Designing and Improving Instructional Strategies for Promoting Cognitive Engagement in a Collaborative Learning Environment

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Declaration

I, The Shao Yann Benedict, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

The purpose of this study is to design instructional strategies that will contribute towards promoting cognitive engagement in a collaborative learning environment, and to evaluate the effectiveness of the instructional strategies through analysis of the cognitive engagement of the students.

Academic modules are attended by a wide diversity of students, who are enrolled into various academic programmes of different disciplines and academic fields, and are supported by the predominant modular systems which are adopted by internationally renowned universities. Some critical concerns with the rising number of diverse students are that these students would have varied educational foundations and prior experiences, and their enrolment into common modules would result to a congregation of diverse students with wide knowledge gaps and different learning approaches. There are challenges when teaching a classroom of students with an assortment of skills, different learning styles and approaches, and varied attitudes toward learning. Such challenges can lead to low cognitive engagement of the students, and can become apparent in collaborative learning where vast amounts of information and experience are shared during group discussions in assignments or tasks using case scenarios, which are prevalent approaches to learning commonly used in higher education.

Cognitive engagement is the extent to which a student engages with the learning materials. It can be observed from the student’s overt behaviour, while undertaking a learning activity in the context of an instructional strategy or learning task, as a reliable proxy to reflect a difference in knowledge-change or learning process. For this study, the students’ modes of cognitive engagement are based on fine grained overt behaviour, and are subsequently categorised as one of four ordinal modes, namely *interactive*, *constructive*, *active* and *passive*.

Impact Statement

This study used the design-based research approach, which required multiple iterative cycles, so as to develop a more comprehensive account and a deeper understanding of the study with respect to iterative educational interventions. The study was thus conducted in four cycles, across two academic years (AY 2015/16 and AY 2016/17), where two cycles were conducted in the second semester of each academic year. A total of 56 local and international students, who were enrolled in undergraduate and postgraduate programmes, were involved in the study.

Altogether, 17 instructional strategies were designed and introduced across the four cycles in order to evaluate their effectiveness in promoting cognitive engagement among the students working together in a collaborative learning environment. Some of the instructional strategies were identified to have issues, and had to be addressed and improved in the subsequent cycle. The findings concluded that the instructional strategies were able to promote cognitive engagement among the students with varied effectiveness, and possible reasons for the results were provided. It was also found that the instructional strategies were progressively improving the cognitive engagement of the students, gradually shifting the levels of cognitive engagement of the students towards higher modes for every successive cycle.

The significant impact of this study is that the findings will contribute towards equipping teachers and practitioners with a set of design principles, as a reference for educators and practitioners in education, for designing and implementing instructional strategies for promoting cognitive engagement in other comparable collaborative learning environments. The research findings will also lead to a comprehensive understanding of applying similar instructional strategies and activities for in-class and out-of-class collaborative learning environments, which will be beneficial for the teachers and practitioners involved in the current and future developments in collaborative learning, especially for diverse students. For educational researchers, the findings of this study will also expand and enhance the theoretical components established in the conceptual frameworks and models used in this study on cognitive engagement in collaborative learning environments.

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Chapter 1. Introduction

This chapter presents the contextual information of the current study. It highlights the challenges in relation to the diversity of students enrolled in an academic module. This, in turn, can potentially affect the cognitive engagement of these diverse students, especially when they engage in collaborative learning in groups. The subsequent sections cover the purpose, the research questions, and the significance of the study. An overview of the dissertation is provided at the end of this chapter.

1.1 Contextual Information

Since the turn of the millennium, the Economic Development Board of Singapore has actively directed the higher education landscape of the country and attracted a growing number of heterogeneous student communities. Strategies have been put in place to arrange for several world-class universities, such as Georgia Institute of Technology, Massachusetts Institute of Technology, Johns Hopkins University and Yale University, to set up satellite campuses in the country. One example is the partnership between Yale University from the United States and National University of Singapore, which resulted in the establishment of a joint campus in Singapore to expand Western-style liberal arts education in Asia (Barta, 2011). This development has played a crucial role in the country's rapid development and expansion of its educational system, having to create escalating supply of highly-educated professionals to meet the employment demands, state-formation and nation-building (Baildon & Sim, 2009). The rise of the global economy, the growth of academic institutions with global reach and governance, and the hybridization of culture in the student communities have also steadily brought about a borderless academic global village (Mok & Lee, 2003). Through the modularisation of programmes across the universities, it has also enabled Singapore to develop higher education into an industry with international academic comparability.

The Ministry of Industry and Trade has further extended the development of education as a business for Singapore, by publishing the *Developing Singapore's Education Industry* policy. Together with the increasing growth of higher education worldwide, Singapore has also strategically positioned itself as a hub for higher education, through the implementation of several educational policies (Lee & Gopinathan, 2005). These policies, which have expanded the whole curriculum reform for local universities, are highlighted by Vidovich, O'Donoghue, and Tight (2012) in a summary outlining curriculum features as:

- a direction to internationalising the curriculum;
- an obligation to students who are enrolled in a range of disciplines to obtain a well-rounded education;
- an expansion in the curriculum's breadth and depth by focusing more on research, communication skills, community service and study abroad components; and
- an increasing importance on inter-disciplinarily and integrated education across the wide range of disciplines.

Along the same vine, there are also studies on the changing landscape of higher education in Singapore, based on the studies on the autonomy and diversity in the tertiary education landscape (Mok, 2008; Ng & Tan, 2010). For example, at the turn of the century, the Chicago Graduate School of Business became the first foreign institution with an international campus in Singapore, offering an executive MBA programme. Modules in the programme were conducted by the academics who serviced the school's original campuses. Unlike other usual higher educational programmes, the students who were enrolled into the MBA programme were able to attend several one-week modules in a span of twenty months and across all campuses. This arrangement allowed working business professionals to keep their full-time jobs, while periodically taking time off to attend classes at any one of these worldwide campuses. The credit transfer facilitated by the modular system across international borders allowed local students enrolled in these programmes to take up modules in the Chicago and Barcelona campuses, with similar arrangements offered to international students interested to enrol into modules in the local campuses. Students were thus able to engage with a wider network of teachers and students all over the world, for discussions and reflections through coursework and research collaboration. By 2015, there was an influx of international students studying in the Asian campus, who were business professionals from Asian countries such as China, India, Korea, Japan and Australia, with a number from Europe and the United States.

The influx of international students in noticeable numbers, for undergraduate and graduate programmes offered by the universities in Singapore, has also been recorded. Current records have shown that Nanyang Technological University and National University of Singapore are leading, with an enrolment of international students forming 31% and 30% of overall undergraduate students respectively (Times Higher Education, 2018). The enrolment volume has significantly increased by 18% with respect to the overall undergraduate intake reported for 2011 (Davie, 2014). These international students are enrolled into various undergraduate and postgraduate programmes offered by the different universities worldwide, and through modular systems put in place by the universities, they are able to sign up for academic modules offered in their course of study, as well as other modules of their interest offered by schools and faculties from within and outside of their universities.

1.2 Problem Statement

Academic modules are attended by a wide diversity of students, who are enrolled into various academic programmes of different disciplines and academic fields, and are supported by predominant modular systems which are adopted by internationally renowned universities. Since the 1990s, the number of students who have enrolled into international universities for higher education has increased by three folds (OECD, 2013). It is also reported that more than four million students went abroad for their studies in 2013 alone. Most international students are from China, India, and Korea, and Asia alone accounts for 53% of these international students. Although most of these students enrol to universities in the U.S. and U.K., international enrolment has also increased in other countries. In Australia, 18% of higher education graduates are international students. In Switzerland, 50% of PhD candidates are from a foreign country (OECD, 2014). Other countries such as Korea, Russia and Spain have just start to join the trend by increasing their international intake (OECD, 2013).

In a recent study by Aggarwal, Woolley, Chabris, and Malone (2015), the general effectiveness of a group of diverse students to collaboratively perform well across a wide range of different tasks is found to be related to cognitive diversity, which includes thinking styles and perspectives of the group (Kozhevnikov, Evans, & Kosslyn, 2014). In the study, groups that were moderately diverse in cognitive styles did better than those that were very similar in cognitive styles and also those that were very different. This implies that groups whose members are too similar to each other lack the variety of perspectives and skills needed to perform well on a variety of tasks. However, on the flip side, groups whose members are too different have difficulties communicating and coordinating effectively (Aggarwal & Woolley, 2013). Other studies have also replicated similar findings, where collaborative groups met online and face-to-face (Engel, Woolley, Jing, Chabris, & Malone, 2014), where groups engaged in online gaming (Kim et al., 2015), and where group members hailed from diverse cultures (Engel et al., 2015).

In the current study, a critical challenge with respect to the rising number of diverse students is that they would have varied educational foundations and prior experiences, and their enrolment into common modules would result to congregations that would exhibit wide knowledge gaps and different learning approaches. As the enrolment into universities worldwide becomes increasingly diverse, teachers would face an uphill task of getting these diverse students to cognitively engage in class. Yamauchi, Taira and Trevorrow (2016), in their study on applying strategies of instruction to increase students' cognitive engagement in a statistics module offered by a public university in Hawaii, United States, found it challenging to teach students with diverse statistical skills, different learning styles and approaches, and varied attitudes toward learning. The problem of low cognitive engagement can also become more apparent during collaborative learning that demands vast amounts of information and experience to be shared, such as group discussions in assignments and tasks using problem or case scenarios, both prevalent approaches to learning commonly used in higher education.

For the modules attended by diverse students, the problem of low cognitive engagement can be due to the presence of several conditions when they engage in collaborative learning among peers with wide knowledge gaps and different learning approaches. Research shows that the *varying capability to collaborate*, the *lack of motivation to collaborate*, the *unwillingness to accept a role transformation from passive to active learning*, and the *difficulties in coordination among the students*, are some of the factors that are likely to affect cognitive engagement in collaborative learning. These factors will be elaborated in the following sections.

1.2.1 Varying capability to collaborate. Several studies have shown that collaboration among students does not happen automatically, as students vary in their capability and willingness to collaborate with each other (Häkkinen et al., 2017). It is showed that if students are to collaborate on their own, they hardly engage cognitively in constructive discussions and interactions, such as raising questions, providing emphasis and justification to their views, elaborating on their explanations, and reflecting upon newly shared information (Kobbe et al., 2007). It is also reported that collaboration itself may not always occur, especially when cognitive, motivational, and socio-emotional problems arise (van den Bossche, Gijselaers, Segers, & Kirschner, 2006). These problems may surface even in carefully designed group activities (Kirschner, Sweller, & Clark, 2006). Cognitive disengagement often arises from the lack of understanding of the thoughts of the other students and their different perspectives (Häkkinen, 2013; Kirschner, Beers, Boshuizen, & Gijselaers, 2008).

1.2.2 Lack of motivation to collaborate. The lack of motivation to collaborate can be the result of misalignments of goals, priorities, and expectations among the students, especially in groups of diverse students (Järvelä, Järvenoja, & Veermans, 2008). In cases where there is a lack of instructional strategies to support collaboration and students are not adequately equipped with collaborative learning skills, learning itself does not happen, and students may even experience negative learning episodes (Farrell & Farrell, 2008; Häkkinen, Arvaja, Hämäläinen, & Pöysä, 2010; Rajuan, Beijaard, & Verloop, 2008). These studies have also established the importance of having instructional strategies to address the challenges in collaborative learning, especially in the context of improving cognitive engagement.

