that Aoife's lighter tone was motivated by a lack of confidence and a fear of rejection from her peers. However, it is possible that Aoife used a lighter tone and a smile to alleviate the potential effects that her comments would have on her group members. In this way, she may have been using the ability to *monitor emotional reactions to determine their reasonableness* in order to ascertain the outcome of the scenario she was in, while also managing her own emotions of frustration or annoyance to achieve the overall goal of task completion. She successfully maintained positive social interactions while also attempting to achieve a desired outcome of task progression.

4.6.4 Theme 2: Task Difficulty

One sub-theme of *Task Difficulty* was identified: *Persistence.*

Figure 4.9 *Theme 2: Task Difficulty*



4.6.4.1 Persistence

In the child whole-class reflection (Task 3), all four group members reported that they found the task content difficult to undertake which impacted their enjoyment of the process. In the video recording, Aoife made six comments about her lack of expertise in the area of coding and Lego. For example, in the opening 10 minutes, she offered her turn to other group members and said "I'm not good with Lego. You can do it" (VR13 Pg2 L40-41). Similarly, Jane made five references to task difficulty during the video recording, including comments like "This is too hard. How are we expected to know how to code?" (VR13 Pg2 L50-51) and

"I can't do this. I'm not good at this" (VR13 Pg2 L63-65). As noted in the introduction to this group, all four girls had Maths and English standardised results which were in the average, above average or well above average range. Therefore, there was no discernible reason why they reported significantly more difficulty than other groups in the study. Despite expressing these beliefs, both Jane and Aoife displayed persistence in the face of task difficulty, even when they encounter repeated setbacks.

Howard and Crayne (2019) define persistence is defined as a behavioural event whereby a person works through obstacles in the pursuit of a goal. The following examples from the transcript of the video recording provides three examples of persistence from both Aoife and Jane. In the first event, the legs of the breakdancing robot had failed to work correctly three times previously. When Emma asked "How are these falling legs going to dance to a song?" (VR13 Pg4 L90), both Jane and Aoife replied with positive statements. Jane said "Don't worry. They will be attached to each other and they will work" (VR13 Pg4 L91), while Aoife replied with "We need one of those things (points) and I'm sure it might work then" (VR13 Pg3, L92). In the next five minutes, they continued to restructure the design of the legs in order to ensure that they could support the body of the robot. In the next event, Jane expressed concern that they were missing an essential Lego piece for task completion: "Guys we're missing a piece. We can't move on without it" (VR13 Pg4 L106). In the next five minutes, Jane, Aoife and Lily spend five minutes searching for the piece in the problem-solving area, the classroom and in the other kits. In the last event, they displayed persistence when they tried to code the robot in the final five minutes available to them for task completion. Both spoke about the difficulty and time-constrained nature of this element. Examples of comments made included Aoife said "We don't have much time but let's keep looking at it", while Jane said "Ok give me the iPad, I will try and get it working". Although

they ultimately failed to achieve the coding aspect of the problem, they worked up to the time limit provided.

The display of persistence shown by group members here could be indicative of well-developed AEI abilities in the areas of emotional understanding and emotional management. Persistent individuals make decisions to persevere rather than withdraw from a task. Mayer et al. (2008) theorise that those with well-developed AEI acknowledge the impact that a decision will have on themselves and others. Those who perceive and understand their emotions well will be much more effective in managing these emotions throughout the decision-making process (Mayer et al. 2008). Data analysis suggests that Jane and Aoife successfully made decisions to persevere with the task, even when they were faced with the prospect of failure. This indicates that they were using abilities from the managing emotions branch to achieve the desired outcome of successful problem-solving.

4.6.5 Summary of Thematic Analysis of Group Eight

The two themes and sub-themes included in this thematic analysis address RQ1, which asked to what degree can AEI abilities be observed and assessed in CPS contexts. Firstly, the type of leadership style used in Group Eight influenced the types of AEI abilities that could be observed. Using a dominant leadership style, Jane made the majority of decisions about how the task would proceed, including the division of roles and responsibilities. Group members Lily and Emma expressed discontent at this system through the direct expression of emotion, which could be linked to the ability to label emotions in oneself and others.

There were also more latent indicators of emotional management abilities. Significant off-task behaviour indicated that group member Emma managed her boredom and discontent at Jane's turn-taking system through initiation of off-topic conversations. The ability to *manage emotions to achieve a desired outcome or goal* is included under managing emotions branch

of Mayer et al.'s (2016) model. In this case, Emma's behaviour could have been viewed as a way to fulfil her outcome of boredom reduction. However, the overall goal of task achievement was also impacted by this behaviour because it distracted others from problem-solving. This thematic analysis suggests that an individual's AEI abilities in the areas of emotional understanding and managed can be observed and assessed in CPS contexts. The type of leadership style used appears to impact the types of behaviours that individuals display.

The findings also have implications for RQ2, which asked what elements of CPS tasks elicited the use of AEI abilities in children working on Lego Spike Prime Tasks. In this group, task difficulty was highlighted as a barrier to task completion and enjoyment in all data sources. However, it did elicit persistence in two group members who persevered to complete challenging sections of the task. Persistence requires an individual to control and manage their emotions in order to achieve a goal. It therefore can be related to understanding and managing emotions in oneself and others. Tasks with an appropriate level of challenge may therefore elicit behaviours related to AEI.

4.6.6 Pen Picture of Group Four (Driver Challenge)

There were two boys and two girls in Group Four: Freya (*GR4F*), Naomi (*GR4N*), Cillian (**GR4C**) and Aidan (**GR4A**), who were working on Task Two, the Driver Challenge. Cillian, a student with high academic abilities, particularly in Maths, displayed an interest in coding and had completed several extra-curricular courses in the area. The other students in the class were aware of his abilities in this area and often expressed satisfaction when they were placed a group together. Freya and Aidan were students with test results in the average to high-average range, while Naomi's results were in the average to low average range. Although

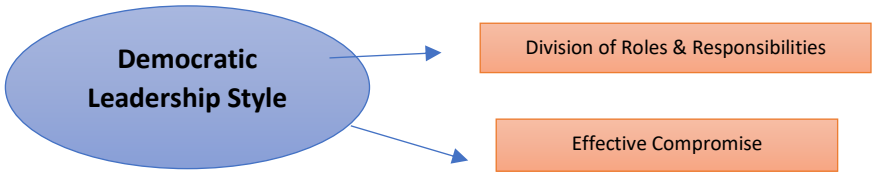
Cillian's expertise meant that he often completed the coding on the iPad, both Freya and Naomi were verbally dominant in the decision making and planning process. They questioned and discussed the outcome of each decision before Cillian completed the coding. Aidan's verbal contributions were less than those of the other group members but he did offer opinions and complete parts of the task.

4.6.7 Thematic Analysis of Group Four

Initial quantitative analysis of Group Four (see Table 4.2) indicated that they were a highly successful group, with minor off-task behaviours and a high rating of agreement on decision-making. These findings were triangulated with qualitative analysis of the running record observations and the child class reflection. This analysis found that all three of the other group members reported Cillian's expertise in the area of coding as a large factor in their success, rather than their own personal attributes at team-work or at problem-solving. While the researcher noted Cillian's skill at coding, she also observed that this group were highly effective communicators who collectively shared decision-making and roles. Although Cillian frequently made the final decisions, he took on board the opinions of others and all of the group members participated in this task. This type of democratic leadership style, alongside his role as the expert, highlighted this group as a group of interest for further thematic analysis. One central theme was identified in the data: *Democratic Leadership Style* which referred to the way in which Cillian lead the group in a democratic and participatory manner. A democratic leader invites others to participate in the decision making process and takes on board the opinions of others when decision-making (Foels et al. 2000). Two related sub-themes were identified: the *Division of Roles and Responsibilities* and *Effective Compromise*.

Figure 4.10

Theme 1: Democratic Leadership Style



4.6.7.1 Division of Roles and Responsibilities

This sub-theme relates to the way by which roles and responsibilities were divided in the group. This dynamic allowed behaviours related to the use of AEI to be observed by the researcher in group member Cillian. A system of turn-taking was not explicitly discussed or followed and no references were made to turn-taking by any group member in the video recording or child whole-class reflection. The researcher discerned that there appeared to be an implicit agreement amongst the group members that, as the person with the most experience in coding, Cillian would carry out the coding and lead the final decisions. However, his democratic leadership style meant that all other group members were also responsible for decision-making.

In total 34 decisions were made about how to proceed with the task in the 31 minute task. Before each decision was made, Cillian asked a question to seek other's opinions or explained how he was going to proceed with the coding. Examples from the recording included "What speed do we want it at (VR8 Pg1 L10), "What ports do you think we should use? (VR8 Pg2 L7) and "Would you like to try it?" (VR8 Pg5 L143). Another consistent pattern in the 31 minutes was that he consistently maintained a calm emotional state, even when faced with failure, a comment which was made by the researcher in the running records

and from his other group members in the child class reflection. This emotional state was observable in the video recording when he responded in a calm tone to queries from his group members about an element of their decision making. One illustrative example of this was when they group initially found it difficult to get their robot to move using the code. The other group members expressed concern that the robot is "defective" (**GR4A,** V8 Pg3 L52), or "broken altogether" (*GR4F,* V8 Pg3 L53) and Naomi asked the researcher "Can we get another iPad just in case?" (V8 Pg3 L54). Cillian offered a verbal reassurance to each group member that he would be able to fix the code shortly as it was an issue with "the activation of the motors" (V8 Pg3 L56). He also expressed patience and a calm temperament when group member Aidan began to change the code himself without consulting with any of the other group member firstly as a "joke" (VR8 Pg3 L91) and then because he believed his idea "would work" (VR8 Pg3 L95). While other group members verbally expressed annoyance at Aidan, Cillian agreed that they should try this idea "to see if it works. It's a good idea" (VR8 Pg3 L97). Cillian's ability to effectively manage the decision-making process with his peers while guiding the coding process was interpreted as an effective demonstration of emotional understanding, including the ability to *appraise the situations that are likely to elicit emotions* and *to determine the antecedents, meanings, and consequences of emotions.* He appeared to understand how particular contexts would elicit the emotions of his group members and consequently focused on involving all group members in the task in order to ensure effective collaboration. Secondly, his consistent demonstration of a calm emotional state, often in the face of frequent verbal queries from others indicated that he was adept at the management of his own emotions. This in turn, had an impact on the types of AEI behaviours that could be observed in other individuals, a sub-theme which is discussed below.

4.6.7.2 Effective Compromise

As noted above, 34 decisions were recorded in Group Four's video recording, with the final decision typically being allocated to Cillian. These decisions were preceded by a verbal interaction between group members. Both Naomi and Freya were involved in these 34 decisions. They typically asked a question about a suggestion made by another individual, offered an opinion on how the task should proceed or expressed a concern about the progress that the group was making. Group member Aidan was involved in ten of these decision making processes and had lower amount of verbal interactions with his peers. These verbal interactions were examples of effective compromise scenarios between the children as they negotiated with each other to make a decision. In the following conversation, they each expressed different ideas about what the correct measurement of code should be:

Naomi: It doesn't work

Freya: Ok let's try 40.

Cillian: Ok let's try it with that again.

Robot doesn't work

Freya: It's not working.

Aidan: No not working. Try 45.

Freya: What about if we moved the boxes a bit?

C: Ok let's do that.

Robot improves.

N: Ok that's better. That looks a lot better.

Freya: Ok so change the measurement to 46 or 47?

N: 47 I think.

C: I'm going to compromise and try this. Go Gary (to robot)

VR8 Pg7 L172-183

Although Cillian made the final decision by changing the code in each of these short interactions, each consensus was preceded by a negotiation and a discussion with other group members. There were five points where Freya and Naomi's voices became raised during these interactions and they appeared annoyed or frustrated. However, at each point they continued to communicate with Cillian and ultimately reach consensus. In this way, the two girls communicated their beliefs while ultimately compromising on the final decision. Another example of compromise was in the final ten minutes of the task. The group had almost found the correct code to move the robot around the obstacle course but were struggling with the final element of the task. Although they disagreed about the measurements, they come to a compromise about how to proceed:

> Freya: Guys we need to keep moving. We don't have much time left
>
> C: Yeah ok I'll change it another 5cm
>
> Naomi: Are you sure we shouldn't do ten? I think it's more.
>
> C: No it's human error. It's being amplified by us slightly changing the position each time (of boxes).
>
> F: I think we should try 8. We don't have much time.
>
> N: Just do ten please?
>
> F: Aah we're wasting time.
>
> C: Ok it's close. I'll try 8 and then we can change it quickly.

V8 Pg8 L238-245

This interaction demonstrates how the group members effectively communicated their perspectives while also compromising on decisions. Collaborative contexts require individuals to compromise with other another in order to reach a consensus when problem-solving (Sun et al., 2020). The use of compromise in these contexts could be indicative of the management of emotions in oneself and others. Although both Naomi and Freya's tone of voices and facial expressions suggested that they were annoyed or frustrated when negotiating, they communicated effectively with their peers in order to reach a resolution. They did not "give in" to emotions but controlled them to reach a decision.

4.6.8 Synopsis of Thematic Analysis of Group Four

The themes and sub-themes identified in this thematic analysis address RQ1: To what degree can Emotional Intelligence Abilities be observed and assessed within Collaborative Problem-Solving Contexts? In this group, Cillian took on the role of the 'expert' as the individual with the greatest interest and experience of coding. He led with a democratic and participatory leadership style and involved others in decision-making. The consistent behaviours shown by Cillian could be indicative of well-developed abilities in the areas of emotional understanding and emotional management.

This type of leadership style also meant that the group communicated effectively with one another about problem-solving. Each group member displayed the ability to compromise effectively with others on key decisions. Compromising with others requires an individual to manage their own emotions in order to achieve a desired goal. It also requires an understanding of how other individuals may react to a suggestion or idea that they do not

agree with. The results of this analysis suggest that the type of leadership style shown has an impact on the types of AEI abilities that can be observed in particular collaborative contexts.

4.6.9 Comparative Analysis of Group Four and Group Eight

The types of behaviours that were related to the observation and assessment of AEI abilities differed in Group Four and Eight. Firstly, the type of leadership style appeared to impact the behaviours of other group members. A decision about the delegated leadership role not made explicitly, but implicitly in both groups. In Group Eight, a more dominant type of leadership style was initiated by Jane, whereas a democratic participatory leadership style was used by Cillian in Group Four. Firstly, this leadership style provided an insight into the emotional management and understanding abilities of both Cillian and Jane themselves. Cillian maintained a calm emotional state throughout the task, consulted on all decisions with his group members and encouraged their participation in the task. This would suggest that he had a developed understanding of how to manage and understand his own and other's emotions (Mayer et al., 2016). In contrast, Jane implemented a system of turn-taking which others expressed dissatisfaction at. Her "bossiness" was noted by others as a factor that impacted their enjoyment of the task. This may suggest that she had less well developed abilities in understanding the emotions of others (Mayer et al., 2016).

The responses of group members to the leadership styles that were used by Cillian and Jane also appeared to be indicative of the use AEI abilities in the areas of emotional understanding and emotional management. In Group Four, expressions of dissatisfaction at the turn-taking system indicated that group members identified emotions in themselves and others which represents an ability of the understanding emotions branch (Mayer et al., 2016). Due to the turn-taking system implemented by Jane, group member Emma found components of the task

boring. Her response to this emotional state was to initiate significant off-task conversations with her peers. This behaviour could suggest that she had less well-developed abilities in the area of emotional management (Mayer et al., 2016). In contrast, group members in Group Eight remained focused throughout the task and communicated frequently when decision-making. This led to the observation of effective compromise between group members, a behaviour which requires an individual to understand and manage emotions. The observation of these themes in the data suggests that AEI abilities can be observed and subsequently assessed in CPS contexts (RQ1). Contrasting leadership styles can lead to the observation of different behaviour in group members.

The results of this thematic analysis also have relevance for RQ2. In Group Four, task difficulty appeared to elicit behaviours related to AEI. All four group members reported that the task was very challenging. Despite these beliefs, they displayed frequent events of persistence, where they continued to problem-solve in the face of task difficulty. Persistence requires an individual to understand and manage their own emotions in order to pursue a challenging goal or task.

4.7 Comparative Analysis Three: Individual Thematic Analysis

The focus now shifts to the first comparative analysis of one individual across a number of collaborative group contexts. It examines if behaviours related to emotional intelligence are consistent across the data or if they vary according to the situation that the individual finds himself/herself in. The focus of this comparative analysis is Rose, a female student who participated in three group tasks.

4.7.1 Pen Profile of Rose

Rose was a student with standardised test results in the low average range for both Maths and English. She presented as a respectful, polite and kind student in her classroom interactions. She appeared to enjoy working in group contexts, offered assistance and support to group members, but did not typically take on a leadership role on in group classroom tasks.

4.7.2 Thematic Analysis

Rose was selected for further thematic analysis because initial qualitative analysis indicated that she maintained the same pattern of behaviours across the groups that she was in. Table 4.3 reminds the reader of the tasks that she completed and the groups that she was a member of.

Table 4.3

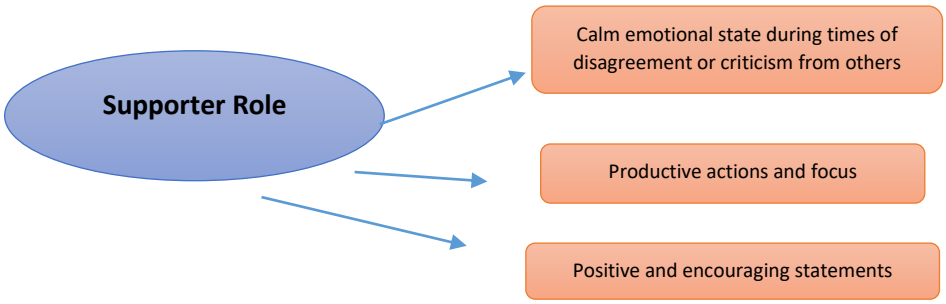
Individual Profile of Rose's Tasks and Groups

Group ID	Task	Group	Highly/Moderately Successful Group
2	*Hopper Challenge*	*Kate (K) Rose (R),* **Harry (H), & John (J)**	Highly successful
5	*Break-dancer Challenge*	*Rose (R), Anna (A),* **Trevor (T) & Ben (B)**	Moderately successful
11	*Super Clean-Up Challenge*	*Freya (F), Rose (R),* **Liam (L) & Harry (H)**	Moderately successful

All of the relevant codes that were applied to Rose's behaviours and interactions throughout these three tasks were organised into a theme and sub-themes. The sub-themes were related to the theme but had enough data and information to support their existence as distinct concepts in their own right (Braun & Clarke, 2006). As Figure 4.11 outlines, Rose consistently took on a 'supporter role' in the CPS tasks. She did not dominate or lead any aspect of the problem-solving process but supported all of her group members in tackling the problem. In this supporter role, she displayed a number of behaviours which were related to the use of EI abilities in the areas of emotional understanding and emotional management, the sub themes of which are outlined below in Figure 4.11. The first sub-theme refers to her maintenance of a calm and relaxed emotional state when faced with disagreement between group members or with criticism by others. The second centres on her consistent focus and concentration throughout the tasks and the third identifies how she uses affirmational statements to support others when making decisions or taking action. Each of these three sub-themes is discussed in more detail below.

Figure 4.11

Themes from Comparative Analysis across three tasks



4.7.2.1 Calm Emotional State during times of Disagreement or Criticism

The data indicated that Rose was consistent in her approach towards the management of disagreement or criticism in the three groups she was a member of. In Group 11's completion of the Super Clean-Up Challenge, Rose faced criticism from her group member Liam

(**GR11L)** five times over a period of six minutes. When she experienced difficulty inserting one of the pieces into the motor of the robot, he questioned her repeatedly using comments like "How hard can it be?", "Are you stupid?" (V15 Pg5 L135), "We've wasted time on this. How could you not get it?" (V15 Pg6 L152). Rose's reaction was a laugh while she then continued to try and insert the piece correctly. She also did not react verbally when group member Freya began to respond to Liam and asks him "Would you ever let up? I know you couldn't do it either"(V15 Pg6 L163). Later in the task the group struggled to identify the correct code in order to move the robotic grabber. When the other three group members disagreed and began to negatively criticise one another's ideas, Rose did not get involved. Instead she encouraged the group to look at the code again and try something a different method.

As mentioned in comparative analysis one, Rose also encountered a significant disagreement between her group members Trevor (**GR5T)** and Anna (*GR5A*) in the first fifteen minutes of the Break-dancer challenge. Throughout these verbal interactions between Trevor and Anna, Rose remained focus on the building aspect of the task. She did not respond verbally to either individual but continued to complete her component of the robot. A similar behavioural pattern was observed during the Driver Challenge with Group Two. The disagreement in Group Two was largely focused on the task and ultimately assisted the group in successful task completion. However, there were five points when group member's voices were raised in discussion and their facial expressions were interpreted by the researcher as those of frustration, annoyance and concern. In these instances, Rose remained in a calm emotional state. One illustrative example was when John (**GR5J)** requested that Rose should return to the classroom and find measuring tape:

J: R will you go get tape so we can mark..?

R (interrupts): No, no, no. We have a ruler.

J: I know, but we also need tape so we can mark where our route is starting from.

K: Yeah not like measuring tape.

J: Just get any tape.

R leaves to go and get the tape.

The researcher observed that Rose's interruption of John suggested some level of frustration with the request. Her facial expression also quickly changed from that of annoyance (as interpreted by the researcher) to a smile. This data analysis indicates that Rose's behaviours were consistent across different group contexts. It is possible that this behavioural pattern could be because of well-developed abilities in the area of emotional management. Individuals who are able to connect or disconnect from an emotion depending on its usefulness in any given situation typically have well-developed AEI (Mayer et al., 2016). They are able to manage their emotions effectively in disagreement or conflict situations. Rose was skilled at managing and disconnecting from any emotions which would not have assisted the group's completion of the task. Very little literature has addressed this area. While a small number of studies have correlated EI and an effective conflict handling style (e.g. Jordan & Troth, 2004; Valente & Lourenco, 2020; Winardi, Prentice & Weaven, 2022), the majority of these have used the trait model of EI, rather than the ability model used in the present research. There is also a significant body of literature which has demonstrated a correlation between certain personality traits and the way with which a person typically manages conflict (e.g., Tehrani & Yamini, 2020; Wood & Bell, 2008). When Rose discussed her participation in the whole-class reflections, she did not make reference to the management of disagreement or her reaction criticism from others. Therefore, in this case,

there was no direct insight from the participant about the internal processes which guided their external observable behaviour.

4.7.2.2 Productive Actions and Focus

Rose took on a supporter role in the three tasks. Unlike other children who generated ideas, made decisions and questioned other's plans, she provided practical help and support. In two of the child class reflection (Task 2 & 3), Rose reported that the coding elements of the task were challenging and she sometimes found them hard to follow. Despite this, she did not initiate or engage in off task behaviours such off-topic discussion, looking out the window or playing with other Lego pieces. Although her contributions did not explicitly guide the higher-order problem-solving aspects of the task, they did keep the group on task and focused on the next step. In Group Two, the Driver Challenge, Rose was an active 'builder' in the initial stages of the challenge. She took her turn building a component of the robot and followed the instructions carefully on the iPad. In the second more complex half of the challenge, Rose's attention remained consistently focused on her group members, the robot and the iPad. She also offered assistance to the group in others ways. When John began coding, Harry **(GR2H)** suggested that "We need to get the boxes ready for the route" (V6 Pg1 L31). Rose immediately began to move and plan out the route with the boxes. In minute seven of the video recording, they succeeded in finding the 'perfect' measurement for a section of the course. When Kate *(GR2K)* exclaimed "It's the perfect measurement!" (VR6 Pg5 L131) Rose immediately generated the idea to write down the measurement in order to have a written record for future reference. She responded "What is it? Ok I'll write it down so we don't forget!" (VR6 Pg5 L132) and she continued to note the different measurements that the group brainstormed for the next five minutes. When John and Harry suggested in minute

14 of the task that someone needed to stand at the end of the table in case the robot falls off, Rose immediately volunteered for the role.

Similar behaviours were shown by Rose in Group Two, the moderately successful group who completed the Break-Dancer Challenge. In this group, the decision making and actions were guided by two dominant group members, Anna (*GR5A*) and Trevor (**GR5T**). However, Rose reminded the group to proceed to the next step and encouraged them to take action at six points in the video recording. Examples of phrases that she used include like "Ok next step.." , "We need to set a code now. Let's get started", (V9 Pg3 L80), "I have the cubes that we need from the box. Whose turn is it?" (V9 Pg1 L28) and "We have the motor ready. So whose turn is it to take the bits out?" (V9 Pg3 L90). She interjected at points when there was indecision about what to do next and guided her group members to take action. Rose's behaviours in Group Eleven mirrored those of the previous two groups and she maintained a productive disposition throughout the task. Although she did not offer suggestions or methods to solve the problem, she did took action in a similar supportive role. The higher-order planning and decision-making was then led by the dominant group members across the three tasks.

The question of whether Rose's ability to remain focused on and interested in the task was related to her use of AEI is complex. This behavioural pattern could be indicative of well-developed abilities in the emotional management branch of the AEI model. MacCann et al. (2020) identified a significant correlation between AEI and academic performance on a range of cognitive tasks. The effect was larger for understanding than management, but not significantly so ($\rho = .35$ versus $\rho = .26$) and was equivalent after considering the effects of intelligence and personality (partial $\rho = .22$ in both cases). That is, both emotion understanding and emotion management may have a role in a student's academic performance. These researchers hypothesised that students with higher EI may be more adept

at regulating the negative emotions such as anxiety, boredom and disappointment involved in academic performance. These arguments align with the behaviours which were displayed by Rose in throughout these tasks.

4.7.2.3 Positive and Encouraging Statements

In the video recordings of all three tasks, Rose made positive and encouraging statements when a group member succeeded at a component of the problem or when they overcame some sort of difficulty in the task. In the case of her contributions to Group Eleven, she offered positive praise and encouragement to her fellow group member Liam even after he criticised her own efforts at the task in the early stages of the video. In the course of the 33 minute task, she positively affirmed his decisions and actions at six points, using statements like “That’s good”, “Well done”, (V15 Pg3 L45-46), “Oh cool you got it working” (V15 Pg4 L1)and “I think you’re right about that” (V15 Pg6 L132). Her tone of voice was observed as upbeat and she smiled when she made each comment.

In a similar vein, she praised all three members of Group Two during the Driver Challenge. In a time period of twenty five minutes, she offered verbal encouragement six times. For example, she verbally reassured Harry and John that they are “close to getting it” and to “keep trying” (V6 Pg4 L94) when they were struggling to create a successful prototype for the obstacle course in the 15th minute of the process. She reassured Kate that “it looks great” and says “No you’re right, put that in the motor”, when she expressed concern that she is “doing the wrong thing” (VR6 Pg5 L140-143). She offered similar contributions in Group Five, particularly to the two dominant group members Anna and Trevor. In this case, she praised the group for getting back on task at five points in the minutes after the disagreement ends.

Although the use of positive statements was not unique to Rose in group contexts, her use was consistent the three group contexts. In the child class reflection for Task 3, the researcher documented a number of observations about Rose's reflection on the task. She noted that Rose said "Lego was hard" and that encouragement of group members was important because "it helps you" (referring to the person who the praise is directed at). This data analysis suggests that Rose may have used positive statements as a strategy to maintain and encourage a positive emotional state in her group members. Open-ended tasks, by their very nature, can produce emotions of frustration, because multiple solutions must often be trialled before success can be achieved. The use of encouragement and praise appeared to motivate and encourage students to persevere at an element of the task in this research. It could be interpreted that Rose's behaviours were indicative of her attempting to manage the emotions of other in order to achieve the desired outcome of successful task completion.

4.7.3 Synopsis of Comparative Analysis

These findings address both RQ1 and RQ2. Similar to the group analysis discussed above, the findings from the individual comparative analysis suggests that CPS tasks can be used as a medium through which AEI abilities can be observed and assessed. Furthermore, this individual comparative analysis highlighted the features of the CPS tasks which tended to elicit these AEI abilities. As described above, disagreement between group members was a defining feature which tended to give rise behaviours related to the use of AEI. In the case of this single comparative analysis, Rose's behaviours across three different groups indicated that she displayed consistent behaviours which point to well-developed abilities in the areas of emotional understanding and emotional management. She maintained a calm emotional state throughout times of disagreement or criticism, maintained focus on the tasks throughout and used positive and encouraging statements towards her peers. These findings suggest that in Rose's case, an assessment of her AEI abilities would be relatively consistent regardless of

the group context that she was placed in or the task she worked on. The implications of this finding for future research are reviewed in Chapter Five.

4.8 RQ3: How beneficial is an AEI framework in supporting the observation and assessment of AEI abilities in CPS tasks?

The aim of the third research question was to determine how beneficial the use of an AEI framework was in supporting the observation and assessment of AEI abilities in CPS tasks. In Chapter 3, the iterative process that was undertaken to design and develop the AEI observation framework was described and analysed. The process for creating the analysis framework can be summarised as (1) reviewing existing AEI literature and existing CPS frameworks (2) collecting observational data of children using AEI abilities in the classroom (3) creating behavioural indicators of AEI abilities (4) refining the framework through the process of data collection and peer reflection.

As previously described in Chapter Three, the researcher completed frameworks for 12 children in Groups Two, Six and Eight. The critical friend completed frameworks for three children, one in each of these groups. An interview was held with this colleague where she reported on her ability to understand terms, use and score all of the dimensions of the framework. In order to assess the inter-rater reliability of the researchers on the framework, the percent agreement statistic was used. Some of the challenges met in the process of data analysis are discussed further in Chapter Five when outlining the implications of this research for future studies in the area.