1.2.3 Unwillingness to transform from passive to active learning. Pérez-Marín, Hijón-Neira, and Santacruz (2016) raised a concern that not all students can readily accept the role transformation from passive to active learners. It is suggested that these students fear failure, or may appear to be weak or incompetent in the presence of more diverse and learnt fellow group members, because of the exposed nature of this new active approach to learning collaboratively. However, it is highlighted that this lack of self-efficacy, or an individual's belief in his or her ability in learning and performance, is the primary cause of low cognitive engagement for many students (Saab, van Joolingen, & van Hout-Wolters, 2009).

1.2.4 Difficulties in coordination. Difficulties in coordinating collaborative learning activities have become more apparent, as an increasing number of modules are attended by both full-time undergraduates and part-time postgraduates working professionals. Similar to the shortcomings that are identified by Larsen, Urry, and Axhausen (2008) in the traditional approach of collaborative learning through face-to-face discussions, collaboration deteriorates when the students are not able to meet regularly for group discussions. In face-to-face discussions, interactions, exchange of ideas, reasoning and negotiations can only be done effectively once all the required members of the group are present. This limitation of requiring all group members to assemble at a predetermined time and location before a collaborative activity can take place makes it critically challenging.

In the context of face-to-face interaction in a classroom environment, it is asserted that group members are not able to reach an agreement or common consensus within a definite meeting time duration, as many students are usually not completely prepared for the topic to anticipate the direction and development of the discussion (Wang & Woo, 2007). Also, if some members are absent during a face-to-face meeting, the development of the discussion and final decision may also be made without equal contributions by all group members, and thus may be biased (Wang, 2008).

In the context of using online learning environments, it has been suggested that coordination by using online tools is helpful but has some challenges as well (Wang, 2010). One example is the generic form of coordinating a group activity which involves the use of emails. Emails offer the features for users to reply, forward, attach, save and delete information and discussions, but they may also be dumped unpredictably in the junk mailbox, or be lost in a long series of exchanges. This chaotic form of interaction via emails, which can "travel different places in one journey" (Larsen, Urry, & Axhausen, 2008, p. 653), makes it difficult for students to follow the evolution of a discussion, or even learn anything from the overall idea of multiple discussions, spread out in mailboxes and folders which may not be in a meaning structure.

1.3 Purpose of the Study

The above problem statement is evidently predominant in classrooms of higher education, where collaborative learning is increasingly introduced in academic programmes offered by institutes of higher learning. However, there is an observable lack of research work in designing instructional strategies for promoting cognitive engagement in a collaborative learning environment. There is also a lack of empirical studies that evaluate the effectiveness of such instructional strategies towards improving cognitive engagement of students participating in collaborative learning.

In this study, with reference to the literature, collaborative learning is taken to be a process within an environment that supports high quality and extensive engagement in group interaction among individual students, with a common purpose of processing and constructing knowledge (Leinonen, 2007; Nicolson & Uematsu, 2013). The concept of cognitive engagement is described as the quality and quantity of students' cognitive effort in the context of in-class and out-of-class instructional strategies and activities, and to the learning process, so as to achieve the desired learning outcomes (Gunuc & Kuzu, 2015).

The purpose of this study is to design instructional strategies for promoting cognitive engagement in a collaborative learning environment. The study also seeks to evaluate the effectiveness of the instructional strategies through analysing the cognitive engagement of students as they participate in collaborative learning.

1.4 Research Questions

The current study aims to answer the following main research questions:

1. *What are the characteristics of instructional strategies for the purpose of promoting cognitive engagement in a collaborative learning environment?*
2. *How effective are the instructional strategies in promoting cognitive engagement?*

The first research question is presented based on the format suggested by Plomp (2007), for a design-based research study: *What are the characteristics of an <intervention X> for the purpose/outcome* $Y(Y_1, Y_2, \ldots, Y_n)$ *in context Z.*

The first research question reiterates the problem statement in the earlier section above, that there is an urgent need for the current study to look into the design of effective instructional strategies for promoting cognitive engagement in a collaborative learning environment for diverse students. For this specific collection of instructional strategies, the second research question further addresses the need to fully understand the effectiveness of the instructional strategies in promoting cognitive engagement.

1.5 Significance of the Study

This section elaborates on the significance of this research study, towards practice and theory. This section provides justification to the amount of research effort in conducting the research study.

1.5.1 Significance of the study towards practice. The significance of this study is that the findings will contribute towards equipping teachers and practitioners with a set of design principles, as a reference for educators and practitioners in education, for designing and implementing instructional strategies for promoting cognitive engagement in other comparable collaborative learning environments. The research findings will also lead to a comprehensive understanding of applying similar instructional strategies and activities for in-class and out-of-class collaborative learning environments, which will be beneficial for the teachers and practitioners involved in the current and future developments in collaborative learning, especially for diverse students.

In the local context, the idea of deploying collaborative learning environments online is not new. Details in the current Continuing Education and Training (CET) Masterplan 2020 by the Singapore Workforce Development Agency (WDA) outline efforts to introduce more e-learning courses using virtual learning environments, so as to make the online learning community more engaging and accessible to working adults with diverse educational qualifications, capabilities and experiences. WDA's Institute for Adult Learning has also taken the lead to experiment and innovate using technology to deliver industrial training, and sharing its learning and insights with CET partners. The findings from the current study can provide the necessary direction and guidance for teachers and practitioners in WDA's Lifelong Learning Institute towards the designing and implementation of innovative, pedagogical and cutting-edge collaborative learning environments, for learners to interact and study together online.

1.5.2 Significance of the study towards theory. For educational researchers, the findings of this study will also expand and enhance the theoretical components established in the conceptual frameworks and models used in this study on cognitive engagement in collaborative learning environments.

Studies have established various approaches for conceptualizing, representing and analysing cognitive engagement through interaction during collaborative learning (Chi & Wylie, 2014; Dillenbourg, 1999; Jeong, 2005). For analysing cognitive engagement, Chi and Wylie (2014) proposed that learning activities can bring about observable engagement behaviours that can be characterised into four distinctive modes, namely *interactive, constructive, active* and *passive,* also known as the ICAP framework. In another research study on cognitive engagement through similar chains of learning events, Jeong (2005) presented a means of analysing state-based representations of interaction, comprising of a single learning activity known as an event, that can lead to chains of subsequent events triggered by peers, to which state attributes can be assigned.

These studies provide the foundation for the current study. The study potentially reaffirms the underlying concepts and provides further enhancements through new findings from observations and analysis. Most importantly, the study also potentially introduces new methods, adapted from the above established frameworks, to measure and evaluate the coherence of students' cognitive engagement. More information on the frameworks is included in Chapter 2 Literature Review.

1.6 Overview of the Dissertation

The study is conducted through a series of educational design-based research cycles. It aims to improve cognitive engagement in a collaborative learning environment, as mentioned in the sections above. The following paragraphs provide highlights covered in the subsequent chapters.

Chapter 2 presents a literature review of past established research work on cognitive engagement in collaborative learning environments. It will be in the form of conceptual frameworks introduced and developed by researchers in the field. In order to shape the design-based research work presented in this dissertation, the cyclical research approach will be mapped out and included at the end of this chapter.

Chapter 3 covers the educational design-based research methodology used to conduct the study and the analysis for this research work, through the use of online technology while completing case study assignments. This chapter also looks into other studies in design-based research which uses cycles of iterations that are more appropriate for the educational field.

Chapter 4 elaborates on the cycles of designing instructional strategies and activities, as well as the methods used in the processing of data, ranging from the collection of data inputs by the students during the completion of case study assignments throughout the running of an undergraduate course module across two academic years, to the extraction of data from questionnaires for perspective views of the participating students on the effectiveness of the instructional strategies in promoting cognitive engagement. It subsequently highlights the results at the end of the cycles, and outlines significant findings from the analysis of the data. Using conceptual frameworks and following the methods of data collection, extraction and transformation provided in earlier chapters, this chapter contains the evaluation of the data and the results of the findings that lead to the revisions, improvements and evaluations of the instructional strategies.

Chapter 5 discusses the findings laid out in the previous chapter, and include a set of design principles for teachers and practitioners to follow when they design and implement instructional strategies for similar collaborative learning environments, and a summary of possible explanations to justify the development of the study, the outcome of the analysis, and the conclusive findings that are established from the data collected. In the closing remarks, this chapter includes possible gaps in the study, and recommendations of further research work that can be performed to close the gaps. Other future research potentials that can be performed to examine collaborative learning in different perspectives in relation to the takeaways from this research work is also included. These possible future research work and their potentials are covered at the end of this chapter. An all-inclusive conclusion sums up the research work done in this study.

Chapter 2. Literature Review

This chapter presents the literature review for the current study. The main aim of this study is to look into the designing of instructional strategies for promoting cognitive engagement of diverse students in a collaborative learning environment. The following sections cover prior research related to the current study, focusing on research work on cognitive engagement (Section 2.1), collaborative learning (Section 2.2), and instructional strategies (Section 2.3). Important references of the ICAP framework (Section 2.4) and the dialogic interaction analysis approach (Section 2.5) are also provided. The chapter wraps up with some relevant empirical studies and the research gaps for this study (Section 2.6).

2.1 Cognitive Engagement

Engagement is considered an essential prerequisite for learning, and learning often begins with engagement. Alonso, López, Manrique, and Viñes (2008), citing earlier works, identified a learning process which consists of six stages. The series of stages starts off with *engagement and motivation*, and is followed by knowledge and understanding, performance and action, reflection and critique, judgement and design, and commitment and identity. It can thus be viewed that learning begins with engagement, which subsequently leads to knowledge acquisition and understanding. Once a student understands, it increases the student’s capability of performance or action. The student’s critical reflection on performance and action continues to lead to higher-order thinking, which enhances the student’s ability to exercise judgement in unfamiliar and uncertain situations and challenges, and to create innovative solutions within the constraints and limitations. Finally, upon exercising judgment comes commitment, where the student increases the capability to recognise new knowledge and understandings, thus internally committing and building up a mental schema. This process allows the student to begin another level of new engagement, and the new cycle continues.

Engagement that occurs during in-class and out-of-class settings has been viewed to have more than one dimension (Baron & Corbin, 2012; Fredricks, Blumenfeld, & Paris, 2004; Gunuc & Kuzu, 2015; Zepke, 2014). These pedagogical studies have identified three different dimensions of engagement, namely *behavioural*, *emotional* and *cognitive*. From consolidated earlier works, engagement is outlined as a learning experience where students, drawing from their varied backgrounds, actively participate in learning and experiencing together, by means of an interactive approach (Macfarlane, 2015; Newswander & Borrego, 2009). It is suggested that engagement entails a *behavioural* dimension, which is outlined by the participative actions of students. It is also noted that engagement has an *emotional* dimension, where students will often establish a relationship with other students and the learning environment. Lastly, engagement has a *cognitive* dimension, which reflects the way students go about processing information and learning more effectively (Fredricks, Blumenfeld, & Paris, 2004).