4.8.1. Ease of Practical Use

Both the researcher and critical friend noted both practical benefits and challenges with the framework's use. In order to provide an illustrative example, Table 4.4 provides four collated

frameworks that were completed for Group Six (Olivia, Isabella, Conor & Liam) when they worked on the Break-dancer challenge (Task 3). The key for the behavioural descriptors is included before the table and is described in detail later in this section. In the first two columns on the left-hand side of the framework, the relevant branch of Mayer et al.'s (2016) model is included, followed by a relevant emotional ability from this branch. For example, the ability to *label emotions and recognise relations amongst them* is from the Understanding Emotions branch. In the next column, the corresponding numbered behavioural indicator is then detailed which includes examples of language that may be used by the group member. For example, the behavioural indicator of the ability to label emotions is when the child makes reference to their own or other's emotions. The following columns are used to record the information observed by the researcher under each child's name. For the purposes of clarity in this writing, the abilities from the AEI model are italicised when referred to in the following sections. Behaviours that were included in the framework are noted in bold.

Figure 4.4

Completed Frameworks for Group Six

Frequency:	✓ every time behaviour is displayed	Intensity
Duration:	< 30 seconds = * 30 seconds - 1 minute = ** >1 minutes ***	Not engaged with this ability Somewhat engaged in ability e.g. listens but can get distracted Fully engaged in use of ability

Branch of AEI Model (Mayer et al., 2016)	**Emotional Abilities arranged from the simplest to the most**	**Corresponding Behavioural Indicators Relevant to Successful Problem-Solving in Lego STEAM Tasks**	**Conor**	**Isabella**	**Liam**	**Olivia**

	complex (Mayer et al., 2016)					
Understanding Emotions (in oneself and others)	i. Label emotions and recognize relations among them	**Makes reference to their own and other's emotions throughout the task** **For example:** **Phrases used to indicate positive emotional state** This is actually fun. **Phrases use to indicate negative emotional state** • This is so hard/annoying • This isn't working. Why isn't it working?	✓✓✓ * X 3 	✓✓ * X 2 	✓✓✓ (negative annoyed by others) * ✓ (yay when succeeding) * ✓✓ this is so hard * ✓ that's cool * ✓ oh no! * 	✓ *
	ii. Determine the antecedents, meanings, and consequences of emotions	• **Listens to others opinions, asks questions and talks through the process of problem-solving.**	✓✓✓✓✓✓✓✓ ✓✓✓ *** (x 11) 	✓✓✓ ** (x 3) 	✓✓✓✓✓✓✓✓✓✓ *** (x 10) 	✓✓✓✓✓✓ *** (x 6)
		• **Displays empathy verbally or with body language** **Body Language Indicators used** • Smiles • Laughing with the person when they make mistakes • Fist pumps, high fives/hugs/arm around the person • Sympathetic facial expression **Common phrases to display empathy** • No that was good. • Keep going. • Well it was really hard, don't worry about it • Sorry I didn't know what you meant	✓ * ✓ * 	✓* ✓ * 	✓ ✓ (only with member of group who is his friend) * x 2 	✓✓ * x 2

	iii. Appraise the situations that are likely to elicit emotions	• **Maintains group cohesiveness by offering assistance to other group members encountering difficulty** • **Manages conflict**	✓ ✓ ** x 2 ✓ ✓ ** x 2	✓ ** ✓✓✓ *** (x 3)	✓ ✓✓ ✓ ** x 4 ✓✓✓ *** (x 3)	✓✓✓✓ *** (x 4) *** (x 3) ✓✓✓
Managing Emotions (MG) **(in oneself and others)**	iv. Effectively manage one's own emotions to achieve a desired outcome (self-regulation of emotion)	• **Accepts making mistakes/handles being corrected by others**	✓✓✓ ✓ * (x 4)	✓✓✓ ** (x 3)	✓ ✓ ✓ * (x 3)	✓✓✓✓✓ * (x 5)
		• **Consistently focused on task (not distracted by off-task behaviour like chatting/other groups working)**	✓ ✓✓ *** (x 3)	✓ ** ✓ ** Distracted for large amount of task	✓ ✓✓✓✓✓ *** x 6	✓ for full 35 minutes
		• **Persists even when encountering challenges and tries new methods to solve problem**	✓✓✓✓ *** (x4)	✓ **	✓ ✓✓✓✓✓ *** x 6	✓✓✓ *** x 3
		• **Uses self-regulation abilities to manage conflict/negative emotions/disagrees without having an argument (reaches compromises/is patient with others)**	✓✓ ✓ ✓ ✓ ** (x5)	✓ ✓ ✓ *** x 3	✓ apologises when he says something ✓ taking turns conflict *** x 2	✓✓✓✓ *** x 4
	v. Effectively manage other's emotions to achieve a	• **Uses positive language and encouragement to ensure others remain focused and motivated to complete task**	✓ (keeps situation calm) ** ✓ ✓ ** (x 2)		✓ ✓ • X 2	✓✓ * x 2

	desired outcome					
		• **Divides workload and negotiates roles (prevents conflict and frustration in others)**	✓ (tries to divide workload even when other child is resisting) ** ✓ (you guys can do this bit) ** ✓✓ *** (x2)	✓✓✓ *** x 3	✓ - does so reluctantly ** ✓ less reluctantly as task goes on *** ✓ gives up Ipad to person who has idea ***	✓✓✓ *** x 3

As Table 4.4 details, the ✓ symbol was used to document the frequency of each of the behaviours included in the framework. In some cases, samples of language used by the child were also included to add depth to recorded observations. For example, in this group all members made reference to an emotional state at least once (the ability to label and recognise emotions in oneself and others). Conor made three references, Isabella made two, Liam made eight and Olivia made one. Examples of language used by the children to express emotions included “This is so hard”, “Ah no!” and “Yay” when celebrating success. Both the researcher and critical friend found this aspect of the framework relatively straightforward to use. The critical friend reported that the behavioural indicators were clear, easy to understand and that they were a way of quantifying social and emotional behaviours which were typically difficult to assess. The use of an additional PC monitor with a laptop assisted the process because the observer could watch the video on one modality and complete the framework on the other. The framework therefore assisted in numerically recording the frequency of behaviours related to AEI abilities, as well as providing a structure on general observations.

As well as recording the frequency of behaviours, the duration of time for each behaviour was recorded. A symbol system assisted in documenting the length of time observed. Behaviours less than 30 seconds were recorded with one star (*), those between 30 seconds and one minute were symbolised with two stars (**) and those that were longer than one minute were recorded as three stars ***. Less complex behaviours related to emotional recognition and labelling were frequently recorded as less than 30 seconds. For example, making reference to an emotional state typically took less than ten seconds. Displays of empathy were generally recorded as less than 30 seconds as children used a phrase or a facial expression to convey emotional understanding. In Table 4.4, Conor was observed making reference to emotions three times. As these three instances were less than 30 seconds this was documented as * x 3 with the one star used as the symbol for less than 30 seconds.

More complex behaviours like the management of conflict were repeatedly longer in duration. As Table 4.4 outlines, four behaviours which reflected the self-management of emotion were included in the framework: **the acceptance of correction from others and acceptance of making mistakes, focus on the task, persistence during challenging times** and the **self-regulation of emotion with others through compromise**. In Group One, Liam was recorded as the most persistent of the group, with six events lasting more than 1 minute, Conor was next with four events which were longer than one minute, followed by Olivia who had 3 instances where she displayed persistence that were longer than one minute. On the other hand, Isabella was recorded as being persistent once throughout the task and this display of persistence lasted between 30 and 60 seconds. The group members varied again when it came to using their self-regulation abilities to reach a compromise with others. Conor displayed five instances of compromise with others which took place over 30-60 second time periods. Olivia displayed four instances of compromise which were longer than one minute while Isabella had three, all also lasting longer than one minute. In contrast, Liam had two

instances of compromise, both lasting between 30 and 60 seconds. The addition of duration into the observational framework was successful as it allowed for a more thorough picture of the children's use of abilities to emerge. The above descriptions suggest that Isabella appeared to lack persistence throughout the task while Liam found compromise difficult or chose not to use it. However, the addition of the duration meant that completion of the framework because a more arduous process. Both the researcher and critical friend had to pause the video recording at multiple points in order to correctly document the correct time duration of a behaviour. This added considerable time to the overall process of observation and made the framework more challenging to use. Future users of this framework would need to reflect on whether the benefits of recording time duration outweighed the additional time for completion, an aspect which is discussed in greater detail in Chapter Five.

The final component of the framework was the use of a 'traffic light' system designed to observe the intensity of the behaviour in question. A red circle was used when a child did not engage with the behaviour, a yellow when they were somewhat engaged and a green for when they were fully engaged. The record completed for the frequency of behaviours informed the choice of colour for each AEI ability. If there was no recorded observations, a red traffic light was allocated. If there were between 1 and 3 behavioural frequencies observed, a yellow traffic light was used. For greater than three frequencies a green traffic light was used. For example, in Table 4.3, Group Eight's engagement with the behaviours linked to the ability to *effectively manage other's emotions to achieve a desired outcome* varied across the members. Two behaviours were used as indicative of this ability: **the use of positive language and encouragement to alter other's moods** and **the division of roles and responsibilities within the group**. In relation to the use of positive language, three of the group members received a yellow symbol because their behavioural frequencies were between one and three. The fourth group member, Isabella received a red symbol because she

was not recorded as using positive language at any point in the task. As Table 4.1 outlines, both Conor and Oliva were categorised as fully engaged with the division of workload indicator because their behavioural frequencies were higher than three, whereas Liam and Isabella were categorised as somewhat engaged with the behaviour, receiving a yellow symbol. In terms of practical use, both the researcher and her colleague reported that this system was quick and accessible way of including engagement in the framework. It provided a visual indicator of a child's engagement and use of a particular behaviour, which could be interpreted with ease by an external observer. This was highlighted as a positive particularly if the purpose of the framework was to provide formative feedback to the group member. Both the researcher and her colleague felt that the use of the frequency criteria appropriately matched the engagement level of the child, in that a recorded frequency of four or higher was reflective of a child who fully engaged with a particular behaviour. However, future use of this observation protocol may require greater exploration of these parameters, particularly if the framework was to become a valid and reliable assessment tool in more standardised settings.

Overall, the AEI observation framework assisted in the observation of AEI abilities when children were working on Lego Spike Prime tasks. The main challenge in its usability was the time consuming nature of the process. Both researchers needed to pause and restart the video many times in order to adequately record the duration of behaviours. Consequently, it would be difficult to complete the framework during a task without the addition of an available video recording for post-task analysis. Despite these challenges, the critical friend had little difficulty learning to use the framework and she was confident in determining the frequency, duration and engagement with behaviours. These findings indicate that the tool could have potential as a usable and practical tool in the future assessment of AEI abilities in CPS contexts.

4.8.2 Scope of Observation Framework as Assessment Tool

Ensuring good reliability and validity in observation assessment tools is challenging for any researcher (Maxwell, 2012). Behavioural observation tools are particularly difficult because they assume that the observer knows precisely what the subject is doing. Validity means that the trustworthiness of data interpretations are directly related to the methodological and analytical processes of the project (Maxwell, 2012). Good reliability protocol certifies that observations will be consistent across time or assessors. Both are linked in that without a valid protocol for the observation of behaviours, the reliability of the measurement tool is not useful. In this section, the strategies used to establish initial construct validity of this novel framework are first described. Construct validity is defined as the degree to which a test measures the concept that is was designed to evaluate (Maxwell, 2012). Subsequently, some initial evidence on the inter-reliability of the framework is presented. These are the initial first steps which can provide guidance for future researchers in the area of AEI assessment.

4.8.2.1 Evidence of Validity of Framework

The construct of validity has received considerable attention in qualitative methods literature (Gardner, 2000; Maxwell, 2012). Much of the attention has been focused upon the issue of whether qualitative interpretations accurately represent the meanings and opinions of the participants. Qualitative researchers must attempt to protect against the various ways in which their research analysis could be misleading. Maxwell (2012) calls this “validity threat” and makes several recommendations for ways in which researchers can protect against these validity threats, several of which are used as evidence of construct validity for the AEI framework:

1. Prolonged Engagement: Research conclusions are more credible if they are the result of repeated observations. As previously described in Chapter Three, the researcher engaged in a sustained eight week period of observation whereby she compiled reflective notes on the types of behaviours observed when children were working on collaborative classroom tasks. Additionally, the behaviours included in the framework were derived from a systematic review of AEI literature, assessment literature and educational research.
2. 'Rich data': Researchers should plan to collect 'rich' data to get a full picture of what is happening in the observations (Maxwell, 2012). Observers may be skilled at capturing all that is happening during an observation, but observations supported with audio or video recordings, as is the case in this research, allow researchers to go back and reexamine what the observer documented.
3. Member Checks: Validation by the individuals being observed, otherwise known as 'member checking', ensures that the conclusions of the observer match what is actually happening during the observation. The use of child reflections and focus group interviews allowed for children to reflect on the abilities that they used while working on the CPS tasks.
4. Triangulation: The first research questions addressed in this Chapter were related to whether AEI abilities could be observed and assessed in CPS contexts. These questions were addressed using thematic analysis of the video recordings, in tandem with observational notes by the researcher and the reflections of the children on the tasks. The results of the thematic analysis from multiple data sources suggested that children used behaviours which could be indicative of the use of AEI. The majority of the behaviours discussed in the thematic analysis can be linked to the behavioural

indicators that were included in the framework which was devised before this process of thematic analysis began. This is unpacked further in Chapter Five.

Validity is a constant struggle in qualitative research (Maxwell, 2012). In this research, the strategies employed will require further validation in future research.

4.8.2.2 Inter-Rater Reliability

As outlined by Cheung & Tai (2021), inter-rater reliability (IRR) is a statistic commonly reported by quantitative researchers to indicate the extent to which raters' scores are consistent between different items of a scale being measured. In qualitative research, the term is often inter-changed with intercoder reliability which is calculated based on the extent to which two or more coders agree on the codes applied to a fixed set of units in qualitative data (Cheung & Tai, 2021; Kurasaki, 2000). In this research, one way to establish initial reliability was to examine the level of agreement between the primary researcher and her colleague on the types of behaviours that they observed in children when completing the AEI observation framework. The following three tables include a calculation of IRR on the framework that were completed for three children by both researchers. In the first left-hand column, the behavioural indicators are numbered in the order that they were included in the framework. The frequency of these behaviours as observed by both the researcher and critical friend is then included. If the researchers reached consensus on the behaviours observed, a ✓ was recorded, while an X was used if they disagreed. The level of percent agreement was calculated by totalling the number of agreements and dividing it by the total number of possible agreements. In the case of Table 4.5, the researchers agreed on 5 of the 11 indicators when completing the framework for Conor from Group Six. This gave a percent agreement of 0.45. As noted by Gwet (2014), per cent agreement figures of less than 0.45 are classified as unacceptable. The level of agreement would therefore be classified as too low in this case.

Table 4.5

Recorded Observation of Behavioural Indicators for Conor (Group 8)

Behavioural Indicators of AEI	**Observations Recorded by Researcher**	**Observations recorded by Critical Friend**	**Agree?**
1	3	3	✓
2	11	12	X
3	2	2	✓
4	2	2	✓
5	2	2	✓
6	4	3	X
7	3	5	X
8	4	2	X
9	5	4	X
10	3	3	✓
11	4	3	X
			5/11 = 0. 45

The second table, Table 4.6, details the results for student Jane who was in Group 8 and completed Task Three, the Break-Dancer challenge. In this case, the per cent agreement was calculated as 0.64, which would also be classified as unacceptable inter-rater reliability.