Behavioural engagement is seen as the most observable and easily measureable of the three components of engagement (Appleton, Christenson, & Furtong, 2008). It often includes class attendance, participation in classes, completion of assignments and tasks, paying attention in classes and asking questions (Fredricks, Blumenfeld, & Paris, 2004; Gerber, Mans-Kemp, & Schlechter, 2013; Krause & Coates, 2008). Emotional engagement is related to student’s feelings and reactions, which includes resilience, perseverance, attitudes, interests, relationships and values towards the course content, class, teachers and peers (Bryson & Hand, 2007; Harper & Quaye, 2009; Sutherland, 2010). Several other studies in the emotional aspect of engagement include the feeling of belonging, and the joy of being accepted as a member of a group or class (Askham, 2008; Kahu, 2013).

Cognitive engagement refers to students' approaches towards understanding and learning. It encompasses investment in deep learning of concepts and skills, learning goals, learning motivation, love of learning, and other similar factors (Appleton, Christenson, Kim, & Reschly, 2006; Fredricks, Blumenfeld, & Paris, 2004; Walker, Greene, & Mansell, 2006; Zepke, 2014). In order to study how to measure cognitive engagement, indicators of cognitive engagement are defined as measureable markers for the specific purpose of establishing a cognitive occurrence (Skinner & Pitzer, 2012). These indicators of cognitive engagement must be action components, which encompass involvement, focus, concentration, captivation, interest, and motivation to extent further beyond expectation. These action components can be inferred from students' overt interactions in the learning activities, which include on-task behaviour, classroom and online discourse, and homework completion.

However, measuring cognitive engagement accurately through the above indicators is not straightforward. Axelson and Flick (2011) criticized that in many studies, the measurement of behaviour alone is often implicitly taken as a proxy for emotional and cognitive engagement, not to mention a proxy for learning itself. They asserted that for the purpose of an accountability measure to provide an index for students' cognitive depth of involvement in their learning, considerations have to be made towards the students' level of involvement in the process of knowledge construction. A common method of assessment for cognitive engagement is self-report survey, where students are given questionnaires to reflect on various characteristics of engagement, and they have to choose the response that best describes them (Fredricks & McColskey, 2012). These self-report methods are mainly used for evaluating cognitive engagement which cannot be directly observed, and can only be inferred from overt behaviours. It is suggested that self-report methods are most appropriate in measuring cognitive engagement, as the compilation of data using other methods, such as teacher rating scales and observations, are highly dependent on inferences (Appleton, Christenson, Kim, & Reschly, 2006). However, a critical limitation of self-report measures is that the inputs from the students may not be truthful, especially if they are conscious that the survey is conducted by their teachers without the provision of anonymity. As such, self-report methods can potentially fail to capture the actual level of cognitive engagement.

Another indicator to measure cognitive engagement involves the use of experience sampling, where students carry electronic devices within a defined span of time, and upon receiving a prompt, complete a questionnaire which require them to report their venues, events, actions and cognitive activities (Hektner, Schmidt, & Csikszentmihalyi, 2007; Shernoff & Schmidt, 2008; Uekawa, Borman, & Lee, 2007). This approach facilitates the compilation of comprehensive data on cognitive engagement at an instance, which reduces problems of inaccurate recollection and biased replies due to social pressure. This method can also facilitate the analysis of any changes in cognitive engagement at different times or conditions. However, there are a few limitations to this method. To collect an adequate amount of data, a large amount of time is needed. There is also a heavy dependency on the students' willingness to participate. Furthermore, cognitive engagement may also be inferred from multiple perspectives, and may possibly be insufficiently covered by the questions in the questionnaire.

For this study, cognitive engagement is defined as the quality and quantity of students' cognitive effort in the context of in-class and out-of-class instructional strategies and activities, and to the learning process, so as to achieve the desired learning outcomes (Gunuc & Kuzu, 2015). Hence, the approach of measuring cognitive engagement is based on observing and analysing the finer grained reactions and activities of students, as they engage in open information exchanges through discussions, reasoning, negotiations and comments, while they involve themselves cognitively in collaborative learning (Axelson & Flick, 2011; Chi & Wylie, 2014). Cognitive engagement while in the process of learning is known as active learning, and can be measured using the ICAP framework (Chi & Wylie, 2014). Section 2.4 covers the ICAP framework in detail.

2.2 Collaborative Learning

Although collaborative learning is not a new term and is rooted from Lev Vygotsky's Zone of Proximal Development (ZPD) concept of learning, increasing interest in its application has developed steadily during the 1990s, a period which coincided with the progressive advancement of the Internet and began an evolutionary transformation in educational technology.

Collaborative learning is initially viewed as a general term for a range of educational approaches, which involves collective effort by students learning together, and reciprocally seeking for answers, solutions, meanings, and concepts, in order to produce a joint creation (Smith & MacGregor, 1992). Since then, subsequent studies have explored further by providing more details to the meaning of the term *collaborative learning*. It usually involves an assignment or issue that has to be resolved by a group of students working together (Cohen, 1994). A more elaborate definition has further deemed collaborative learning as the attainment of skills, know-hows or proficiencies through group interaction, where group members distribute work and develop joint understandings of the assigned task (Derycke & D'Halluin, 1995). A description of collaborative learning also states that it involves a range of interactions amongst students with the aim of achieving a shared goal (Dillenbourg, 1999). Other studies have further outlined collaborative learning as a setting where two or more students learn together

(Dillenbourg, 1999; Lee & Smagorinsky, 2000; Mitnik, Recabarren, Nussbaum, & Soto, 2009). Collaborative learning has also been described as a learning effort in which students proceed to jointly learn with others and become proficient in a specific subject matter together, and is especially constructive in classrooms with students from various backgrounds (Koehn, 2001). In a similar study on joint construction in collaborative learning, it is observed that as learners' progress through collaborative activities with supportive clues and hints in a software environment, there is a significant increase of *high quality collaboration (HQC)* instances, which is defined as a form of collaboration where learners were able to co-construct their knowledge and understanding of the computer-aided tasks together (Gutiérrez, 2006).

In recent studies, *collaborative learning* has been defined distinctively different from *cooperative learning*. Cooperative learning is the instructional use of small groups to promote students working together to maximize their own and each other's learning (Johnson, Johnson, & Holubec, 2008). Nicolson and Uematsu (2013) added on and asserted that cooperative learning should be taken to be "a process, whereby tasks are separated and assigned in advance, which group members carry out or solve independently" (p. 271). Collaborative learning, on the other hand, is aligned with the definitions and descriptions provided at the start of this section. It is more of an on-going process that involves two or more students who synchronously and interactively build upon a joint solution for tasks and outcomes (Curtis & Lawson, 2001). Nicolson and Uematsu (2013) further emphasized that the focus of learning in a collaborative environment is on the quality and extent of promoting cognitive engagement through the interactive exchanges among the students, where the process and production of knowledge resulting from the interaction among students is the desired outcome (Leinonen, 2007).

Theoretically, collaborative learning and cooperative learning are indeed different. Nevertheless, a number of researchers have also suggested that theoretical constructs and guidelines from both approaches are similar and can be used together (Slavin, 1999, Terzić, 2012; Tu, 2004).

Theories in collaborative learning revolve around four items, namely *situations*, *interactions*, *processes* and *effects* (Dillenbourg, 1999). Learning *situations* can be favourably collaborative if the students are *interdependent* on each other, are more or less *symmetry* in academic level, capable of performing tasks of similar difficulties, share common goals, and are able to work together with low division of labour. Collaborative *interactions* further involve three criteria, namely *interactivity, synchronicity* and *negotiability*. *Interactivity* is the extent to which interactions *influence* the peers' cognitive processes. *Synchronicity* among students is described as the feeling of *reasoning* synchronously towards increasing the group process of mutual modelling, i.e. the effort produced by a student to model the knowledge state of the other students. *Negotiability* involves collaborative students having the possibility to negotiate how to interact, usually through meta-communication, and the availability of a space for negotiation or a space for misunderstanding.

Processes are mechanisms that are specific to collaborative learning. Dillenbourg (1999) explained that collaborative learning is not one single mechanism. In order to understand learning from collaboration, it is necessary to study the *individual cognition* of students learning by themselves. Students, seen as individual cognitive systems, do not learn because they are made up of individuals. They learn because they perform individual cognitive activities, such as reading, constructing, inferring, self-explaining, and conflict, which trigger learning mechanisms that include induction, deduction, compilation, and cognitive load. Learning processes specific to interactions include *internalisation* process where a student transits from engaging in interaction to reasoning and subsequently cognitive change, and *appropriation* process where a student reinterprets his or her own action by referring to what the other students say or do next. These examples of *group cognitive processing* imply the existence of differential reasoning, and that the perception of discrepancies with respect to the knowledge of peers increases the awareness of one's own knowledge.

The last item focuses on how to measure the *effects* of collaborative learning. Dillenbourg (1999) continued to explain that a collaborative learning situation includes a variety of contexts and interactions. Therefore, one should not be concern about the effects of collaborative learning in general, but more specifically about the effects of particular categories of interactions. Categories of interactions include the distinction between social conflicts (i.e. accusations and criticisms not relating to the tasks) and cognitive conflicts (i.e. discussions, debates and resolutions of task conceptualisation), or the distinction between cognitive and metacognitive episodes.

A comparable framework of cooperative learning would be the five basic pillars proposed by Johnson and Johnson (2005). These pillars are identified as *individual accountability, positive interdependence*, *promotive interaction*, *social skills*, and *group processing*.

Johnson, Johnson and Holubec (2008) further elaborated and provided details for the five pillars. *Individual accountability* is defined as the measurement of whether the contribution of an individual member of a group has contributed to achieve the group's overall goals. It is the belief of each individual student that he or she is accountable for his or her contribution, performance, and progress. *Positive interdependence* is present when students perceive that they can reach their learning goals if and only if other students in the learning group also reach theirs. To further elaborate on this point, they claim that a member within a group cannot succeed unless all its members succeed, and that the group either swims or sinks as a whole. *Promotive interaction* is a set of characteristics in the tasks or learning activities that requires the students to engage in ongoing conversations, dialogues, exchanges and mutual supports. *Social skills* encompass communicating, building and maintaining trust, providing leadership and managing conflicts. Lastly, *group processing* entails a set of initiatives to allow the group to improve its work together continuously over time. These include setting the objectives for the collaborative activities, explaining to the students the expected actions throughout the activities, monitoring the activities and providing feedback, and facilitating students to reflect and improve on their work together.

With reference to the above literature, this study uses collaborative learning broadly as an adapted term to refer to *a process within a learning environment that supports high quality and extensive engagement in group interaction among individual students, with a common purpose of processing and constructing knowledge together.*

Also with reference to the above literature, five *components of collaborative learning for promoting cognitive engagement* are adapted for this study. They are *individual cognitive accountability, interdependent situations, influential interactions, reasoning and negotiations skills, and group cognitive processing*. Section 2.3 below provides a more detailed explanation of these components.