Table 4.6

Recorded Observation of Behavioural Indicators for Jane (Group 8)

Behavioural Indicators of AEI	**Observations Recorded by Researcher**	**Observations recorded by Critical Friend**	**Agree?**
1	4	4	✓
2	5	5	✓
3	1	1	✓
4	2	2	✓
5	2	2	✓
6	2	3	X
7	3	2	X
8	2	2	✓
9	4	2	X
10	4	3	1
11	5	5	✓
			7/11 = 0. 64

The final table, Table 4.7 details the observations carried out by the researcher and critical friend on Kate (Group 2) who was working on Task 2, the Driver Challenge.

Table 4.7

Recorded Observation of Behavioural Indicators for Kate (Group 2)

Behavioural Indicators of AEI	**Observations Recorded by Researcher**	**Observations recorded by Critical Friend**	**Agree?**
1	7	7	✓
2	13	10	✓
3	1	1	✓
4	6	6	✓
5	1	1	✓
6	7	6	X
7	7	7	✓
8	10	8	X
9	8	8	✓
10	7	7	✓
11	2	2	✓
			9/11 = 0. 81

The percent agreement between the researchers was 0.81 for Kate which would be considered satisfactory. The use of inter-reliability measurement, using per cent agreement is not to verify the framework as a reliable instrument tool that is ready for use by assessors. It is to highlight that there were both consistencies and discrepancies in the observation of behaviours by the researcher an and critical friend that would need further rigorous analysis before the tool was to be used as an assessment tool. Upon examining the three tables above, the researchers appeared to reach consensus on some items more than others. For example, they consistently observed the same frequency of behaviours for the reference of emotions in oneself of others, **offering assistance to other group members encountering difficulty, displaying empathy with body language or verbally** and **listens to other opinions, asks questions and talks through the process of problem-solving.** It is possible that these

behaviours were more straightforward to observe as they were more “obvious” and easier to identify than others in the framework. It is also possible that the researcher and the critical friend interpreted the other behavioural indicators differently because their prior knowledge of the children or of the theory of AEI varied considerately, an element which is discussed further in Chapter Five.

4.8.3 Conclusion

This framework was developed to explore if an observational tool could assist in the assessment of AEI abilities during CPS contexts. It represents a new form of assessment in the area of AEI which has largely relied on text-based tests. It provides an initial step from which further research can be undertaken. Further developments in the use of AEI in authentic real-life contexts will inform the development of valid behavioural indicators. Taken together, the results of the items across the three videos indicate some variation in how the framework was completed by the two researchers, an issue which future research will need to investigate. Instruments may have varying levels of validity regardless of the IRR of the instrument (Cheung & Mai, 2012). The framework may have good IRR but poor validity, even if coder’s scores are highly similar. The framework must properly represent the construct it is intended to measure, in order to ensure that good decisions about AEI can be made of the basis of data collected from this instrument. As outlined in Chapter Three, a rigorous procedure was followed when creating the behavioural indicators of AEI for the framework. This study therefore provides a strong indication that the framework can measure AEI. However, further research will need to be carried out in this area, an issue which is discussed in detail in Chapter Five.

Chapter Five: Discussion and Conclusions

5.1 Introduction

In the last number of years, interest in Ability Emotional Intelligence (AEI) has grown in both organisational and educational settings (e.g., Freudenthaler & Neubauer, 2017; Kim, 2020; Qualter et al., 2019). This is largely as a consequence of the substantial body of literature which has reported significant correlations between measures of AEI and a variety of positive outcomes, including high academic and job performance (e.g., Ayub et al., 2021; Fernández-Berrocal & Extremera, 2016; MacCann et al., 2020; Skordoulis, 2020). Mayer, Caruso and Salovey (2016) propose four branches to AEI, each representing one problem solving area. From the most cognitively basic, to the more complex, they are: 1) perceiving emotion, 2) facilitating thought using emotion, 3) understanding emotions, and 4) managing emotions (Mayer et al., 2016). Mayer et al. (2016) describe between five and eight types of reasoning or abilities within each branch, which are concisely summarised here. Perceiving emotion refers to recognising emotions in oneself, emotions displayed by others, and emotional stimuli in the environment. Facilitating thought using emotion involves deliberately using emotion to benefit thinking, such as decision-making, recollection, and reasoning, as well as choosing problems guided by currently experienced emotion. Understanding emotions relates to understanding about the source and relationship between emotions, including which contexts will result in particular emotions, and how cultures may vary in their appraisal of emotions. Managing emotions involves managing emotions within oneself and others to achieve a desired outcome, evaluating strategies to govern experienced emotion, and engaging or disengaging with emotions as required.

Current assessment trends in AEI centre on the use of text-based performance assessments which ask participants to solve problems that are related to emotions and contain answers deemed correct or incorrect. As discussed in Chapter Two, there are both strengths and limitations associated with the reliance on these types of measures. Firstly, they are useful in the provision of an overall score across the four branches of the AEI model. Additionally, they are relatively time efficient and do not require a manual correction system. While these are benefits for organisations who wish to assess AEI using a convenient approach, as argued by O'Connor et al. (2019), the question remains whether a test of emotional knowledge relates to how a person uses their AEI in their everyday life. According to Petrides (2011), the operationalisation of AEI is also problematic because of the subjectivity of emotional experience. Text-based assessments are also limited because they do incorporate elements that have been shown to influence emotional processes, such as tone of voice and body language (Davis et al., 2020; Lawson & Mayer, 2021). Another shortfall is that they do not assess AEI in the context of other skills or abilities which are relevant to work and educational settings.

In response, this study explored a novel type of assessment for AEI through the medium of CPS Lego robotics tasks. CPS differs from individual problem solving due to the communicative process that is involved. Chen et al. (2019) describe how the collaborative procedures comprise the social skills components of the construct, whereas the problem-solving elements require cognitive skills. CPS was selected as the medium of exploration for a number of reasons. As detailed in Chapter Two, there is a strong theoretical convergence between AEI abilities (Mayer et al., 2016) and the collaborative skills of CPS (Hesse et al., 2015). Consequently, it was likely that CPS contexts would elicit the use of AEI in individuals and that they may be some overlap between the social skills of CPS and the

mental abilities of AEI. Additionally, as CPS is considered as one of the vital 21st century skills, it has received substantial research interest, including inclusion in two international assessment projects; the PISA 2015 CPS assessment and the Assessment and Teaching of 21st century Skills (ATC21S).

Three research questions guided the study:

1. RQ1: To what degree can Emotional Intelligence Abilities be observed and assessed within Collaborative Problem-Solving Contexts?
2. RQ2: What elements of CPS tasks elicit the use of AEI abilities in children working on Lego Spike Prime Tasks?
3. RQ3: How beneficial is an AEI framework in supporting the observation and assessment of AEI abilities in CPS tasks?

Using a qualitative case study design, groups of 5th class pupils aged between 10 and 12 years of age were videoed while working collaboratively on Lego robotics tasks, using an assessment framework designed and adapted for the purposes of the study. Thematic analysis of these video recordings were complimented by running record observational notes completed by the researcher, child class reflections and three focus group interviews. This final chapter summarises and contextualises the findings in relation to the broader research landscape. The strengths and limitations of the study are discussed and the theoretical implications of the findings are reviewed. The penultimate sections contain a number of recommendations for future research. The chapter concludes with an epilogue.

5.2 The Observation and Assessment of AEI within CPS contexts

On the basis of this research, the findings indicate that it is possible to observe and assess abilities of AEI through the use of CPS robotics tasks. Three abilities of the understanding emotions branch and two abilities of the managing emotions branch were observed. However, the degree to which these abilities were directly observable varied. The majority of the abilities required interpretation of the implicit meaning underlying children's behaviour by the researcher. Additionally, varying group dynamics impacted the types of abilities that were observed.

5.2.1 Direct Observation of AEI Abilities

The first ability included under the understanding emotions branch is the ability *to label emotions and recognise relations among them* (Mayer et al., 2016). When children referred to or described an emotional state that they or others were feeling, it was interpreted as an explicit external indicator of the ability to label emotions. It was possible to directly observe and assess this indicator when children directly named or made specific reference to their own or others emotions. This was relatively straightforward to observe and assess while the children were working on the tasks.

However, it was more challenging to directly observe the second component of the ability, i.e.. their ability *to recognise relations among them.* The analysis of emotions is a hierarchical component of the understanding emotions branch (Mayer et al., 2016) in that it involves recognising the relationships between different emotions and how they relate to one another. For example, fear may turn to relief quite rapidly, or anger may turn to sadness given a

particular context. This aspect of the ability was more challenging to observe directly as it was latent and difficult to link to a verbal or non-verbal behaviour which could be recorded. It may be the case that specialist training is required to gauge an accurate assessment of this ability. However, there were other helpful ways that latent abilities may be deciphered through individual's behaviours and reflections. The following section outlines how many of the other AEI abilities were not inherently explicit in the data, but could be deduced from a thorough and systematic analysis of interactions between group members.

5.2.2 Interpretation of Latent AEI Abilities

More complex abilities of the understanding emotions branch could be inferred from the thematic analysis but, as noted in the previous chapter, they were not as explicit in the data. Similar results were found for the two abilities which were observed from the managing emotions branch, in that they required some interpretation from the researcher. These abilities required greater contextualisation of the latent causes of children's behaviour. For instance, the ability to *determine the antecedents, meanings and consequences of emotions* (Mayer et al., 2016) asserts that an individual can understand how their own and other's emotions will be deciphered by others, as well as the consequences that this will have on a given context (understanding emotions branch). A behavioural pattern in the data which indicated use of this ability was when children used encouragement and motivational statements towards one another. These types of statements were frequently used in response to a group member's expression of worry, frustration of anxiety about a portion of the task or a component of problem-solving. Individuals determined that these 'negative' emotions experienced by their group members could have a potentially determinantal effect on the group's progress. Typically, the use of encouragement or reassurance reinforced a positive emotional state in the other individual. This behavioural pattern was characterised as use of this ability because the child interpreted the meaning of other's expressions, as well as understanding the

potential consequences of their group member's expressed emotional state. The triangulation by design, and then, during analysis and interpretation provided other data sources that could verify the interpretations of the researcher. When data was drawn from the video recordings, it was triangulated with data from the child class reflections, running record observations by the researcher and, where applicable, with the data derived from the focus group interviews with children. This process facilitated the interpretation of latent abilities and added overall rigor to the conclusions that are drawn here.

5.2.3 Simultaneous Use of Multiple Abilities

There was also convergence between the behaviours which represented the use of abilities related to the understanding emotions branch and those that signified use of the abilities of the managing emotions branch. Data analysis indicated that the children employed a variety of AEI abilities simultaneously throughout many of the problem-solving tasks. Reaching effective compromise, for example, required an individual to *appraise the situations that are likely to elicit emotions* (understanding emotions branch), in order to respond in an appropriate manner to a fellow group member's idea or proposal. It also involved the ability to *effectively manage one's own emotions to achieve a desired outcome* when dealing with opposition or differing opinions from other group members (managing emotions branch). Furthermore, children often displayed the ability to *effectively manage other's emotions to achieve a desired outcome* when they negotiated compromise with their peers in this type of setting (managing emotions branch). The direct application of particular behaviours to specific AEI abilities is challenged by the overlap between the branches of emotional understanding and emotional management. The creation of an AEI assessment through the vehicle of CPS tasks would be relatively straightforward if each ability could be directly mapped onto one specific behaviour. However, this concurrent use of AEI abilities aligns with the theoretical model put forward by Mayer et al. (2016). AEI is not characterised by

sequential use of each of the abilities in the four branches but is dependent on the situation or the problem that the person faces.

5.2.4 Impact of Group Dynamics and Individual Difference

In groups that were classified as highly successful, there was a higher display of 'positive' behaviours related to AEI. These included effective compromise, a democratic leadership style, encouragement and flexible thinking. These were positive behaviours in that they assisted the group's effective completion of the task and maintained collaboration. In contrast, in groups that were classified as moderately successful, there were more frequent displays of behaviours that inhibited group productivity such as off-task discussions, disagreement and rigid thinking. These findings indicated that the type of AEI behaviours which were observed by the researcher were dependent on the group dynamics that emerged between the children. Furthermore, the broad range of behaviours which were observed across different group dynamics demonstrate that CPS contexts can facilitate the assessment of AEI abilities across a continuum of capabilities.

At times, particular behaviours or interactions that emerged within a group dynamic signified that children may have had less well-developed abilities in the branches of emotional management and emotional understanding. This was particularly apparent when significant disagreement occurred between group members. In contrast, positive group dynamics appeared to strongly facilitate the assessment of behaviours which related to well-developed AEI. It is important that an assessment medium facilitates the evaluation of those who demonstrate capabilities at the high, middle and lower end of a construct. In this case, the CPS tasks used facilitated the observation of capacities across a continuum.

It is also significant to note that there were some cases in which children's behaviours related to AEI remained consistent across groups and tasks. In the individual thematic analysis of one child's behaviours across three different groups, similar findings were reported for each of the tasks. These findings raise questions for assessment design in the area of AEI which is discussed below.

5.2.5 Key Conclusions

Findings from this study suggest that CPS contexts can indeed provide a vehicle to assess an individual's AEI. A wide array of behaviours, previously discussed in Chapter Four, and summarised above, were observed and interpreted as representative of AEI. As the first study to explore this type of assessment, these findings are an exciting step in this area. However, this type of AEI assessment is not without its challenges. Firstly, there are other factors which may influence behaviour and outcomes in collaborative settings. As discussed in Chapter Two, there has been ongoing debate in the literature about whether personality or intelligence is a stronger predictor of an individual's behaviour and their life outcomes. Measures of personality have previously been linked to CPS outcomes. For example, in a review of 47 papers by Jolić Marjanović et al. (2023), the authors reported that the traits of Conscientiousness and Agreeableness were consistently positively related to the quality of CPS interactions. An individual's disposition to collaboration in itself has also been found to influence their behaviour and performance in both human-human and in online CPS tasks (Graesser et al., 2018; Li et al., 2023). However, studies have not yet explored specifically whether AEI or personality has stronger predictive validity in CPS contexts. Given the latent nature of the construct, it proved difficult, at times, to distinguish conclusively between the types of behaviours that were indicative of AEI and those that may have been related to other individual difference factors.

An additional challenge was the reliance on the use of observational research methods. This poses a threat to the trustworthiness of a study as researcher bias and error can affect the strength of interpretations which can be drawn (White & Klette, 2024; White, Maher & Rowan, 2023). However, the extent and nature of the efforts taken to ensure that this research study was undertaken with appropriate rigor have been documented; in turn, this serves to underline the authenticity of both the findings and conclusions drawn.

A particular strength of this research was that the researcher had a preexisting relationship with the children who participated in the study, as well as significant background knowledge in the area of AEI. Notwithstanding the current researcher's familiarity with the case and triangulation safeguards implemented, it may be challenging for an external researcher, with little experience in the area of AEI, to face a group of individuals and attempt to assess the meaning behind particular interactions and behaviours. Training of assessors would therefore be an important part of this type of assessment in an organisational or educational context. The use of the observation framework, which is discussed in greater detail in Section 5.4, may also assist in providing a structure for future assessors in this area.