2.2.1 Computer-Supported Collaborative Learning. Many studies have reported the advantages of embracing collaborative learning. Literature has highlighted that collaborative learning enhances high academic achievement, promotes interpersonal relationships and social skills, and improves the attitudes of students working together (Johnson, Johnson, & Smith, 2007). This learning approach also promotes students to learn and collaborate, while actively constructing and reconstructing knowledge

(Barkley, 2010). Putting all these earlier assertions together, it is thus emphasized that collaborative learning potentially promotes engagement among students by creating a synergy for students to be motivated and empowered, increasingly within an active online learning environment (Monteiro & Morrison, 2014).

A recent paper by Hsieh (2017), citing earlier research findings, highlights the expanding effort of including computer programs and functions into collaborative learning. The rapid growth of studies in the area of *Computer Supported Collaborative Learning (CSCL)* has helped to understand how people can learn with the support of technology (Koschmann, 2002; Stahl, Koschmann, & Suthers, 2006), and investigate the extent to which collaborative learning processes occur through technology-supported interactions among students in online environments (Kessler, Bikowski, & Boggs, 2012; Lee, 2010; Li & Zhu, 2013). The collective conclusion that is gathered from these studies highlights that the benefits of CSCL, the scaffolding among peer learners, and the abundance of technical resources have significantly extended the use of such collaborative learning environments (Hsieh, 2017).

Apart from the above highlighted benefits, shared interactive representation in CSCL has also been identified as a major advantage for collaborative learning. Learning environments that support online engagement for collaborative learning have been studied extensively by Stahl, Koschmann, and Suthers (2006), particularly those that involve activities that support the exploration and construction of knowledge, and the embodiment of interaction within CSCL environments. In their study, it is proposed that CSCL serves as a means to construct *shared interactive representation*. With such an affordance of CSCL, students can search for information online, and criticise, debate, discuss, compile, and present what they have found as a team. This results in the discovery and construction of knowledge by the students, shared within their learning groups, and represented in the form of interactions. In using online connectivity and resources as a channel to share information, the students in collaborative groups can potentially engage in discussions as they gather information and present them collaboratively online. The advancement of collaborative technology, such as shared screen projections that display the integrated work of all learners involved in a joint task, also shows the ability to facilitate interaction and support group learning (Zurita & Nussbaum, 2007). These shared screen projections can further enhance communication among the learners, thus promoting effective shared knowledge constructed through collaboration (Chung, Leet, & Liut, 2013; Nussbaum et al., 2009). This shared interactive representation and exchanging of information online can also be conducted synchronously and asynchronously, thus removing the dependence of space and time altogether.

The extensive use of CSCL has progressively been observed in institutions for higher education across Asia, including Singapore (Tham & Tham, 2011). This beckons the need for students to make a radical shift away from the standard absorption model of simply receiving information, to active engagement in interactive tasks and constructive knowledge creation, which can be gradually explored through collaborative learning. CSCL cannot be effective simply by digitizing classroom contents and dissemination to large numbers of students (Stahl, Koschmann, & Suthers, 2006). The posting of classroom contents, such as slides, texts or videos, does not make compelling instructions. Although they are important resources for students, they can only be effective with instructional strategies and activities to facilitate and promote coordination, motivation, and student engagement in CSCL.

It is suggested that an online collaborative learning environment is a possible alternative to the traditional classroom approach (So & Bonk, 2010). As an online learning environment allows students to coordinate across different modes of communication, it can better support collaboration and provide continuality when collaboration involves multiple time and space. While it is considered that CSCL has become an important part of the learning experience for university students, the way the students perceive and approach such learning is equally important. In the context of CSCL, online learning approaches do not aim to replace face-to-face interactions among group members, but instead to enhance the collaborative learning process by providing multiple resources (So & Bonk, 2010). Collaborative learning in CSCL environments has also been gradually transforming the role of students from being passive learners to being owners of knowledge construction. In the process of getting the students to be involved in interactive activities, this transformation also evolves the traditional role of the students from passively receiving information where the students only internalise the facts, to actively participating in the construction of knowledge and understanding (Pérez-Marín, Hijón-Neira, & Santacruz, 2016).

However, Pérez-Marín et al. (2016) had also raised concerns that not all students can readily accept this role transformation. These students fear failure, or may appear to be weak or incompetent, because of the exposed nature of the newly introduced approach to learning. In particular, it has been highlighted that the primary challenge for active learning when applied in collaborative learning environments is to maintain a high level of engagement. It has also been observed that some students may even resort to simply making their own notes and subsequently studying by themselves without having to meet or interact with others, as this approach of evading collaboration with other students is perceived to be easier (Brown, 2000).

A study on the quality of interaction among students by Smith, Sheppard, Johnson, and Johnson (2005) emphasizes the importance of students becoming active students, so as to apply a deeper approach to learning, as well as become acquainted with other students towards building a sense of community through the process of learning together. To reach this high quality in student interactions, traditional teacher-directed instructions have to be reshaped towards student-centric activities, where teachers cease their role of solely knowledge transferring and transform themselves into guides to students experiencing learning through the interactive student-centric activities.

Therefore, even with an active learning environment based on the CSCL models in place, collaborative learning cannot be assumed to spontaneously play out on its own. By simply introducing the use of CSCL without the support of instructional strategies, there are raised questions which concern the effects on both the quality of interactions between students and the experience of students and teachers (Curtis & Lawson, 2001). Other forms of collaborative learning disruptions involve students who shy away from interacting with peer students and are more inclined towards studying alone. For effective collaborative learning to occur, supportive instructional strategies would be necessary for every student within the group to engage and participate actively in the learning process, and contributing sufficiently to the group work (Wang, 2009).

The above observed challenges strongly highlight the fact that the positive benefits of collaborative learning claimed in many studies do not automatically happen in collaborative learning environments. Designing effective instructional strategies to enhance engagement in collaborative learning is also crucial (Wang, 2010).

2.2.2 Case-based Collaborative Learning. For this study, a thorough look into rudiments of collaborative learning, especially with the use of case-based assignments, is necessary.

Case-based learning (CBL) is a common pedagogical approach for many disciplines through the decades in classroom-based higher education. Progressively, CBL is becoming progressively common in higher education, both in classroom and online learning environments (Reinmann & Mandl, 2006). The use of case studies has also been engaged in many disciplines, such as business (Weil, Oyelere, Yeoh, & Firer, 2001; Weil, Oyelere, & Rainsbury, 2004), medical (Hege et al., 2007; van Dijken et al., 2008), teacher education (Zottmann et al., 2012) and accountancy (Weil, McGuigan, & Kern, 2011), among other fields.

Citing earlier works, Çam and Geban (2017) described CBL as a form of student-centric approach to learning. The study highlights CBL as consistent with constructivist approaches as students participate actively and construct their own knowledge (Koballa & Tippins, 2004). Cases are real or frictional stories that have specific pedagogical and learning objectives, and thus sufficient materials related to the situation in the field of study should be provided in the case (Naumes & Naumes, 1999). CBL has also been referenced with problem-based learning (PBL), as pointed out by Çam and Geban (2017). Although there are similarities between these two approaches, it is necessary to note that CBL and PBL have differences in terms of cases. As the name goes, PBL involves problem situation, whereas CBL involves a story or scenario with a learning objective. Similarities are observed in CBL and PBL in that both use stories in the instructional process.

There are many advantages in using CBL. Firstly, as it is necessary for modules to cover inter-disciplinary applications in business, finance, security, logistics or other commercial domains to support diverse functionalities, the CBL approach helps by providing events in a context or situation that aims to promote effective learning. It is emphasized that CBL offers students an opportunity to work on genuine and composite scenarios, that helps to induce a deeper understanding in applying to real professional settings (Kopp, Hasenbein, & Mandl, 2014). CBL also supports the integration of ideas through collaborative activities, and contributes towards enhancing the capability of working in a group (Williams, 2005).

Case-based collaborative learning (CBCL) refers to an alternative small-group instructional method that borrows from the principles of case-based learning and collaborative learning (Krupat, Richards, Sullivan, Fleenor, & Schwartzstein, 2016). Case-based learning and collaborative learning approaches share similar advantages. Students typically prepare by analysing cases and discuss in groups, such as recognizing key characters, defining the primary concerns, and evaluating internal and external conditions (Jenlink, Stewart, & Stewart, 2012). Similar to case-based learning by individual students, students often need to collaboratively identify the perspectives of the key characters by placing themselves in similar positions. This first-person perspective involves establishing resources, affiliations, and constraints; identifying decisions to be made; identifying alternative solutions; determining sources and nature of conflicts; and foreseeing and reviewing the possible results. The advantage of this process of discussions and debates allows students to apply theoretical paradigms and concepts, develop theory from practice and implementing practice from theory, and learn from the knowledge shared by fellow students.

Research studies on CBCL can be found in literature, ranging from case scenarios used as examples in lectures, as preparation for class discussions, and as discussion points to encourage inquiry by students (Baeten, Dochy, & Struyven, 2012). In using cases, simulations of role-play, discussions of specific topics and correlations of knowledge acquired from past modules and experiences are activities claimed in the literature that encourage and promote critical thinking and generation of creative solutions.

Studies have shown that the learning approach of synthesising case-based and collaborative learning together has been able to determine how cognitive activities and metacognitive regulation during CBCL contribute to explain the differences in collective understanding (Khosa & Volet, 2014). Dowell and Asgari-Targhi (2008) also pointed out that case scenarios are suitable tools for collaborative learning, as they can stimulate spontaneous debates and discussions. A case presents information in the form of a scenario which involves one or more issues, and these issues give ample opportunities for students to explore and provide solutions.

Although CBCL has become an established part of vocational and professional training, it is cautioned that the designers of learning environments for CBCL have to understand how learners learn through collaboration (Dowell & Asgari-Targhi, 2008). The design of the instructional strategies and activities within the learning environment should eventually be able to effectively engage students cognitively.

The advancement of technologies has raised some issues where collaborative, distributed and non-linear forms of engagement are introduced as educational approaches (Bower, 2017). Engagement in CBCL can be complex and confusing, when co-presented and distributed digitally in granular entries online, as well as in non-digital world of discussions and debates done with post-it notes and postcards on a classroom wall (Laurillard, 2009). An online approach using tools such as emails, discussion forums and chat groups tend to produce scraps of information hidden within the spaghetti of exchanges, which is not ideal as the quality of engagement would be lacking. Although emails, discussion forums and online chat groups offer the features for students to reply, forward, attach, save and delete discussions, information may also be dumped unpredictably in the junk mailbox, or be lost in a long series of exchanges. This chaotic form of engagement where information can "travel different places in one journey" (Larsen, Urry, & Axhausen, 2008, p. 653), makes it difficult for students to follow the evolution of the discussion, or learn anything from the overall idea of multiple discussions, which is spread out in mailboxes and folders which is not designed to be in a meaningful structure (Wang, 2010).

Collaborative editing online tools, such as Google Docs, may be used to create possible collaborative online learning environments for CBCL. The collective editing of text, comments and peer feedback do not only promote interaction among the students, the dialectical activity is also a process of knowledge construction (Behar, Macedo, Passos, & Passos, 2009). In their study on collective text editing, Behar, Macedo, Passos and Passos (2009) also highlighted the strong association of students involved and objects, such as supporting material, tools of the learning environment, and the content of the documented discourse. Viewing it as a progress towards knowledge construction and deeper learning amongst the students, they suggested that in a process of collective authorship, the students would benefit through coordination of different viewpoints in the course of analysing, discussing and commenting on the inputs made by fellow students in reviewing case studies. This displacement of perspectives through the use of interactive co-authorship in case study learning activities is viewed as a channel for students to collectively create new insights, connect to referenced prior works and write contents. It results in building new knowledge as well as increasing group awareness (Macedo, Reategui, Lorenzatti, & Behar, 2009), where group members become more informed about the other members' writing and more conscious about being engaged in a collaborative team work (Tammaro, Mosier, Goodwin, & Mosier, 1997). As such, an online collaborative editing tool, such as Google Docs, would have great potentials for creating a collaborative learning environment. With its synchronous and asynchronous features, it promotes self-regulating, self-coordinating and self-organising for contributions and exchanges among students learning in groups (Winne & Nesbit, 2009).

However, it has been highlighted that studies on the use of instructional strategies to support case-based learning are rare (Zottmann et al., 2012). Citing an earlier empirical study, Zottmann et al. (2012) concluded that learning may not even occur when cases are used alone without having proper instructional support in place. In their empirical study involving pre-school teachers as students, it is highlighted that instructional support, through the provision of different perspectives constructed from comments by fellow students in a computer-supported case-based learning environment, has resulted in students benefiting from constructive feedback from peers. The positive effects of instructional support for collaborative learning in multiple perspectives are related to a collective form of competency of the students in analysing case studies. This form of learning support successfully fosters the ability of the group as a whole to apply conceptual knowledge collectively, and enables students to extent their understanding past their own perception (Koury et al., 2009; Zumbach, Haider, & Mandl, 2008).

Apart from the above few studies, research efforts to further explore possible instructional strategies to facilitate, enhance and promote cognitive engagement in a collaborative learning environment appears to be lacking in the literature.

2.3 Instructional Strategies for Collaborative Learning

For this study, instructional strategies have been defined as instructional methods that include specialized instructional stages which are aligned with the specific purposes and context of the subject for students to gain the desired learning outcome (Silver, Hanson, Strong, & Schwartz, 1996). It is highlighted that instructional strategies have a significant impact on the quality of learning (Baker & Dwyer, 2005). These instructional strategies determine the instructional activities to be introduced in the instructional process, and the teaching and learning methods to be used in the process. The underlying factors in selecting the instructional strategies to use in the process include the instructional approach and activities, the conceptual theories, and the appropriate models adopted (Eristi & Akdeniz, 2012).

Instructional activities often refer to the collection of teaching and learning tasks from which teachers and educational designers select for students to complete (Chi & Wylie, 2014). It is also proposed that instructional strategies and activities can be interconnecting and overlapping, where they can be used together in a single approach to learning (Wang, 2010). For instance, it has been observed that instructional strategies and activities which encompass role-playing, discussion, collaborative learning and case studies can be used together in a lesson. There are conventional learning activities which are commonly adopted for specific instructional strategies (Wang, 2010). Such activities that normally occur in the process of instruction are known as facilitators, and are explanatory causal factors that have the potential to influence cognitive engagement (Skinner & Pitzer, 2012). Facilitators include informing students of the aims and objectives, uncovering misconceptions, stimulating recollection of prior learning, distributing the learning materials, offering learning support, promoting enquiry of knowledge, simulating thinking, encouraging discussions, coordinating interactions, eliciting performance and providing feedback about performance correctness.

As such, instructional strategies can be introduced to promote cognitive engagement in a collaborative online learning environment. The next sections provide details of possible instructional strategies for collaborative learning based on the five components of collaborative learning for promoting cognitive engagement.

A visual overview of how instructional strategies are designed and introduced into a collaborative learning environment for promoting cognitive engagement is provided in Figure 2.1.

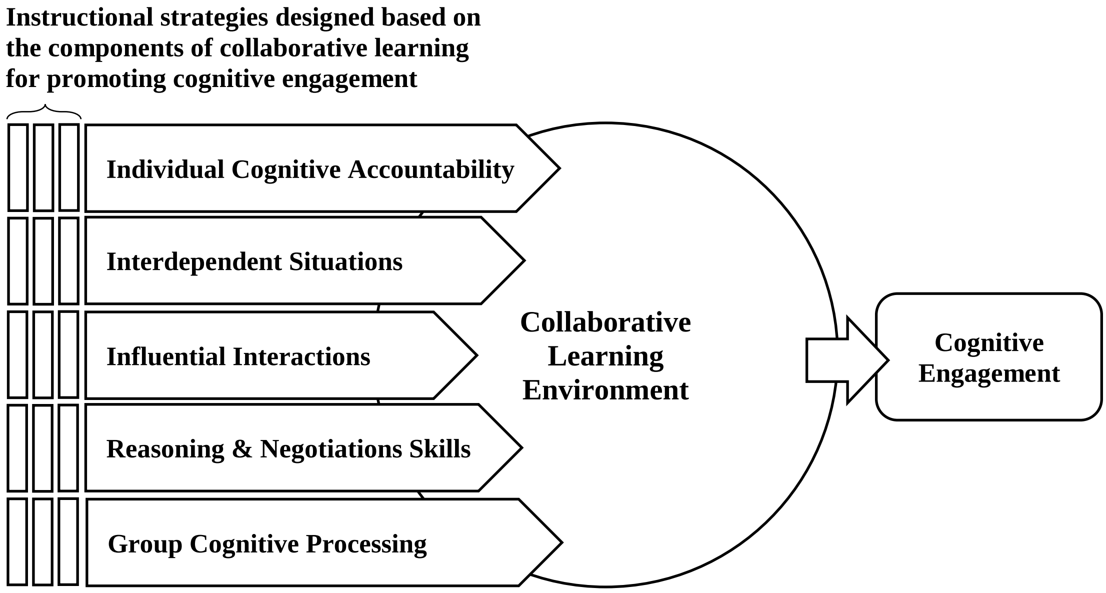

Figure 2.1: Instructional strategies based on components of collaborative learning

2.3.1 Individual cognitive accountability. This component is adapted from individual accountability, which is the extent to which the contribution of an individual member of a group has added towards achieving the group's generally goals (Johnson, Johnson, & Holubec, 2008). As such, each individual believes that he/she is accountable for his/her own cognitive effort, contribution and performance.

The individuals that compose most project groups would usually possess a range of diverse skillsets and abilities. Apart from the diverse cognitive capability, knowledge capacity and domain expertise of each group member, what makes each individual student unique is also the broad spectrum of complimenting or, in some occasions, opposing perspectives and attitudes towards different subject matters. The interaction of members within these learning groups gives rise to the possibility of collaboration among these individuals, supplementing each other, and making reciprocal contributions to a given task (Järvelä, Häkkinen, Arvaja, & Leinonen, 2004). Nevertheless, the completion of a complex task is still the sum of the cognitive efforts contributed by each individual student, and each student is held accountable for his or her contribution of the work.

Should every member in the group conforms strongly to the critical role of making fair and equal individual contributions to the group work, due to an unwavering belief that as individuals they are individually accountable for their share of cognitive effort in the group, a collaborative system within the group can be sustained. However, it has also been found that individual cognitive accountability is not easy to establish and maintain within a group. Establishing it has to do with effective communication and coordination (Wang, 2010), and sustaining it has to be a shared commitment among the group members (Bane, 2004).

With the feature of individual cognitive accountability apparent among the student group members, studies have shown that the students would often take ownership of their individual learning progress (Moallem, 2003; Neo, 2003; Kirschner, Strijbos, Kreijns, & Beers, 2004). Therefore, by participating in collaborative learning, students who possess the traits of individual cognitive accountability are potentially self-regulators of their own learning progress (Milner-Bolotin, 2001).

2.3.2 Interdependent situations. Dillenbourg (1999) asserts that learning situations can be favourably collaborative if the students are interdependent on each other, are more or less symmetry in academic level, capable of performing tasks of similar difficulties, share common goals, and are able to work together with low division of labour. Johnson, Johnson and Holubec (2008) also put forth the notion that positive interdependence existed when students believed that they were able to attain their learning goals only if other students in their group were also able to reach theirs. This means that a member within a group cannot be successful in reaching his or her goals unless all its members are also successful in reaching theirs, and that the group either swims or sinks as a whole.

Just like with the presence of individual cognitive accountability, interdependent situations in the context of teaching and learning through collaborative editing and creation of new knowledge would require preparatory communication and coordination. Without such proper preparation in place, some critical challenges may surface. A potential challenge is the “free-rider” effect (O’Neil & Drillings, 1994). This kind of effect is related to social loafing, which is the tendency to contribute reduced amount of work when one is part of a team. Another challenge is to coordinate a shared understanding to complete the complex task in an effective and efficient manner by integrating differing perspectives (Bossche, Seger, & Kirschner, 2006; He, 2009). It is found that these challenges arise due to varying backgrounds, work styles, communication preferences and expectations.

2.3.3 Influential interactions. This component is adapted from promotive interaction, which is defined as a set of characteristics in the tasks or learning activities that requires the students to engage in ongoing conversations, dialogues, exchanges, and mutual supports (Johnson & Johnson, 2005). Students learning together need to promote each other’s learning and success by sharing resources, assisting each other, reviewing each other’s work, and supporting, motivating and encouraging each other’s efforts. These activities must also involve cognitive element for them to be meaningful, and not simply “going through the motion”. As such, the degree of interactivity among the students should not be defined by the frequency of interactions, but by the extent to which these interactions *influence* the cognitive processes of peers (Dillenbourg, 1999).

In collaborative learning, students are expected to learn from the group work, and improve interpersonal and small group interaction through teamwork. However, there are expected situations of communication breakdowns and conflicts that arise during discussions, where seeking a common understanding or resolution among students with strong individual views can be extremely difficult. Relevant instructional strategies are necessary to provide support for promoting influential interactions.

2.3.4 Reasoning and negotiations skills. Students must learn to communicate effectively with their fellow students for maximum academic success. They must know how to maintain a sense of *synchronicity of reasoning* while, to some extent, *negotiate*, justify, and attempt to convince others to accept their viewpoints (Dillenbourg, 1999). However, students may not able to automatically reason and negotiate effectively with other members in the group, especially during collaborative learning. The novel use of collaboratively working together using co-editing tools and methods makes interacting even more unnatural.

Thus, the students need to be supported with instructional strategies to know what is expected of them in order to communicate effectively and productively on the group assignment. They would need to be instructed on how to share and present information and knowledge to the rest of the group. They would also need to display the skill of listening to others, and manifest their learning in their replies and inputs. An appropriate instructional strategy would be able to promote *reasoning and negotiation skills* among students, so as to achieve success in collaborative interaction and learning.