5.3 Assessment Design: Features of CPS tasks that can elicit AEI abilities

In relation to RQ2, three features of the CPS tasks were found to elicit the use of behaviours related to AEI and are outlined as follows: (1) the cognitive challenge involved, (2) the open-ended nature of the tasks and (3) the social challenges which were part of the collaborative processes.

5.3.1 Cognitive Challenge

According to the research literature, robotics learning experiences like the ones used in this research provide pupils with diverse challenging opportunities to apply new STEM knowledge and transversal skills through their collaborative development of solutions to complex, real-world problems (e.g. Anwar et al., 2019; Evripidou et al., 2020; Graffan, Shefield & Koul, 2022). The challenging nature of these tasks meant that children frequently exchanged ideas, discussed alternative methods and proposed solutions to issues that they faced in prototype design. The nature of the tasks also added an incentive for students because they were perceived as fun and relevant to the children's life experiences. When groups responded positively to the cognitive challenge, they typically displayed higher frequencies of behaviours which could be interpreted as positive indicators of emotional management and understanding, including flexible thinking and expressions of encouragement and reassurance. Within the theory of social constructivism, this level of task difficulty is often referred to as the zone of proximal development (ZPD). As Vygotsky (1978) explained, ZPD is "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). The collaborative nature of the tasks in this study meant that the majority of pupils were comfortable with the level of task difficulty. The sharing of perspectives and workload meant that no one person was responsible for the success or failure of the problem-solving process.

5.3.2 Open-ended Tasks

Nieminen, Chan & Clarke (2022) outline the importance of open-ended, or what are sometimes referred to as 'ill-defined' tasks, in CPS. Open-ended tasks can be differentiated from well-defined tasks in that there may be more than one correct way to solve the problem and the task may be developed further by changing the properties or characteristics of the original task (Hesse et al., 2015; OECD, 2015). When collaborative groups enter into an open-ended problem state, they are unaware of the actions that will guide them to the solution In this study, open-ended tasks were found to result in actions connected to AEI. Compromise when decision-making, disagreement between individuals and different leadership styles were behavioural patterns which emerged when group members worked on open-ended CPS tasks. When problem-solving collaboratively, group members were obliged to build knowledge and make decisions through shared interactions. Given the diversity of options that can present in an open-ended task, this can result in effective or ineffective compromise scenarios in which groups take on one individual's ideas and trial his or hers suggested path. What this study showed is that, if this is carried out effectively, group members display awareness of other's emotions and perspectives in a sophisticated manner. They exhibit flexible thinking in relation to their own and others' ideas of problem-solving processes. In contrast, it was also observed that rigid thinking about the course of the task can result in disagreement between team members, as was apparent in this research. As highlighted by Li, Poysa-Tarhonen & Hakkinen (2023), open-ended tasks also run the risk that individuals can become side-tracked. Discussions which lead to inaction can greatly hinder productivity and collaboration (Li et al., 2023). In this research, the inclusion of a time limit put an additional burden on groups. While this may hinder productivity, these 'side-tracking' behaviours were of interest in the current research as they often pointed to the use

of abilities in the emotional understanding and emotional management branches of the AEI model (Mayer et al., 2016).

5.3.3 Social Challenge of Collaboration

Problem-solving using cognitively challenging open-ended tasks is a complex process for an individual to undertake in a group (Li et al., 2023). Social challenges that are associated with working as part of a team create additional demands on an individual. In this research, these types of social challenges evoked interactions involving AEI abilities. As mentioned previously, in the initial stages of problem-solving, group members must establish a mutual understanding of the problem (Graesser et al., 2020). This requires members to socially engage in building and finding a common ground. In the case of this research, the mixed gender composition of classmates brought a variety of different experiences, temperaments and knowledge to the collaborative context. As the group progresses through the various problem-solving stages, they must achieve an agreed-upon solution to a component of the task that requires completion. Variations in understanding must be clarified and responsibilities must be distributed (Care et al., 2016). Negotiating and coordinating this agreement led to interactions which required the use of AEI abilities. In the course of these interactions, responses to disagreements between peers, responses to leadership styles and turn-taking systems that were put in place and responses to task difficulty all elicited various abilities of the understanding and managing emotions branches.

5.3.4 Conclusions

The selection of CPS tasks for inclusion in this research followed a rigorous process of review and piloting. Researchers in PISA and the ATC21S project followed stringent criteria

when considering how best to design tasks that would elicit use of CPS skills. These criteria provided guidance for the present research. The Lego Spike Prime Education tasks were used because: (1) they were collaborative in nature involving groups of two or more children (2) they were open-ended and were structured to elicit the four stages of CPS (3) they were not domain or subject specific which meant that all children had equal access to the content (4) the technological content was of interest to children of this age group (5) they were symmetrical in terms of status and resources in that all children had equal access to the resources available and there were no pre-defined roles within the group. Following an initial piloting process, the tasks were identified as adequately challenging and engaging this group of participants. There are many different types of tasks that can elicit collaborative skills in group settings (Hesse et al., 2015; OECD, 2013). The findings of this research suggest that the elements of task design described above elicited the use of both collaborative and AEI abilities in children and should be considered by future test developers when designing similar assessments. However, given the exploratory nature of the methods used in this research, future studies in this area are required to substantiate the research findings. Despite the strong empirical support linking CPS contexts and the observation of AEI, it cannot be asserted definitively that these features of the CPS tasks directly elicited the use of AEI. Creating links between behaviours and intelligence is not a straightforward process; hence the need for further research, suggestions for which are offered later in this chapter.

5.4 Use of the Observation Framework

In addition to examining the degree to which AEI abilities can be observed and assessed within CPS contexts and the elements of such tasks that elicit children's use of these abilities, this study sought to determine how useful or beneficial an AEI framework is as a research tool. Additionally, the inter-rate reliability of the framework was assessed using a calculation

of percent agreement. The main finding was that the framework was user-friendly when recording behavioural frequency and intensity. However, recording the duration of times of behaviours was a challenging and arduous process. Overall, the level of inter-rater reliability of the framework was low. The level of consensus between the researcher and her colleague was higher for some items rather than others. For example, the researchers consistently agreed on behavioural indicator one, *makes reference to their own and others emotions throughout the task,* but consistently disagreed on behavioural indicator six, *accepts making mistakes/handles being corrected by other.* The conclusions which are drawn from these findings are now discussed below.

5.4.1 Conclusions

The outcomes from this study suggest that there is merit in the use of an observation framework for the assessment of AEI in educational or organisational contexts, as opposed to written performance-based assessments. One of the main constraints of text-based performance assessments in AEI is that may not relate to how a person utilises their AEI abilities in any given context (Mayer et al., 2016; O'Connor et al., 2019). While they are useful in the provision of an overall score of an individual's knowledge in the area of AEI, the framework used here gives a picture of how an individual uses their emotional abilities within real-life settings. It would be particularly useful in the provision of feedback to individuals on how they could improve or develop their use of emotional abilities with others in group settings. However, as mentioned previously, observational methods have limitations in that it can challenging for an external observer to discern if a particular behaviour is indicative of the use of a latent construct such as AEI or if it could be attributed to a different internal or external factor. As mentioned previously, the researcher had an existing relationship with the participants in this study. This, along with another of other measures,

including data triangulation, assisted in the observation and interpretation of behaviours included in the framework.

In its current form, the process of the framework's development was based on the behaviours of children aged between 10-12 years of age. Given that AEI is an adaptable and developing intelligence, behaviours related to the abilities may present differently in adolescent (e.g. those in post-primary education), or adult populations (e.g. those undertaking credentialling tests or other workplace assessments). The thick description of the research context, including the participants, development of the framework and data collection will assist in transferring the findings of this study to other settings where this study may be replicated or adapted.

5.5 The Assessment of AEI Through CPS Tasks: Synthesis of Key Conclusions

The overarching goal of this study was to explore whether AEI could be observed and assessed through the medium of CPS tasks. This section synthesises the conclusions which were outlined in the sections above. Although it was possible to directly observe the use of one ability from the understanding emotions branch of the AEI model in the CPS tasks, in most instances, abilities from both the understanding and managing emotions branches were inferred from the interactions which took place between group members. Facial expressions, body language and dialogue all assisted in this process. The addition of other data sources, such as child reflections and focus groups, greatly supported the validation of interpretations which were made from the video recordings. Therefore, while CPS tasks were a successful mechanism through which AEI abilities could be observed and assessed, the strength of these observations and assessments were enhanced when reflective opportunities were provided.

This allowed children an opportunity to verbalise the cognitive processes behind particular behaviours or interactions.

The group dynamics which emerged between group members varied considerably and facilitated a richness of experience to emerge. In some groups, children displayed behaviours which suggested that they may have had less well-developed AEI, while in others, children displayed behaviours which suggested that they had more well-developed abilities. An additional strength of the CPS tasks used in this study is the potential they offered to assess a wide continuum of AEI abilities.

A number of caveats must be included with these conclusions. AEI is a complex construct and the study of emotions has generated complex and considerable debate in the literature. This complexity was reflected in the relatively low inter-rater reliability between the observed behavioural records of the researcher and her critical friend based on their use of the AEI observational framework. This result was not unexpected, however. Although there are some observable and measurable phenomena (e.g. facial expressions) that can assist in deciphering how emotions are being used in particular contexts, the process is not always straightforward (see Eckman, 2003). For example, Ekman distinguished between macro and micro facial expressions, with micro facial expressions much shorter in duration and often unconsciously displaying a concealed emotion. The use and observation of emotions in human beings is therefore multifaceted and this study has taken an initial positive step in attempting to develop the framework to observe and assess AEI. It is concluded that an AEI observation framework can assist in this assessment process, but it requires further development and refinement.

5.6 Theoretical Implications

In Chapter Two, the theoretical convergence between the social skills of the CPS model (Hesse et al., 2015) and the mental abilities of Mayer et al.'s (2016) AEI model was outlined. This present study has demonstrated that a number of the social processes involved in CPS also involve some element of AEI use in individuals. To remind the reader, a skill is categorised as a broad term which may include knowledge, attitudes and specific abilities. Skills are typically thought of as adaptive in that they are acquired through formal or informal teaching; they are not innate (Care et al., 2016; Hesse et al., 2015; Scott, 2015). Mental abilities, also considered adaptive, are defined as specific cognitive abilities that are used to solve a psychological task or solve a problem (Mayer et al., 2016). Skills are therefore broader and can encompass specific mental abilities. Three broad social areas are included in the CPS model: Participation, Social Regulation and Perspective Taking. Each of these areas is then divided into relevant specific skills.

For example, negotiation is a key part of the social regulation processes of CPS in reaching a compromise with others. As the findings of this study demonstrated, reaching effective compromises was one significant way in which AEI abilities linked to understanding and managing emotions could be observed. This aligns with findings from previous studies where correlations between high scores on an AEI measures correlated with higher scores on specific negotiation outcomes like establishing trust, the desire to negotiate again with the participant and overall satisfaction with the negotiation process (e.g., Kim, Kundiff & Choi, 2014; Mueller & Curhan, 2006; Pulido-Martos, Lopez-Zafra,& Augusto-Landa, 2013). Although there is a substantial body of literature that has examined the role of AEI in team work, the specific links between CPS processes and AEI abilities has not yet been explored.

The findings of this study suggest, firstly, that AEI abilities are used within CPS contexts and secondly, that AEI abilities underly some of the social skills included in CPS models.

In 2016, Mayer et al. (2016) published the latest updates and revisions on the AEI model, a number of which are related to the findings of this research. The authors emphasised that the four branches of the AEI model are related. For example, emotional perception assists in emotional understanding which subsequently assists emotional management (Mayer et al., 2016). As noted previously, the abilities appeared to overlap in collaborative contexts as individuals were often observed using abilities from both the understanding and managing emotions concurrently. Another significant revision of the 2016 paper the clarification that AEI can be 'positioned' amongst two other 'hot intelligences': social and personal intelligence. Hot intelligences serve as a broad term for any type of intelligence that relates to the processing of highly charged and personal information such as emotions, personality and social relations (Mayer et al., 2016). As previously mentioned in Chapter Two, evidence for the existence of both personality and social intelligence is relatively limited in the current literature and they are emerging areas of interest in intelligence theory. Mayer et al. argue that in the future social, personality and emotional intelligence may be incorporated under one broader model. However, they also believe that it "seems reasonable to keep them separate until such time as mathematical models indicate that models that nest them yield a superior fit" (2016, p.9). In the case of this study, some of the external manifestations of behaviours linked to AEI could also be connected to either personal or social intelligence. Indeed, one of the mitigating factors in the study was that personality and general social skills could be influencing behaviour, rather that specific AEI abilities. The findings of this study point to the need for further research examining how these different hot intelligences emerge through the collaborative interactions of groups members working on problem-solving tasks.

5.7 Implications for Educational and Workplace

Outcomes from the current study have clear implications for educational settings. In addition, the findings have implications for those focused on workplace/organisational assessments also e.g. Prometric, the funders of this study. Many countries are adapting curricula in order to transition from a knowledge-based approach to a skills or competency-based framework (Reynolds et al., 2020). Although terminology differs across countries and research and social contexts, there is a renewed emphasis on the importance of social and emotional skills in order for individuals to successfully live within varied and adapting economies and societies (OECD, 2019). An example from the Irish context is in the revised Junior Cycle curriculum at post-primary level where 'Working with Others' is one of the six key skills included in the curriculum framework. Pupils learn through subject areas but the main focus is on the development of these key skills through learning experiences in the classroom. 'Working with Others' involves the development of good relationships, dealing with conflict and learning with others. Additionally, there is a continued shift towards the use of formative assessment, in which the data inform future teaching and learning. Educational settings may benefit from the use of an observation framework such as the one designed for this study. It provides a medium by which AEI can be assessed in a classroom environment where students are working collaboratively. Most importantly, it can be used as a tool to provide feedback to students on their use of emotional abilities in group settings. While the collaborative task may be altered, the types of AEI abilities that would be observable may be similar.

Human relationships involving emotions play a role in many professions (including those of interest to Prometric). However, AEI has gathered particular interest across a number of

sectors where emotional abilities are particularly pertinent, including the military and the field of medicine. In nursing practice, numerous studies have demonstrated that well-developed AEI has an impact on both the professional experiences of nurses and the relationships with patients in their care (e.g. Dugue, Sirost & Dosseville, 2021; Raghubir, 2018; Raeissi et al., 2022). Similar findings have also been reported for doctors, with those scoring low on AEI more likely to experience burnout and to have less effective communications patterns with their patients than those who score high on measure of AEI (e.g., Cherry, Fletcher & O'Sullivan, 2013; Cherry et al., 2014; Jackson-Koku & Grime, 2019). Dugue et al. (2021) emphasise the potential need for greater training and development in the area of AEI for those working in the medical profession. The findings of this study demonstrate that an evaluation of AEI could, in theory, be integrated into an existing CPS task. They provide guidance on how an AEI assessment could be incorporated into an existing performance assessment used in medical education. For example, the Objective Structured Clinical Examinations (OSCE) are used in medical education because they allow a student to practice and demonstrate clinical skills in a standardised medical scenario that replicates a real-life problem. An external observer rates and scores the medical student on a range of competencies in communication, clinical reasoning and medical knowledge (Kakadia, Chen & Ohyama, 2021; Goh et al., 2019). OSCES have been used as high-stakes performance assessments and for the purposes of providing feedback to students in both undergraduate postgraduate medical education. This study has provided an overview of the types of behaviours linked to AEI that are displayed when individuals collaborate. The findings have the potential to inform the inclusion of an AEI assessment within an OSCE; albeit with significant adaptations. In order to achieve this, a number of steps would need to be undertaken including (a) the development of an CPS medical task which could be simulated in an examination setting; (b) adaptation of the behavioural indicators to reflect

those used by adults in collaborative professional contexts. Should such steps be taken, the findings from this research have the potential to make a significant contribution to comparable research in the medical field.