2.3.5 Group cognitive processing. It is also important to facilitate students to engage in group cognitive processing, where students mutually reflect, remodel and reinterpret their collective understanding under the light of the information that has been shared by the rest in the group (Dillenbourg, 1999). The perception of discrepancies with respect to the knowledge shared by other students will also increase the awareness of one’s own knowledge. Such engagement in group learning and knowledge consolidation from collaborative activities has been performed through different approaches. For example, it is highlighted that written assignments in collaborative learning are frequently represented by individual efforts coarsely stapled together, and multi-authored works lack significant group enhancement (White, 2002). Writing is seen as essentially a private activity, and it will take "structured critique and revision cycle with conscientious input to generate seamless documents of substance written by groups" (White, 2002, p. 196). It is suggested that instead of laboriously orchestrating students to write collectively on one case study, each student can write individually on a topic as an evolving disclosure of a case scenario, identify the central concepts to be developed, organise them and produce an engaging narrative to be presented to the rest of the group. The rest of the students will then take on opposing views and debate on the original case. This approach of group cognitive processing not only taps the diverse perspectives of others in the team, students that initially review the case studies are also able to put themselves in the role of a teacher, reflect on the constructivist pedagogy and thereby develop into better collaborative students.

2.4 ICAP Framework

As this study focuses on the use of instructional strategies towards improving cognitive engagement in collaborative learning, the processes for measuring cognitive engagement are examined. This form of engagement while in the process of learning is also known as active learning (Chi & Wylie, 2014). Citing earlier works, they put forth the meaning of active learning as learning that requires a student to engage cognitively and constructively with the materials provided, and to be participative in the learning activities and information provided, rather than passively receiving it.

Cognitive engagement is the extent to which a student engages with the learning materials, and it can be observed from the student's overt behaviour while undertaking a learning activity in the context of an instructional strategy or learning task, as a reliable proxy to reflect a difference in knowledge-change or learning process. The learning activity and its resulting overt engagement behaviour can be characterised as one of four identified modes, namely; *interactive*, *constructive*, *active* and *passive (ICAP)*.

Each engagement mode can be mapped to distinctive sets of supporting knowledge-change processes (Chi & Wylie, 2014). It is asserted that the *passive* mode occurs when students are oriented towards absorbing information from the instructional materials without displaying any overt behaviour related to learning. Some examples include students attending and listening in a class with no obvious action, and watching an educational video and not taking any notes. Although it is possible for students to internalise and process the information while listening in a class or watching a video, with an obvious mannerism of passive engagement, this form of engagement is mapped to the *passive* mode, which in the ICAP framework is the lowest mode of engagement.

Students' engagement can be taken to be in the *active* mode if some form of observable motoric action or physical manipulation occurs. Using this observation as a distinctive characteristic of being active, studies in literature have provided numerous examples of such active learning behaviours, such as carefully inspecting an object by rotating it (James et al., 2002), or searching for items in a setting from a given description (Kastens & Liben, 2007). With respect to performance measures, active behaviours often excel ahead of passive behaviours. From the perspective of learning measures, participating in active activities extends the learning progress beyond passive activities, as can be seen when students replay sections of a recording in order to review selectively different parts of the video (Chi, Roy, & Hausmann, 2008), reproducing steps of a solution to a problem (VanLehn et al., 2007), or underlining specific sentences which they perceive to be of high importance (Katayama, Shambaugh, & Doctor, 2005).

The behaviours that belong to the *constructive* mode are those which involve students constructing or producing additional outputs or information, beyond the given learning materials (Chi & Wylie, 2014). As such, the criterion of the *constructive* mode is one that involves a generative behaviour. To meet this criterion, the output of the generative behaviour should include new ideas that go beyond the information given, where a student can draw out a concept map (Biswas, Leelawong, Schwartz, & Vye, 2005), integrate several words and diagrams (Butcher, 2006), converge different multimedia resources into one report (Bodemer, Ploetzner, Feuerlein, & Spada, 2004), introduce new causal relations and hypotheses (Suthers & Hundhausen, 2003), extract analogies and inferences (Chinn & Malhotra, 2002), generate a series of events in accordance to historical phenomena (Dawson, 2004), or reflect upon internal comprehension and other self-regulatory thoughts (Azevedo et al., 2006). It is important that the output must go beyond the given materials. Where a student produces an analogy as an exact copy of the materials provided, then the student is actively reiterating rather than constructively, as no new information is produced.

The ICAP framework is completed with behaviours that are characterised under the *interactive* mode (Chi & Wylie, 2014). They define interactive behaviours to students' dialogues that meet two criteria. The first criterion is that two or more of the students' messages must be largely constructive. The second criterion is that there must be an adequate amount of message exchanges among the students. Dialogues become interactive when two or more students exchange ideas, resulting in the creation of new ideas that none of the students knew before, or had the ability to produce them as individuals. These mutual exchanges of ideas indicate that the students substantially contribute to the content of the exchanges, by providing defences and arguments for a viewpoint (Weinberger & Fischer, 2006), offering critics of the positions of others by requesting for justification or elaboration (Okada & Ishibashi, 2016), questioning and replying to the queries of others (Staarman, Krol, & van der Meijden, 2005), clarifying misconceptions to each other (Roscoe & Chi, 2007), or enhancing each other's contributions by building upon shared ideas (Sullivan & Wilson, 2015).

From the set of knowledge-change processes mentioned above, each mode predicts a different level of cognitive engagement, such that the *interactive* mode of engagement will reflect the highest mode of cognitive engagement, followed by *constructive*, *active*, and lastly, *passive* mode. The ICAP framework thus depicts the different levels of engagement observed from different modes of overt behaviours as a proxy of cognitive engagement.

For this study, the underlying knowledge-change processes can be observed from the exchanges in the discourse among students as they involve in collaborative work. Segments of exchanges of utterances can then be clustered into sets of distinctive utterance chains. The sets of utterances chains can subsequently be evaluated using the above ICAP modes of cognitive engagement.

2.5 Dialogic Interaction Analysis

It is suggested that *utterances* in a dialogue are messages that are exchanged and perceived in the context of the specific setting and purpose of the activity in which the dialogue takes place (Bakhtin, 1986). Each utterance must be in relation to the rest of the dialogue that it precedes and follows. As a result, the meaning of the issue discussed in a dialogue does not exist in a single utterance. Instead, the meaning is constructed from progressive interrelationship of the utterances collectively. Through the exchange of utterances in a dialogue, the understanding and interpretation of an issue are constantly revisited and reconstructed. As such, learning through conflicts and arguments that arise from the exchanges are what motivate deeper inquiry, reflection, and understanding of individual viewpoints and perspectives (Jeong, 2005).

Indeed, literature on collaborative learning shows that the conflict and argument of both sides of an issue are needed to motivate inquiry, reflection, articulation of individual viewpoints and perspectives, and to achieve deeper understanding (Jonassen & Kim 2010; Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2013). This is achieved by engaging learners in dialogic argumentation as an educational approach to prepare them for more complicated issues by actively participating in knowledge generating communities (Jeong & Frazier, 2008; van Amelsvoort, Andriessen, & Kanselaar, 2007). It requires learners to establish arguments, defend views, articulate and review critiques, revisit and clarify misconceptions, and eventually understand the issues at hand (Aleixandre-Jimenez, 2007; Cho & Jonassen, 2002).

Focusing specifically on conflicts, two main assumptions are proposed: Conflicts are not produced by ideas from one single utterance alone, such as a claim or an argument, but by the comparison of opposite ideas embedded in an exchange of messages (Jeong, 2005). Conflicts produced in such exchange help to trigger successive dialogues that aim to *verify (argument → claim → evidence)* or *inferring (argument → claim → explain)* specified arguments and claims. The analysis of dialogic interaction fits this study, focusing on *message-response pairs (argument → evidence, challenge → explain),* and not isolated utterances. Such interaction patterns are forms of reasoning called *argumentation schemes* (Dowell & Asgari-Targhi, 2008). It is suggested that collaborative learning not only involves a characteristic argumentation scheme to which learning will be systematically related, learning outcomes are also consistently associated with the argumentation scheme. As such, this study recorded and examined an equivalent dialogic scheme for collaborative learning online using a table of utterance annotation

(Table 3.1), and identified markers that presented evidences of claims, arguments, explanation, and other indicators of cognitive engagement.

Some studies have proposed the use of dialogic interaction analysis to study teaching and learning online (Bakeman & Quera, 2011; Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). In these studies, dialogic interaction analysis is used to evaluate group interactions in computer mediated communication, especially in relationships of messages and interactions that support cognitive engagement. Dialogic interaction analysis is commonly used to study student interactions in threaded discussions, where messages in threads are hierarchically organized with main headings, supported by successive responses in trailing subheadings. This form of online interactions enables students to easily review and selectively reply to messages that are exchanged anywhere in the discussion. As these messages and responses are organised in in the form of links and threads, data analysis of each unit of interaction by dialogic analysis is achievable.

For the current study, interaction was recorded and analysed in collaborative learning sessions, where the exchanges of utterances by students represented dialogic interactions containing indicators of cognitive engagement. Although the utterance exchanges were similar to entries in the discussion platforms, research into dialogic interaction analysis of such exchanges for collaborative learning had not been widely studied. Therefore, this study analysed the dialogic interactions of the students engaged in collaborative learning, and evaluated the effectiveness of the instructional strategies towards improving cognitive engagement.

2.6 Empirical Studies and Research Gap

Recently, there are a few studies using collaborative learning as a pedagogical approach to improve cognitive engagement. The studies usually involve case-based learning as well. From these studies, it is observed that there are several common characteristics which can serve as guidelines in order to leverage on collaborative learning. These characteristics include the use of retrospective and real-life case studies, discussion on case studies with open-ended case-related questions, team assignments, role playing, and documenting reflections (Frankl et al., 2017; Korkmaz, 2012; Krupat, Richards, Sullivan, Fleenor, & Schwartzstein, 2016).

In most studies, the teachers select case studies to be discussed. The cases studies provide retrospective and real-life scenarios, where students are able to refer to actual practice, methods and processes used by others in the same field (Frankl et al., 2017; Krupat, Richards, Sullivan, Fleenor, & Schwartzstein, 2016). Discussions on the given case studies are usually done among group members, ranging from a team of two to seven. However, it has been suggested that groups need to be small (three to five students) to obtain meaningful interaction (Johnson, Johnson, & Smith, 2007). During the discussions, open-ended and case-related questions are addressed, and alternative solutions are shared with consensus among discussion members. In many studies, prior to the discussion, the members in different teams are assigned various roles of different characters in the case studies, sometimes according to the students' level of competency, background knowledge in the subject, or interest (Korkmaz, 2012). For studies where all the students are taking up generic role playing, collaborative learning specific instructional strategies such as connecting prior learning and providing pre-discussion information are used (Frankl et al., 2017). After the discussions, students are usually asked to reflect on the discussions and lessons learnt by self-documenting the knowledge that they have gained form the sessions.