Similarly, assessment systems in the military frequently involve the simulation of a high-performance situation which can then be used to appraise the use of particular skills or abilities (De Armas, Tori & Netto, 2020). In a recent review on the impact of EI in the military workplace, Garcia Zea, Sankar and Isna (2023) discussed the significance of EI training in supporting military leaders' ability to cope with and manage stress and traumatic experiences. They suggest that supervisory performance assessments and EI training programmes should have a prominent role in the work life of military personnel. The findings could also be used to develop and integrate an evaluation of AEI abilities through a current assessment of other skills. An observation framework, similar to the one developed for this study, could be modified and refined to include behavioural indicators of AEI which are particularly relevant to military settings.

5.8 Strengths and Limitations

There are several strengths to be acknowledged regarding this research. Firstly, at the time of writing, this study is among the first to investigate the assessment of AEI through the medium of collaborative problem-solving. Previous work in AEI assessment has centred around the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) which was developed by the researchers responsible for the AEI model (Mayer et al., 2002a,b) and, more recently, the Situational Tests of Emotional Understanding and Management (MacCann & Roberts 2008). In contrast, this study centred on the observation and assessment of AEI in high-fidelity contexts that individuals face in the workplace or educational settings. When this project was

designed, it was unclear whether the observation and assessment of AEI would be possible in these types of authentic contexts. The results of the study suggest that there is indeed scope for the development of AEI assessments through CPS tasks. This study offers a valuable contribution because it details behaviours which can be linked to specific abilities of the AEI model, something which has not been done before in the ability model.

This study benefitted from the use of a case study design. Case studies have the potential to "retain more of the "noise" of real life than many other types of research' (Hodkinson & Hodkinson, 2001, p.3). In this research, it allowed sustained observation of participants working collaboratively in a variety of different group compositions, across a diverse range of tasks. This afforded the opportunity to analyse the contrasts and consistencies that occurred between groups, individuals and tasks in relation to the use of abilities in the areas of emotional understanding and emotional management. The use of video-based field-work was significant in that the researcher could analyse events and complex interactions between individuals retrospectively. This retrospective analysis, along with the triangulation of data sources, strengthened the quality of the interpretations that could be made on participants' behaviours.

This study is distinguished from other work in the area of AEI assessment through the design of an observation framework. The framework was designed to be used as a tool to observe and record the frequency, duration and intensity of behaviours related to AEI abilities that were used in CPS tasks. The design of the framework was an iterative process whereby the researcher engaged in significant and sustained periods of observation and revision for design purposes. The behaviours which were included in the framework were drawn from these sustained observations, as well as from relevant literature in the area. In practice, the

framework was relatively convenient and simple to use. Although literature from the area of Social, Emotional and Behavioural Difficulties was used when designing the framework, to best of the researcher's knowledge, this is the first tool of its kind to be created for AEI assessment and can serve as a prototype for future research in the area. Although additional research is required, this is an exciting first step in broadening the field of AEI assessment beyond traditional multiple-choice tests.

However, there are also several limitations of this study that need to be addressed. One potential limitation is that a sample of 28 students from one school is inadequate to provide the generalisation of results beyond this setting. Maxwell (2020) distinguishes between internal generalisation, that is, generalisation within a setting group or population, and external generalisation, which is generalisation to other settings, groups or populations. In the case of this research, internal generalisation to another school setting with a similar age range of children may be possible. However, external generalisation to adolescent or even adult populations is challenging because children between the ages of 10-12 may have developmentally different emotional abilities to adults or post-primary students.

Another limitation is the heavy reliance on the researcher's interpretation and selection of data. There were several advantages to being an 'insider-researcher', including a pre-established relationship with the participants and a greater understanding of the construct or culture being studied (Jacobson & Mustafa, 2019; Stahl & King 2020). However, greater familiarity can result in a loss of objectivity and can lead to issues of researcher-bias. In this case, it is possible that the researcher could have more likely to interpret behaviours as indicative of AEI because of a strong knowledge of the area and a desire to report positive results in the research. Despite the stringent procedures and the rigorous research trail that

was put in place in this study, the issue of researcher-bias should be acknowledged as a legitimate limitation.

The final limitation focuses on the reliability of the data derived from the AEI observation framework. The findings in this study provided an overview of the framework's utility as a practical tool as well as an analysis of the inter-rater reliability between the interpretations of the researcher and her colleague on three completed frameworks. However, this research did not carry out the typical statistical tests needed to verify the reliability of the framework as assessment instrument. Although this was beyond the scale of the present study, it was a limitation because the findings cannot fully address how beneficial the framework can currently be.

5.9 Recommendations for Future Research

In exploring the potential of CPS contexts for AEI testing, this study has contributed to the research literature pertaining to AEI assessment. Notwithstanding this contribution, this field remains largely dominated by studies which have used performance-based text assessments. More research in the area is necessary to achieve transparent conclusions about the value of this novel type of assessment over, or alongside, these performance tests. The limitations of this study, as well as some elements of the research problem that were not explored now direct the five notable recommendations for what may be addressed in the future.

It is recommended that new research projects should attempt to replicate the findings of the current study in other educational or organisational settings. The exploratory, case study approach employed here does not allow for the findings to be generalised to other contexts. As such, it remains unknown if behaviours related to the use of AEI abilities would be found

in post-primary, third-level students or indeed employees. According to Mayer et al. (2016) AEI is an intelligence that develops across the lifespan. However, there is little research available on the variation in AEI ability at different stages of child, adolescent and adult development. Using the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), Cabello et al. (2016) found that AEI varied with age, whereby younger adults scored lower than middle aged adults. A longitudinal study of women aged 65 and older reported that emotional functioning improved during a 9-year-follow-up period, from a median baseline of 0.65 to a median of 0.78 nine years later (Zaslavksy et al., 2014). Given this scant literature, it would be beneficial for future studies to explore if similar behavioural patterns would be witnessed in older populations of individuals working on CPS tasks.

A substantial volume of data was collected in this study, and as discussed in previous chapters, decisions regarding the inclusion (and omission) of data was determined by the extent to which they addressed the research questions posed. Hence, there are interesting data (for example, relating to the potential impact of gender on the types of AEI behaviours that could be observed and assessed during the CPS Lego tasks) that have not been fully explored in this research that may warrant further study. There is literature which has reported a gender difference in AEI, where women tend to score higher on the MSCEIT (e.g. Cabello et al., 2016; Fernández-Berrocal et al., 2012). This would suggest that females may have been more likely to display behaviours related to positive AEI. However, the type of task used may also mediate this effect. Women are largely underrepresented in STEM professions and gender stereotypes can play a role in how group members tackle a task (Moe, Hausmann & Hirnstein, 2021; Wu, Park & Dasgupta, 2020). Video data collected for the purposes of this research suggest that gender may play a role in the types of interactions that are observed in

STEM tasks, albeit this was not discernible across the data as a whole. Hence, the recommendation that future research be designed to investigate gender further.

A number of strategies were used in this study to address threats to validity, including prolonged involvement, triangulation and member checking. However, future investigations would also benefit from additional researchers, particularly in the data analysis stages. In this study, thematic analysis of video recordings was carried out by one researcher, with an additional colleague involved in the data analysis procedures which were related to the AEI framework. The involvement of a second or multiple coders in the thematic analysis of video recordings would produce rich data analysis. Including two or more coders in the coding process is a good step in providing inter-coder reliability, as well as inserting an additional level of scrutiny and rigor to the coding process through added perspectives of different researchers (O'Connor & Joffe, 2020). The interpretation of behaviours linked to emotional understanding and management by two or more researchers could add further weight to the findings of the present study.

Additional studies could build on the work that was completed by the researcher in this study on the design and use of an observation framework for AEI abilities in CPS tasks. High quality observational frameworks that work with older students and with adults in the workplace need to be developed and validated, not just in Ireland but across different countries and social contexts. Although a calculation of inter-rate reliability was carried out for three completed frameworks in this research, the per cent agreement between the researcher and her colleague was low. In its current format, the framework would be most suitable as an assessment tool whereby an educator or an employer could provide formative feedback to a student or an employee on their use of emotional intelligence in a group setting.

However, the instrument could be further developed as a high quality assessment protocol through additional statistical testing of, for example, its construct validity and inter-rater reliability. Data on its consequential validity (i.e. the impact of its use on test taking populations) might also be gathered. It may also be possible to explore the validity of the observation protocol and framework more comprehensively through some concurrent validation work with existing measures such as the youth version of the MSCEIT developed by Mayer and Salovey (see Rivers et al., 2012 for a review).

The platform through which AEI is assessed could be varied in future explorations. This research used CPS tasks from the Lego Spike Prime Education Kit in which groups built robots collaboratively, using a shared iPad for coding. There is a substantial and growing body of literature which has explored CPS processes using digital-based platforms rather than 'real-life' contexts as in this study (Andrews-Todd et al., 2020; Dindar, Järvelä & Järvenoja, 2020; Du et al., 2022). For example, Andrews-Todd & Forsyth (2020) designed a simulation-based task in which participants had to collaborative effectively to proceed through the designed levels. The participants collaborative interactions were through their actions on the task and through chat messages with each other. Given the significant role that digital platforms have in today's workplaces, a further study could explore the types of AEI behaviours that team members use when working collaboratively in this type of setting.

Finally, further studies could address the simultaneous assessment of CPS and AEI through one assessment tool. One possibility is that an external observer could complete distinct observation protocols for both CPS and AEI using retrospective analysis of video recordings. However, that would be extremely time consuming and an arduous process. Given the significance of transversal skills in today's society, it would be beneficial for test developers

or educators to assess different sets of skills or abilities concurrently. As discussed in the theoretical implications above, the social skills that are included within CPS models typically mirror or include some abilities from the AEI model. An additional study could map the development of a wider assessment in which both were assessed together.

5.10 Epilogue

As an educator involved in the process of curriculum change, carrying out this research has heightened my awareness of how we must adapt quickly in order to address the needs of our students for a future world. It has highlighted the challenges that accompany this type of authentic assessment, while also signifying the opportunities that qualitative observational research methods can offer in examining and assessing latent constructs like AEI. As a teacher-researcher, undertaking this research was both challenging and rewarding, not least because of the complex nature of the construct under investigation.

While the findings of this research have implications for those who are explicitly interested in AEI assessment, they also have relevance for the wider area of transversal or soft skills assessment. From an educational perspective, many of the challenges that were identified in assessing AEI through CPS tasks will be similar for other transversal competencies. For example, developing behavioural assessment indicators for areas like critical thinking and creativity, which are challenging to assess (see Long et al., 2022 for review) may provide a new approach for educators who are grappling with adapting curriculum. The use of observation frameworks may prove effective in providing a structure for student interactions in a collaborative classroom.

This research was completed at a time of momentous technological change. The latest advancements in machine learning have resulted in more sophisticated innovative technology digital content generation such generative artificial intelligence (AI) (Hu, 2022). Tools like ChatGPT can produce human-like answers to questions and yet, they can also provide highly inaccurate information, raising ethical issues about their use. These advancements lead to general concern in organisational settings, in the media and in educational domains about whether many jobs will be replaced or will become obsolete. Despite these anxieties, there is an emerging argument amongst academics (e.g. Chowdrury et al., 2023; Vrontis et al., 2022), that while the job market will be altered, humans will continue to play a vital role across almost all sectors.

In a Harvard Business Review of the jobs market in 2017, Beck and Libert argue that the rise of AI makes EI much more important in today's world. They believe that those who wish to stay relevant in their professions will have to develop skills and competencies that AI has difficulty replicating- "understanding, motivating and interacting with human beings" (Beck & Libert, 2017, p.4). They provide two exemplars of where the human capabilities of social understanding, empathy and emotional awareness will be significant, despite AI. For example, a smart machine may be able to diagnose an illness and provide a recommended treatment plan to an individual. However, it requires a person to understand the complexities of a patient's life (finances, family, quality of life etc.) in order to create an optimal course of treatment. In a similar vein, a smart machine may be able to create recommendations for a business in order to improve productivity. A human remains best matched, however, to be aware of the politics that may exist between leadership teams and to motivate others to implement change. These sentiments were echoed in a recent Forbes article entitled, *Remember the Human Element of the Emerging AI World*. Here, Bjorn Reynolds, CEO of

Safeguard Global, a global recruitment company, argues that, “the rise of this technology presents an opportunity for us to rethink work and skills, allowing us to focus on the areas where humans truly excel—creativity, strategic thinking and understanding complex emotions" (Reynolds, 2023, para. 12). If that is the case, and many believe it is, then, the good news is that, in essence, our value as humans is heightened by the limitations of generative AI. The outcomes of the research presented in this thesis, therefore, take on even greater significance for all those involved in preparing well-equipped citizens for an AI enhanced world.

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Appendix A: Intelligence Testing: A Broad Landscape Review

Positioning AEI within existing theories of intelligence has been challenging, given the diverse nature of intelligence theory in general. Similar debate exists around the area of intelligence testing. Modern testing of intelligence is typically attributed to academics Alfred Binet and Theodore Simon (1905), who proposed the forerunner of the now revised Stanford-Binet Intelligence Scales. The purpose of the Binet-Simon Scale was to identify children within the Parisian school system who were not benefitting from this method of instruction and who may be better suited to special education classes. It was revised in 1908 to include the concept of mental age, whereby a child who was nine years old but who scored at a five-year-old mental age would be classified as requiring special education. This concept of 'mental age' was later brought to the United States and adapted to create the concept of 'intelligence quotient' by Lewis Terman, a development in intelligence testing which has shaped the debate for many years. Another significant scale was developed by Wechsler, and Wechsler Scales of Intelligence remain popular with psychologists worldwide (Fletcher & Hattie, 2011). Wechsler's original scale can be distinguished from Binet's in that, in addition to an overall intelligence quotient (IQ), it also provided distinct scores for verbal and performance measures of intelligence. Typically, these tests require an individual to work through a series of questions or standardised tasks which assess cognitive abilities in areas such as logic, problem-solving, spatial awareness and language.

When intelligence testing became more commonplace, an additional debate which emerged and became contentious was around the interplay between genetics and intelligence. Sternberg, Grigorenko and Kidd (2005) summarise how, in the 1970's, papers about the interplay between race and genetics which suggested that there was a genetic difference between individuals intelligence because of their race led to tension around the use of IQ

tests. The debate about heritability and intelligence arose again following the publication of Richard Herrnstein and Charles Murray's *The Bell Curve* in 1994, which suggested that differences in intelligences contribute to variations in socio-economic outcomes amongst different groups of people. However, as highlighted by Fletcher and Hattie (2011) the original goal of IQ testing, as conceptualised by Binet, was to identify individual rather than group difference. As highlighted by Geisinger (2019), the use of intelligence testing as a whole remains popular because of their predictive validity for a range of outcomes. Section 2.3.1 in this thesis describes how Mayer, Caruso and Salovey (1999) used guidance from existing intelligence testing research to device an ability-based performance test for AEI. On the whole, Mayer et al. have not engaged in debate about the genetic components of AEI. However, like much of the research around intelligence testing, many studies of AEI relate to its predictive validity.

Like all psychological constructs, intelligence is only as important as its value and predictive powers. Although there are slight variations between the tests, there is a robust body of evidence which suggests that general intelligence tests have strong predictive validity for a range of life outcomes. For example, Gottfredson (1997, p.83) argued that *g* " can be said to be the most powerful single predictor of overall job performance". In a large-scale study, Schmidt and Hunter (1998) summarised 85 years of research in the United States on the predictive validity of a range of variables for job performance. Their study incorporated, amongst other factors, job experience, years of education, general intelligence tests, peer ratings of performance and job knowledge tests. The results of the study showed a consistently strong correlation between job performance and intelligence tests (.54). An updated meta-analysis was published by Schmidt et al. (2016) which reported largely similar results. Unlike general intelligence which is generally established as a meaningful predictor of variance in life outcomes, the predictive validity of AEI remains a well-debated issue and

Section 2.2.6 in this thesis focuses on the specific research examining the predictive validity of AEI.

Despite the predictive strength of intelligence tests, there remain critics about their ability to directly identify how a person may behave or perform in certain situations. This criticism is particularly strong from researchers who examine areas of intelligence like social or emotional intelligence. In their latest update on the AEI model, Mayer et al. (2016) assert that there is a significant distinction between intelligence and behaviour. The authors also emphasise that "the prediction from intelligence to individual instances of 'smart behaviour' is fraught with complications and weak in any single instance" (Mayer et al. 2016, p.291 on page 44). Some researchers have explored whether the predictive validity of personality is more significant than intelligence. One example of is in the area of academic grades or academic performance. A meta-analysis by Richardson, Abraham and Bond (2012) reported that college GPA correlated with intelligence ($\rho = .21$) to about the same degree as the personality trait conscientiousness ($\rho = .23$). Both intelligence and conscientiousness predicted better than any other personality trait, except for procrastination ($\rho = -.25$). Furthermore, there is some data suggesting that measures of self-discipline predict grades better than cognitive ability does (Duckworth & Seligman 2005; Duckworth et al. 2019), especially when the self-discipline measures are reported by teachers. However, a more recent meta-analysis by MacCann et al. (2020) found that general intelligence was the strongest predictor of academic performance, followed by the trait of conscientiousness and then AEI. A caveat for each of these pieces of research is that some are carried out within particular sectors of education and with different age groups.

Intelligence testing and the 'power' which should be attributed to intelligence tests remains a contentious area. This section has highlighted how the broad landscape of intelligence testing has been used by AEI theorists to inform thinking and assessment development.

Appendix B: Ethics Approval Letter

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Deirdre Dennehy
Centre for Assessment Research, Policy and Practice in Education (CARPE)

Prof. Michael O'Leary
Centre for Assessment Research, Policy and Practice in Education (CARPE)

Dr. Zita Lysaght
School of Policy and Practice

21st October 2021

REC Reference: **DCUREC/2021/200**

Proposal Title: **An Exploration of the Role that Ability Emotional Intelligence Plays in Collaborative Problem-Solving: A Case Study in the Irish Context**

Applicant(s): **Deirdre Dennehy, Prof. Michael O'Leary, and Dr. Zita Lysaght**

Dear Colleagues,

Thank you for your application to DCU Research Ethics Committee (REC). Further to expedited review, DCU REC are pleased to issue approval for this research proposal.

DCU REC's consideration of all ethics applications are dependent upon the information supplied by the researcher. This information is expected to be truthful and accurate. Researchers are responsible for ensuring that their research is carried out in accordance with the information provided in their ethics application.

Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee. Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Dr. Melrona Kirrane

Dr. Melrona Kirrane
Chairperson
DCU Research Ethics Committee

DCU
Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
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Appendix C: Plain Language Statement for Parents

Introduction to the PhD Research Study:

Your child in 5th class is invited to participate in a PhD study being carried out by researcher Deirdre Dennehy, a student of the Centre for Assessment Research, Policy and Practice in Education at the Institute of Education, DCU.

Title: An Exploration of the Role that Ability Emotional Intelligence Plays in Collaborative Problem-Solving: A Case Study in the Irish Context

Contact details: deirdre.dennehy6@mail.dcu.ie

Supervisors:

Prof. Michael O'Leary

Centre for Assessment Research, Policy and Practice in Education, Institute of Education, DCU

michael.oleary@dcu.ie

Dr. Zita Lysaght, School of Policy and Practice, DCU

zita.lysaght@dcu.ie

Details of What Involvement will Require:

The aim of this project is to explore what types of emotional abilities are used to solve Science, Technology, Engineering, Arts, and Mathematics (STEAM) problems in groups.

- **Collaborative Problem Solving (CPS)** combines the skills of individual problem-solving with the social skills of collaboration.
- **Emotional Intelligence** refers to an individual's ability to manage and use their own emotions effectively.
- Both CPS and EI been identified as important skills for pupils to develop at school in order to prepare them for the future workplace. The current study seeks to explore what types of emotional abilities are observable when children are working on CPS tasks with the goal of informing future research in the area of policy and educational practice.

If you wish your child to participate it will involve:

- Working in groups to build and code a robot from the Lego Spike Prime Education Kit. The researcher will observe the groups and they may be videotaped for some of the tasks.
- Reflecting on the process of building and coding the robot through group or individual short interviews/written reflection which may be recorded in audio format.
- Your child will work with their group for about 45 minutes to an hour at a time. They will work on the robots and the coding once or twice a week for about six weeks. This time will be integrated as a part of curricular time allocated to problem-solving in Maths, Science, SPHE and some discretionary curricular time.

Benefits to Participants

Children will have the opportunity to develop their STEAM skills through the building and coding of the robots. They will also have the opportunity to develop their problem-solving abilities, collaborative skills and emotional intelligence. The main results of the project will be reported to the children once it is finished.

Potential Risks to Participants
There are no serious risks to children if they participate in this study.

Voluntary Involvement
Involvement in this study is purely voluntary. Children are free to withdraw from the study at any point without prejudice or reason. There will be no penalty enforced on any child who wishes to withdraw. They can continue to participate in the tasks without their data being used for the purposes of this thesis. At any stage, you are welcome to request that any data related to your child be removed from the study.

Personal Data Protection Notice (GDPR)

- DCU is the Data Controller for this study
- The personal data being collected in this study is video footage of your child and it is requested in order to fulfill the aims of the study as outlined above.
- Once collected, the videos will only be viewed by the researcher, her supervisors and for the purposes of defending this doctoral thesis. When using quotes or observations from the videos in the final published thesis, pseudonyms will be assigned to all data and any potential information which may identify the child will be removed.
- All electronic data will be stored on a secure drive and hard data will be stored in a locked desk drawer.
- Once the data has been transferred onto the drive, it will be deleted from the recording devices.
- The data is only being collected for the purposes of this doctoral thesis.
- All data will be retained for three years after the project at which point it will be disposed of securely.
- It must be noted that protection of this data is subject to legal limitations. It is possible for this data to be subject to subpoena, freedom of information claim or mandated reporting by some professions.
- Should you feel unhappy with the way your child's data is collected, you have the right to lodge a complaint with the Irish Data Protection Commission and you can contact the DCU Data Project Officer, Mr. Martin Ward (*data.protection@dcu.ie Ph.: 7005118 / 7008257)*

Other Relevant Information:
The completion of this thesis is separate to Deirdre Dennehy's work as a teacher in [redacted] Your child's involvement/non-involvement will in no way affect the teacher-pupil relationship or the parent-teacher relationship. This research is funded by Prometric, who fund and support research at the Centre of Assessment Research, Policy and Practice but have no role in the project.

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Appendix D: Informed Consent Form for Parents

Research Study Title: An Exploration of the Role that Ability Emotional Intelligence Plays in Collaborative Problem-Solving: A Case Study in the Irish Context'.

Principal Investigator: Deirdre Dennehy (deirdre.dennehy6@mail.dcu.ie), PhD candidate, Dublin City University
Supervisors: Prof. Michael O'Leary (michael.olearly@dcu.ie), School of Policy and Practice, Dublin City University

The purpose of this research is to explore how children problem-solve collaboratively on STEAM tasks. This study aims to generate new information on the role of emotional abilities in Collaborative Problem-Solving. This research is funded by Prometric through the Centre for Assessment Research, Policy and Practice in Education (CARPE) at Dublin City University.

Confirmation of particular requirements as highlighted in the Plain Language

Statement

I have read the Plain Language Statement (or had it read to me)	*Yes/No*
I understand the information provided	*Yes/No*
I understand that my child's participation will be recorded	*Yes/No*
I understand the information provided in relation to data protection	*Yes/No*
I have had an opportunity to ask questions and discuss this study	*Yes/No*
I have received satisfactory answers to all my questions	*Yes/No*
I am fully aware of all of the procedures involving my child and of any risks and benefits associated with the study.	*Yes/No*
I know that my child's participation is voluntary and that I can withdraw them from the project at any stage without giving any reason.	*Yes/No*
I understand that data will be stored for three years after completion	*Yes/No*

Signature:

I have read and understood the information in this form. My questions have been answered by the researcher.

I agree for my child participate in the above study

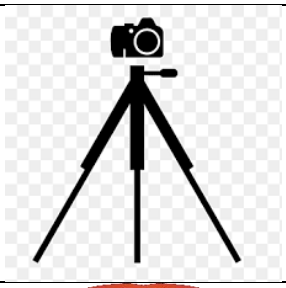
_____

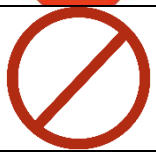
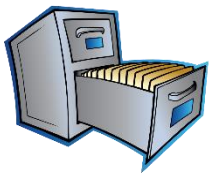
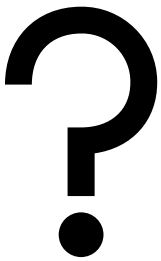
Name of child

_____ _____

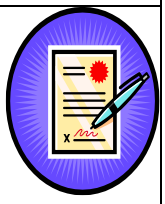
Parent's signature *Date*

Appendix E: Plain Language Statement for Child Participants

	Solving problems in groups is important in schools and in workplaces. There are lots of different types of skills that you need to solve problems in groups. I want to explore what types of social skills that are used when students solve problems in groups.
	I am looking for pupils to take part in a study that will involve working in groups to build and code robots from the Lego Spike Prime Inventor Kit. You can take part if you wish.
	Here is some **information** about how the study will work.
	You will be placed in a group to start working on some of the Lego tasks. You will work together to try and build and code the robot. You will have a chance to try and build a couple of different robots and to do different challenges with the robots.
	You will work with your group for about 45 minutes to an hour at a time. You will work on the robots and the coding once or twice a week for about six weeks.
	When you are completing the tasks, I may be observing your group. I am not testing you and there is no right or wrong way to behave. I will be looking to see how the groups interact when solving the problems.
	On some of the tasks, your group might be videorecorded when doing the tasks.
	I would also ask you to answer some questions on your group about your experiences of completing the tasks. This is called a **focus group** and you will do one after you complete each task in the Lego kit. I may also ask you some questions about your experiences of completing the tasks by yourself

	or ask you to write down how you found the tasks.
	If you do not feel comfortable taking part in the study, we will stop immediately. You can still take part in the normal lessons of making the Lego robots without being part of the study.
	I will write about the tasks in my project but I will never use your name.
	I will keep all of the information in a locked drawer, which no one else can open or in a safe place on my laptop.
	I will keep the information for three years in case I write other essays about the projects. After this I will safely delete the information.
	If you and/or your parent(s)/guardian(s) have any questions about this project, please contact the researcher: Name: Deirdre Dennehy Email: deirdre.dennehy6@mail.dcu.ie **Or** If you and/or your parent(s)/guardian(s) have concerns about this project and wish to contact an independent person, please contact: The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Appendix F: Child Assent Form

I have had this research explained to me. 	I understand that I will be asked to be part of a group to complete tasks using Lego.
I understand that the researcher might observe my group 	I am happy to have my group tasks video recorded
I understand that I will answer some questions in a group of by myself on how I found the tasks. I am happy to have my voice recorded when answering the questions. 	I know that I can take a break or stop taking part in the study whenever I want. I know that my data will be kept confidential.
I would be happy to talk to another person if I have any big concerns. 	I agree to take part in this project  Name_____ Witness_____ Date

Appendix G: Instruments Used in Initial Quantitative Analysis

Likert Scale Observation: Level of Agreement between Group Members

How often do the group members agree on key decisions related to the problem-solving process?

1	Never
2	Rarely (approx. 10% of time spent on task)
3	Sometimes (approx. 30% of time spent on task)
4	Often (about 50% of time)
5	Usually (70% and over)

Observation Protocol for the Presence of Minor/Significant Off-Task Behaviour

Minor Off Task Behaviour	**Significant Off-Task Behaviour**
Less than two minutes, only one group member	Longer than two minutes, involved more than one group member
✓	✓

- If there were more than three instances of significant off task-behaviour, the group was recorded as having a 'significant frequency of off-task behaviour'.
- If there were less than three instances of significant off-task behaviour the group was classified as having a "minor frequency of off-task behaviour".
- If only minor task behaviour was recorded, the group was classified as having minor frequencies of off-task behaviour.

Classification of Group as Moderately/Highly Successful

Group were classified as highly successful if they had completed the task in the time allocated, had a rating of four or above for inter-personal agreement and had minor incidents of off-task behaviour.

Appendix H: Group Profiles

4.2.2 Group Profiles

12 different groups participated in this research. Group profiling is therefore essential for the reader to understand the story of the data in a clear and succinct manner. Table 1 outlines a number of descriptive characteristics which can be used to understand each group. Pupils were grouped according to mixed ability, as is advised by current educational practice. Hence, there were a variety of children with differing abilities and personalities in each group. Typically, the gender of the group was balanced with two males and two females, but this was not always the case due to practicalities in the classroom such as absenteeism due to the COVID-19 pandemic. Group composition was modified after the first two tasks were completed. This ensured that participants would have the opportunity to collaborate with a variety of different personalities and to allow different dynamics to emerge across groups.