Although these studies are on instructional strategies in collaborative learning, there are some differences in terms of the objectives and outcomes. One study compares students' academic performance from two pedagogical approached, namely collaborative learning and problem-based learning (Krupat, Richards, Sullivan, Fleenor, & Schwartzstein, 2016). The results from this study show that the mean final exam score of the collaborative learning students, whose mean exam scores in prior courses are below the median of all participants, are significantly higher than that of their problem-based learning counterparts, thus implying that case-based collaborative learning particularly benefits the students with initially lower academic performance. Another study develops a set of seven case-based collaborative learning instructional strategies, and identifies and defines the principles and behaviours needed to lead a successful case-based collaborative learning session, so as to establish a shared understanding of a student-centric, collaborative pedagogic approach (Frankl et al., 2017). The outcome shows that 73% of participating faculty rated the instructional strategies as exceedingly helpful, especially in identifying new instructional techniques. Other studies also mention improvements in students showing more interest in the subject and better understanding of the topics (Korkmaz, 2012). However, none of these studies have analysed how instructional strategies have an effect on the cognitive engagement of students.

Although the instructional strategies in these studies have shown to improve learning outcomes, they have been studied and designed mainly for in-class environments. Whether they would work as effectively in the online environment is uncertain. Moreover, the studies mainly focused on the impact of collaborative learning on academic results and performances but did not study the effectiveness of the instructional strategies in promoting cognitive engagement in collaborative learning at all. As such, a study in designing instructional strategies for promoting cognitive engagement in a collaborative learning environment is essential. The aim of this study is to fill this research gap.

2.7 Conclusion

The sections above have made relevant references to research works in conceptualising cognitive engagement and collaborative learning, and the advantages and challenges they entail. There are also theoretical frameworks in the literature on cognitive engagement, and collaborative learning, and how these pedagogical approaches to learning can be combined as one in a virtual learning environment.

However, there is an apparent lack of research work done on instructional strategies towards promoting cognitive engagement in support of collaborative learning amongst students. On top of this research gap, there is also a lack of literature that investigates the overall effectiveness of such instructional strategies in promoting cognitive engagement in collaborative learning approach.

This dissertation hence describes a study of promoting cognitive engagement through the design of instructional strategies for a collaborative learning environment. The desired outcome of the study, through the formulation of new and improved instructional strategies, would also be extended further by providing additional support for students to progressively attain higher levels of cognitive engagement.

Chapter 3. Methodology

Design-based research was used as an overall methodological approach for this study. The first section of this chapter (Section 3.1) provides prior work done in the development of design-based research, and subsequently explains how the methodological approach is appropriate for the purpose of this study. Upon establishing the potentials of this approach, the later sections outline the participants selected for the study (Section 3.2), the overview of the study (Section 3.3), and the methods used for data collection and analysis (Section 3.4). The final section (Section 3.5) concludes the chapter, by providing a summary of the research process.

3.1 Design-Based Research

Design-based research has evolved from what is previously known as Design Experiment (Reisman, 2008), and is first introduced by Brown (1992) and Collins (1992). It involves a process of designing and setting up of a learning environment, while at the same time conducting experiments within the environment. When research is conducted in classrooms, it is complicated due to the multifaceted nature of the learning environment (Brown, 1992). It is thus not possible to conduct a traditional formal experiment by changing one variable, because altering any aspect of the learning environment would lead to other ripple effects throughout the classroom. A key aspect of design-based research is contributed by Brown (1992), which is subsequently looked into by others, particularly on the notion of looking at research environments holistically, maintaining a record of both the changes that is made in the environment and the resulting outcomes (Bell, 2004; Collins, Joseph, & Bielaczyc, 2004; diSessa & Cobb, 2004).

The extensive use of the design-based research method is also studied by Savenye and Robinson (2004). It is observed that for many years prior to their study, there has been a noticeable increase in studies on educational technology which utilise the interpretive approach to qualitative research methods. Although these studies contribute to descriptive knowledge, the results fall short when the studies involve solving unique practical problems confronted by most teachers and educational researchers (Reeves, 2006). The difficulties in solving practical problems are encountered by many educational researchers, who aim to conduct research that yield more consistent and reliable results (Reeves, 2006; Reeves, Herrington, & Oliver, 2005), and eventually improve the effectiveness, impact, and efficiency of real world teaching and learning. Progressively, several studies on design-based research has also gained acceptance as a preferred research paradigm in the education field (Oh & Reeves, 2010; Kelly, Lesh, & Baek, 2008; Richey & Klein, 2007).

There are several definitions for design-based research in literature. A definition provided by Wang and Hannafin (2005) describes a systematic yet flexible methodology that is designed to enhance practices in education, using iterative cycles of analysis, design, and implementation of interventions, involving researchers and practitioners working together in real-world environments, and resulting to contextually specific design principles. Subsequently, although many other authors have provided varying descriptions of what design-based research should entail, it is generally agreed that this new methodology involves a series of similar phases (van den Akker, 2007; Hakkarainen, 2009; McKenney & Reeves, 2012; Plomp, 2013). For instance, Reeves (2006) depicted the phases of design-based research approach as follows:

1) Analysing practical problems by researchers and practitioners working together;
2) Developing solutions that are supported by current design principles and advancements in technology;
3) Testing and improving solutions interactively in real-world environments; and

4) Reflecting on the results to generate design principles and enhance possible solutions.

Apart from providing a process flow for the design-based research approach, it is proposed that educational researchers conducting a design-based research should also closely keep in mind the practicality of the research approach, focusing on the problems faced by teachers and students (Reeves, 2006). It is further stressed that the primary aim should be to identify practical problems, and ultimately result in the adoption of certain solutions or creation of product design models and principles.

However, this initial model illustrates a linear approach that does not include the cyclical feature of iterations, which should be inherent in design-based research. The initial model also falls short in suggesting the required number of iterations that will sufficiently and effectively conduct a study using design-based research. To fill in this gap, other studies have explored deeper into this emerging methodology, and produce models that offer more detailed descriptions of the phases for the design-based research process. Building on these prior models, a generic model for conducting educational design-based research is produced, where there are core phases and essential elements defined within the cyclical process, namely analysis-exploration, design-construction, and evaluation-reflection (McKenney & Reeves, 2012). The dual-focus phases and the cyclical structure of the model provide both theoretical and practical perspectives for the design-based research approach. In the course of processing through the phases, the model also involves interaction with the research environment and builds on student-inspired feedback. The implementation and spread of the interaction with the students within the research environment gradually increase with time along the process.

With reference to the design-based research model proposed by McKenney and Reeves (2012), the current study adapts a similar methodological approach of design-based research for conducting the research on collaborative learning, thereby evaluating the instructional strategies and learning activities for promoting cognitive engagement. An illustration of a design-based research cycle for this study is provided in Figure 3.1.

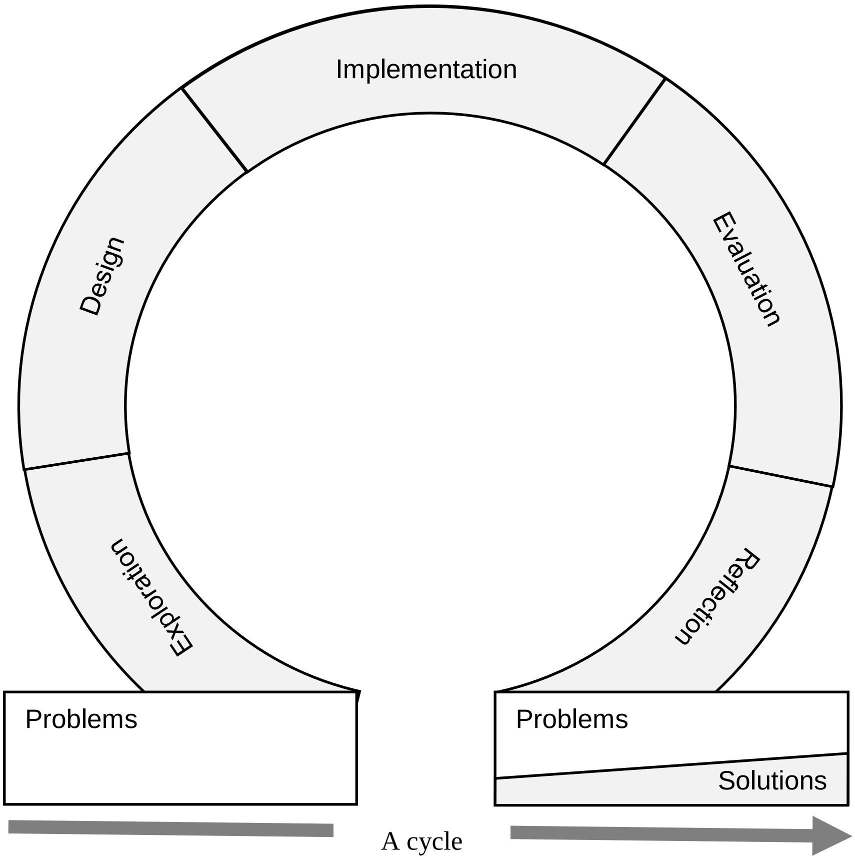

Figure 3.1: A proposed model for a design-based research cycle

The above proposed design-based research cycle illustrates the phases within one cycle of the design-based research process, which is similar to the model proposed by McKenney and Reeves (2012). For a complete cycle, there should be altogether five distinctive phases, namely *exploration*, *design*, *implementation*, *evaluation*, and *reflection*. The phases are conducted as a complete cycle in sequence, starting from the exploration phase, and concluding with the reflection phase. Improvements can be made to the model proposed by McKenney and Reeves (2012), by spreading the initial three core phases (analysis-exploration, design-construction and evaluation-reflection) into five distinctive phases. Each phase can be specifically defined as follows:

1) *Exploration* phase involves initiating a study of the problem or problems faced in practice, and includes making references to relevant prior research works and findings from the literature that could potentially lead to a possible solution;
2) *Design* phase describes the process of designing of possible solutions, which are informed by prior works and findings from the literature, with reference to existing conceptual theories, frameworks, models, principles or technological innovations;
3) *Implementation* phase spells out the steps taken to setup and conduct the study in practice using the designed solutions, and methods employed for data observation and recording;
4) *Evaluation* phase involves researchers who evaluated the data using analytical techniques and methods, and presents the findings conclusively in tables, graphs and forms of data visualisation models that best represent the evaluated data; and
5) *Reflection* phase engages both researchers and practitioners together in reflecting upon the meaning that can be inferred from the evaluation, introducing possible solutions or improvements to prior solutions, or offering conclusions to the study. The trapezium depicts improvements made towards solving an initial problem.

The initial generic model of McKenney and Reeves (2012) is extended further, and granular cycles are introduced, where the process of educational design-based research is repeated in regulative cycles, in which the phases above are included. Similarly, with reference to the above extended design-based research model, the initial proposed design-based research model can be extended. By connecting multiple cycles in series, where the cycles are conducted progressively, each cycle can provide feedback for the subsequent cycle, forming a single extended model as illustrated in Figure 3.2. Improvements to the solution at the end of each cycle is made to address the problems and issues found in the cycle.