As Table 1 outlines, each group has a group identifier. The group composition is then described, with females indicated in *italics* and males indicated in **bold.** Pseudonyms were also assigned to all participants. Within each group, every child also has a unique identifier. For example, Oliva is in Group 1. Her ID is *GR10,* meaning that she is in group 1, the first letter of her pseudonym is O and the italics means that she is female. In a similar vein, John is in Group 2. His ID is **GR2J,** indicating that he is in Group 2, the first letter of his pseudonym is J and he is male. Table 1 also includes the most recent 2022 norm-referenced standardised test results in Maths and English for all groups. The range and average of Standard Ten (STEN) scores provides an overview of the range of abilities in Maths and English that children brought to the task. For example, Group 1's scores range from three to nine in Maths, giving average of 9, while they range from three to eight in English, giving an average of six. Finally, Table 1 also indicates if there is a child with SEN in the group. However, specific information about the type of SEN is not included here in order to protect the confidentiality of participants. A group profile provides an initial lens on the group.

Table 1

Group Profiles

Group Identifier	**Group Composition: Gender** (Name in **bold for male** and *italicised for female*) and Pseudonym	**Individual Identifier within Group**	**Norm-referenced standardised test results (May 2022, Maths)**		**Norm-referenced standardised test results (May 2022, English Reading)**		**Special Educational Need Present in Group Member**[b]
			Range of STen[a] **scores**	**Average**	**Range of STen**[a] **scores**	**Average**	
G1	*Olivia (O), Emily (E),* ***Noah (N) & Aidan (N)***	*GR1O, GR1E,* **GR1N, GR1A**	3-9	9	3-8	6	
G2	*Kate (K) Rose (R),* **Harry (H), & John (J)**	*GR2K, GR2R,* **GR2H, GR2J**	3-9	7	4-9	7	
G3	**Daniel (D), Sean (S), Conor (C) & Liam (L)**	**GR3D, GR3S, GR3C, GR3L**	7-9	7	4-9	7	
G4	*Freya (F), Naomi (N),* **Cillian (C) Aidan (A)**	*GR4F, GR4N,* **GR4C, GR4A**	3-9	6	6-9	8	
G5	*Rose (R), Anna (A),* **Trevor (T) & Ben (B)**	*GR5R, GR5A,* **GR5T, GR5B**	3-9	6	4-8	6	
G6	*Olivia (O), Isabella (I),* **Conor (C) & Liam (L)**	*GR6O, GR6I,* **GR6C, GR6L**	4-9	7	5-8	7	
G7	**Daniel (D), Noah (N), Ben (B) & Cillian (C)**	**GR7O, GR7N, GR7C, GR7L**	5-9	7	4-9	7	✓
G8	*Emma (E) Aoife (A), Jane (J) & Olivia (O)*	*GR8E, GR8A, GR8J, GR8O*	5-8	7	6-10	8	
G9	*Anna (A), Naomi (N), Kate (K)* **James (J) & Sean (S)**	*GR90, GR9N, GR9K,* **GR9J, GR9S**	3-9	6	5-9	7	✓
G10	**Conor (C), Daniel (D), John (J) & Jim (J)**	**GR10C, GR10D, GR10J, GR10J**	1-9	6	1-8	5	✓
G11	*Freya (F), Rose (R),* **Liam (L) & Harry (H)**	*GR11F, GR11R,* **GR11L, GR11H**	3-9	7	4-9	7	
G12	**Trevor (T), Ben (B), Noah (N) & Aidan (A)**	**GR12T, GR12B, GR12N, GR12A**	3-9	7	4- 9	7	✓

[a] STen scores vary from one to ten. Scores from 8-10 are well above average, 7 is high average, 5-6 is average, 4 is low average and 1-3 is well below average.

[b] Special Educational Needs: A restriction in the capacity of the person to participate in and benefit from education on account of an enduring physical, sensory, mental health or learning disability or any other condition which results in a person learning differently from a person without that condition. Education for Persons with Special Education Needs Act (2004

4.2.3 Profile of Tasks and Groups

Having outlined group composition, it is important to profile the tasks and the ways in which the different groups worked on the tasks. This research used four tasks; Hopper Race, Drive Challenge, Break-dancer challenge and Super clean-up challenge. Each challenge involved a group of children building and coding a robot to solve a problem. Table 2 uses five quantifiable descriptors that reflect group success when working collaboratively on these tasks. These descriptors provide a window into the participants that will assist the reader. Groups are identified by their group identifier and their colour which were previously included in Table 1. The first two descriptors are linked to task completion; firstly whether the group solved the problem in the time allocated and secondly, the duration of time that was needed to solve the problem. In accordance with Lego Spike Prime guidelines, 40 minutes were allocated for completion of the Hopper Race task and Driver Challenge, 35 minutes for the Break-dancer challenge and 45 minutes for the Super Clean-Up Challenge. As Table 2 outlines, Group One successfully completed the Hopper Race task in 30 minutes, 39 seconds. In contrast, Group Five did not complete the Driver challenge within the forty minute time period that was allocated to them. These two descriptors given an indication of the group's success at problem-solving and collaboration.

The next descriptor in Table 2 is the level of agreement between group members when decision-making. Decision-making is a significant component of CPS. Groups must decide how to allocate roles, tasks and how to proceed with each step of the problem-solving process. A rating of inter-personal agreement was deducted from observations using a five point Likert rating scale. A rating of five meant that the group frequently reached agreement on key decisions. In contrast, a rating of one meant that agreement was rare throughout the task. A rating of two or three meant that groups sometimes/often agreed when decision making. Although time spent on decision-making is an important component of CPS, a lack of consensus can lead to less productivity. Time that could have been spent on solving the problem is spent on solving disagreements.

An additional descriptor is the presence of off-task behaviours. As these tasks required sustained attention from children for relatively long periods of time, there were many incidents where children became distracted at some point during the task. Chatting about topics not relevant to the problem, building Lego not relevant to the problem, walking away from the group, attempting to distract others using humour or song, asking questions and looking out the window were all examples of minor off-task behaviours exhibited by group members. However, these were only classified as significant when they lasted longer than two minutes and when they involved more than one group member. This level of off-task behaviour had an impact on the group as a whole leading to less

successful problem-solving because the group were not focused on solving the task. As Table 2 documents, five of the groups were classified as having significant off-task behaviour whereas eight of the groups had minor off-task behaviours.

The culmination of these descriptors is the identification of the group as highly or moderately successful. Group were classified as highly successful if they had completed the task in the time allocated, had a rating of three for inter-personal agreement and had minor incidents of off-task behaviour. Overall, Tables 1 and 2 provide an initial lens from which the groups and the individuals within the group can now be explored. One element that is not included in either table is a profile of the individuals within the groups. This will be included at a later point when the focus shifts to within-group analysis of the use of AEI in CPS tasks.

4.2.3 Profile of Tasks and Groups

Having outlined group composition, it is important to profile the tasks and the ways in which the different groups worked on the tasks. As previously discussed in Chapter 3, this research used four tasks; Hopper Race, Drive Challenge, Break-dancer challenge and Super clean-up challenge. Each challenge involved a group of children building and coding a robot to solve a problem. Table 2 uses five quantifiable descriptors that reflect group success when working collaboratively on these tasks. These descriptors provide a window into the participants that will assist the reader. Groups are identified by their group identifier and their colour which were previously included in Table 1. The first two descriptors are linked to task completion; firstly whether the group solved the problem in the time allocated and secondly, the duration of time that was needed to solve the problem. In accordance with Lego Spike Prime guidelines, 40 minutes were allocated for completion of the Hopper Race task and Driver Challenge, 35 minutes for the Break-dancer challenge and 45 minutes for the Super Clean-Up Challenge. As Table 2 outlines, Group One successfully completed the Hopper Race task in 30 minutes, 39 seconds. In contrast, Group Five did not complete the Driver challenge within the forty minute time period that was allocated to them. These two descriptors given an indication of the group's success at problem-solving and collaboration.

The next descriptor in Table 2 is the level of agreement between group members when decision-making. Decision-making is a significant component of CPS. Groups must decide how to allocate roles, tasks and how to proceed with each step of the problem-solving process. A rating of inter-personal agreement was deducted from observations using a three point Likert rating scale. A rating of three meant that the group frequently reached agreement on key decisions. In contrast, a rating of one meant that agreement was rare throughout the task. A rating of two meant that groups sometimes agreed when decision making. Although time spent on decision-making is an important component of CPS, a lack of consensus can lead to less productivity. Time that could have been spent on solving the problem is spent on solving disagreements. As Table 2 describes, all of the groups received a rating of either two or three because they frequently or sometimes reached agreement when making decisions throughout the task.

An additional descriptor is the presence of off-task behaviours. As these tasks required sustained attention from children for relatively long periods of time, there were many incidents where children became distracted at some point during the task. Chatting about topics not relevant to the problem, building Lego not relevant to the problem, walking away from the group, attempting to distract others using humour or song, asking questions and looking out the window were all examples of minor off-task behaviours exhibited by group members. However, these were only classified as

significant when they lasted longer than two minutes and when they involved more than one group member. This level of off-task behaviour had an impact on the group as a whole leading to less successful problem-solving because the group were not focused on solving the task. As Table 2 documents, five of the groups were classified as having significant off-task behaviour whereas eight of the groups had minor off-task behaviours.

The culmination of these descriptors is the identification of the group as highly or moderately successful. Group were classified as highly successful if they had completed the task in the time allocated, had a rating of over three for inter-personal agreement and had minor incidents of off-task behaviour. Overall, Tables 1 and 2 provide an initial lens from which the groups and the individuals within the group can now be explored. One element that is not included in either table is a profile of the individuals within the groups. This will be included at a later point when the focus shifts to within-group analysis of the use of AEI in CPS tasks.

Table 2

Task and Group Profiles

Task	Group ID	Task completed in time allocated	Duration of task	Rating of agreement between group members (5- high agreement, 1- low agreement)	Off task behaviour present during task		Group classification for working collaboratively on problem-solving task:	
					Minor	Significant	Highly successful	Moderately successful
Hopper Challenge	1	Y	30.39	3	✓			✓
Time Allocated: 40 minutes	2	Y	35.00	4	✓		✓	
	3	Y	20.54	3	✓			✓
	4	Y	25.28	4	✓		✓	
Driver Challenge	1	Y	26.33	3	✓			✓
Time allocated: 40 minutes	2	Y	25.77	4	✓		✓	
	3	Y	26.35	3	✓			✓
	4	Y	31.53	4	✓		✓	
	5	N	35.00	2		✓		✓
Break-dancer Challenge	6	Y	34.41	3	✓			✓
Time allocated: 35 minutes	7	Y	26.12	4	✓		✓	
	8	Y	34.08	3	✓			✓
Super clean- up Challenge	9	N	45.09	4	✓		✓	
Time allocated: 45 minutes	10	Y	23.59	4		✓		✓
	11	Y	33.15	4	✓		✓	
	1	N	42.32	3	✓			✓

Appendix I: Running Record Observation Form

Group ID:

Task:

Date:

Dynamics in the initial stage of CPS:

Dynamics observed in later stages of CPS:

Behaviours observed linked to AEI:

Levels of agreement when decision-making:

Off task behaviour?

Appendix J:Child Classroom Reflection Template for Researcher

Task _____

Date_____

Group	Recorded Observations made by Group Members

Guided Question Prompts

- What worked well in your group?
- What didn't work so well?
- What helped you to solve the problem together?
- What did you find challenging?
- How did your group work together?
- How would you describe your role in the group?
- Were you happy with the result of your group work?

Appendix K: Transcription in Video-Based Research

A particular challenge raised by video-based researchers is the issue of transcription (Cowan, 2018; Mondada, 2018). Video recordings create multi-modal data, in that there is usually both audio and video within the recording. This is particularly challenging and time-consuming to transcribe (Jenks, 2018). In the positivist tradition, transcription is a 'straightforward' stage of research, whereby speech is transferred into writing as preparation for analysis (Cowan, 2018). In the interpretivist paradigm, it is acknowledged that the process of transcription will inevitably leave transcriber's analytical and theoretical "fingerprints" on the resulting transcript (Tessier, 2014). Researchers attempting to transcribe body language, gestures and other multi-modal aspects of human behaviour have referred to the process as transduction, where meaning is remade across modes (Bezemer & Mavers, 2011). Bezemer and Mavers (2011) argue that transcripts are therefore edited representations through which analytical insights can be gained and certain details are lost. Taking into account these arguments, questions may arise as to whether or not it is suitable to transcribe at all. New ways to disseminate research include digital theses and online journal content (Jenks, 2018) It is increasingly possible to include extracts of original video recordings as part of a text's publication. However, transcription can still be viewed as a significant 'discovery procedure' (Duranti, 2006, p.307) and a way of making the researcher's data and analysis shareable and open to discussion.

As mentioned above, almost a substantial amount of video data were collected in this study. It was important therefore that key issues were considered before commencing transcription (Heath et al., 2010; Luff & Heath, 2012; Jenks, 2018). The first of these was the selection of video for analysis. Heath et al. (2010) argue that it is virtually impossible to use and analyse all of the video that is typically gathered in a research setting. The researcher must make a

decision about what to transcribe in line with what the research questions of the study require (Jenks, 2018). Jenks (2018) argues that a study is generally designed with a reader in mind and the transcripts should, to some extent, reflect the needs of the intended audience. In the present study, the researcher wished to provide an overview of groups in which AEI abilities were used successfully and groups in which they were not. Therefore, selection for transcription was a purposive process.

Having selected videos for transcription, the next step was to discern what exactly to transcribe. There are a number of different systems available for the transcription of multi-modal data (Davidson, 2009; Paulus et al., 2015). The first is verbatim transcription, which involves typing everything that is seen and heard on the video (Paulus, Lester & Dempster, 2014). This includes portraying all articulations made by participants, without altering nonstandard language usage, or dialect and without skipping over any repetitions or hesitations. A verbatim transcript should also incorporate all of the non-verbal actions that a participant uses, including facial expressions and gestures. Although the verbatim transcript can be appealing to researchers who wish to capture nuanced interactions between participants, it is a labour-intensive process. Other types of multi-modal transcription involve the use of symbols to represent different kinds of body movements or facial expressions. One of the most common of these is Jeffersonian transcription which was developed within conversation analysis (Hepburn & Bolden, 2013). Features like the rate of speech, volume, pauses and overlapping speech are all represented using a standardised notation system that can be used by the researcher to create a detailed overview of the raw data (Paulus et al., 2015). This is also a particularly time-consuming process as the transcription must be done in rounds. There are also examples of studies where researchers have combined a written

transcription with stills or images from video recordings. This adds an additional dimension for the reader of the transcript (Jenks, 2018).

During the pilot phase of this study, verbatim transcription was attempted by the researcher, using Microsoft Word. Even with multiple rounds of observation, it was very challenging to capture every type of action, gesture, facial expression, utterance and conversation of the group members. Therefore, the transcription style was adapted in the later part of the study. Instead of Microsoft Word, the videos were directly transcribed in NVivo. NVivo is a qualitative data analysis research software that aids data organisation and permits structured exploration of a data set. Direct transcription of the video recordings within NVivo software was a relatively straight forward process and was helped by the functions that were available through the software, such as the adjustment of speed function and the shortcut keys to stop and start the video.

Each video was watched multiple times (usually three) when transcribed. The first round was get to know the data, the second to transcribe and the third to pick up on any missed data from the first two viewings. In order to make the data readable and usable, not all multi-modal data was transcribed. The researcher attempted to include as much as possible but if some were not deemed relevant to the use of AEI abilities, it was not included. Symbols from the Jeffersonians tradition were incorporated where necessary.