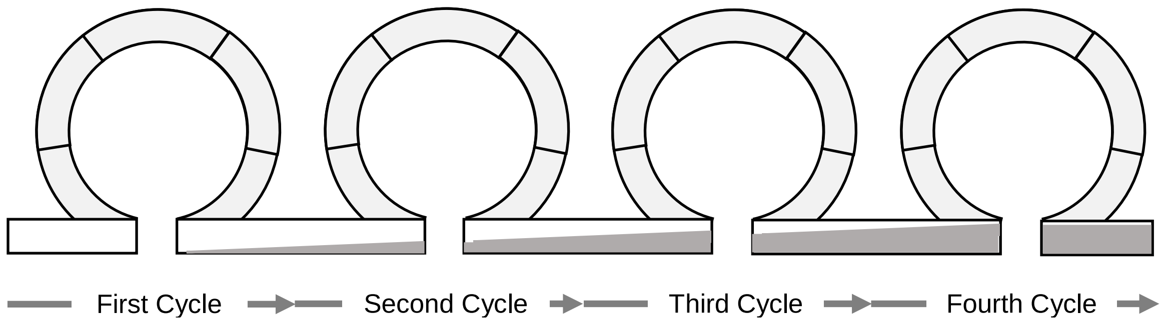

Figure 3.2: A proposed model for extended design-based research

It is also suggested that most educational design-based research studies involve numerous cycles over a relatively longer period of time, and the improvements and changes introduced between cycles depend heavily on the objectives of each study that employs this approach (McKenney & Reeves, 2012). With regards to the number of cycles required for design-based research, it is said that it would be impossible to produce significantly reliable and useful results by conducting a simple study with only one cycle of intervention (Amiel & Reeves, 2008). It is highlighted that more practical and transferrable results can be obtained by conducting iterative cycles of design and redesign, thus allowing for the examination of critical data and possible issues. As for the length of time necessary to engage in design-based research, it is suggested that there must be sufficient time for the "systematic investigation of design factors over a sustained period of time to allow for a theory of engagement to emerge" (Amiel & Reeves, 2008, p. 36). Plomp (2013) further accentuated this point by providing an explanation that achieving the two major outputs of educational design-based research, namely producing theoretical design principles and introducing empirical-based interventions, are possible if the research involves applicable phases which encompass preliminary research, development, and assessment.

It is therefore most practical to conduct the current study through a series of iterative cycles, where each cycle would span across a six-month semester. This would allow sufficient amount of time for the results from each cycle to be used for improving instructional strategies towards promoting cognitive engagement for the next cycle. A series of cycles would then define the whole design-based research, from which conclusive evaluation of results would be able to establish and support theoretical design principles based on empirical-based interventions.

For the current study, it is proposed that the design-based research approach required multiple iterative cycles, so as to develop a more comprehensive account and a deeper understanding of the study with respect to iterative educational interventions. Such educational interventions can include processes that involve instructional strategies and series of activities that support instruction and learning (McKenney & Reeves, 2012).

3.2 Overview of the Research Process

The study was conducted in four cycles, across two academic years, AY 2015/16 and AY 2016/17, where two cycles were conducted in Semester 2 of each academic year. All the student participants were enrolled in the same academic module, namely IS4234 Control and Audit of Information Systems, where they participated in collaborative learning while completing multiple case-based assignments on the topics of control and audit of information systems.

Control and audit topics, contents and know-hows were based on the Internal Control Framework published by the Committee of Sponsoring Organizations of the Treadway Commission (COSO), and the Control Objectives for Information and Related

Technology (COBIT) framework by the Information Systems Audit and Control Association (ISACA) for information technology management and governance.

The following subsections provide an overview of the research process, which include details of the participants of the study, and the processes of the study.

3.2.1 Participants of the study. The students who were enrolled in the academic module IS4234 Control and Audit of Information Systems for academic years AY 2015/16 and AY 2016/17 were involved. The IS4234 module was offered in every second semester of each academic year by the School of Computing, National University of Singapore, to full-time undergraduate and part-time master students as part of their coursework.

Across the two academic years, a total of 56 students were involved in the study, of which 35 students were enrolled in AY 2015/16, and the other 21 students were enrolled subsequently in AY 2016/17. Among the students who enrolled into the module, 10.7% (six students) were from the Master of Computing part-time program which included three foreign students. Among the undergraduate students (fifty students), 32% of them (16 students) were foreign students. The undergraduate students were in their early 20s, while the master students were in their early 30s and were working professionals.

The instructional strategies were designed and implemented by the researcher and a research assistant. The researcher, who was also the instructor of the academic module, had 15 years of teaching experience in higher education, and was familiar with various pedagogical practices such as case-based and collaborative learning. The research assistant had several years of teaching experience at pre-university level, and was proficient in developing instructional strategies for online learning environments.

3.2.2 Process of designing instructional strategies. In this study, the instructional strategies were primarily aimed to alter the collaborative learning environment towards promoting cognitive engagement progressively through the iterations. Basic instructions were introduced to the students in class with the aid of slides and written instructions together with the assignments. These basic instructions, each based on the five components of collaborative learning for promoting cognitive engagement, were; 1) Review the case study in detail; 2) Complete the case study assignment together; 3) Discuss the main points in the case study; 4) Debate and resolve any conflicting viewpoints; and 5) Reflect on the discussion, debate and viewpoints. Figure 3.3 shows how new/improved instructional strategies were designed and introduced into the collaborative learning environment to supplement these basic instructions. The effectiveness of the instructional strategies in promoting cognitive engagement were subsequently analysed.

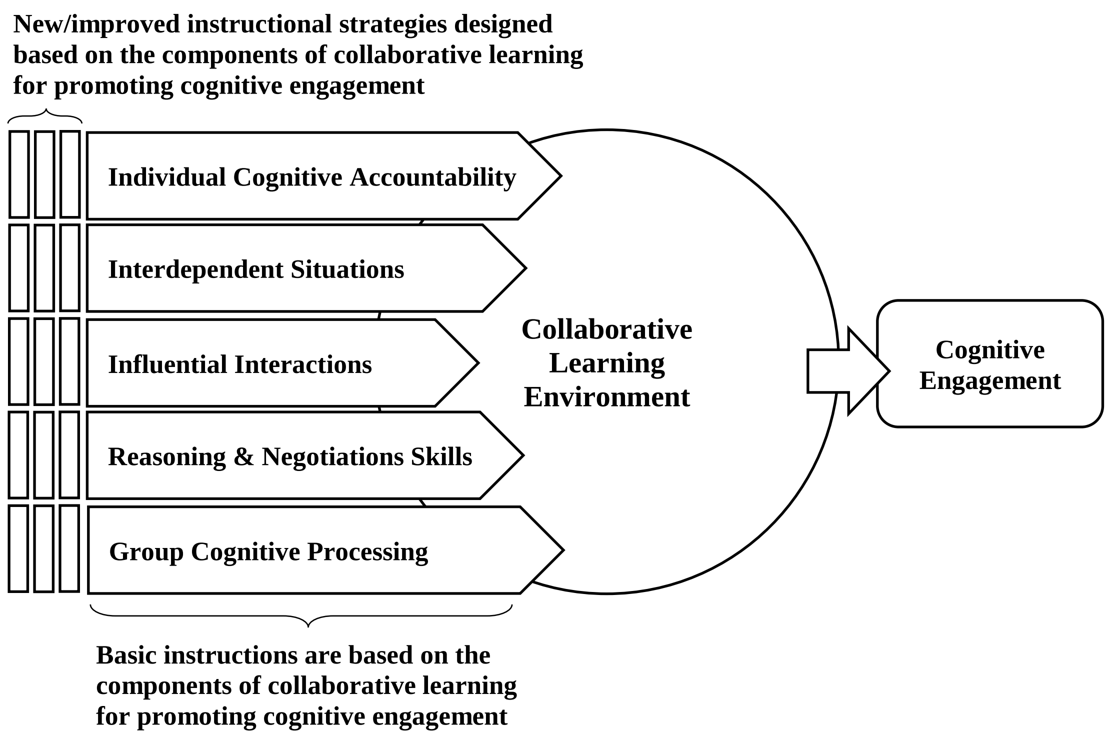

Figure 3.3: New/improved instructional strategies supplementing basic instructions

Prior Section 2.3 has highlighted a number of studies that assert the importance of *individual cognitive accountability* and *interdependent situations* components. In the literature, variations of these two components are seen as two of the most essential and prominent components in collaborative learning (Wang, 2009), and are also generally seen as most crucial for realizing collaborative learning in an effective way (Ruys, Van Keer, & Aelterman, 2012). These two components can also enhance effects of the subsequent components, where students encourage each other to reach their goals, give each other feedback, challenge conclusions and reasoning of others, and take diverse perspectives to explore different points of view (Hermann, 2013). Thus, to initiate the study on the effectiveness of the instructional strategies on cognitive engagement, the first cycle was designed to start off with the introduction of new instructional strategies based on the first two components, namely *individual cognitive accountability*, and *interdependent situations*. Once the instructional strategies were found to support cognitive engagement for the first cycle, they would continue to be implemented in the rest of the cycles. Instructional strategies with issues would be improved, and together with new ones, extended and introduced in the next cycle.

3.2.3 Process of conducting the study. In existing research, case scenarios are normally discussed among groups of students, with the aid of printed cases on paper documents distributed to all students in a classroom setting (Bagdasarov et al., 2012; Korkmaz, 2012), or with online shared document platforms for all students to access shared knowledge, references and discussions (Braeckman, Fieuw, & Van Bogaert, 2008, Frankl et al., 2017; Richardson & Ice, 2010). Each approach has observable benefits. Using printed cases saves the teacher time and effort to coordinate students to register and login to an online platform in order to access the materials, while using an online platform to share case documents allows the teacher to edit or add more materials that can be distributed to the students at a later date. Therefore, for the purpose of this study, both paper-based and technology-supported approaches were used.

In the first cycle, the paper-based approach was used, where case scenarios were printed for all students in class. After studying the case, the students were allowed to analyse and write their views on the paper, before discussing with other students within their group. Conflicting or compatible views were debated and recorded by the students, and where possible, conclusions reached were also recorded. From the second cycle onwards, improvements to the instructional strategies were made as the students collaboratively worked on case scenarios disseminated through an online shared document platform. The students were allowed to analyse and input their views as comments online, and other students were able to discuss, debate, verify, and conclude online through exchanges of comments. Similarly, conflicting or compatible views were debated and recorded by the students online, and where possible, conclusions reached were also recorded online automatically.

3.2.4 Process of data collection and analysis. Four cycles of iterations were conducted, i.e. two per semester, leveraging on the natural academic calendar spanning a 2-year period in which IS4234 was offered during Semester 2. In each iteration, groups of students were given case scenarios on IS control and audit, where they discussed, debated, and gave their views of the cases via comments based on control and audit of information systems. Self-annotation of each entry by the students for enhancing cognitive engagement were also introduced. In order for the students to engage effectively in meaningful discussion, they were given a table of utterance annotations to tag their discussions online, as shown in Table 3.1.

Table 3.1: Table of utterance annotation

Annotation	Description of Annotation
+	Annotates an utterance by a student supporting a claim/statement.
-	Annotates an utterance by a student opposing a claim/statement.
ARG	Annotates an utterance by a student presenting an argument.
EXP	Annotates an utterance by a student providing additional support, explanation, clarification, elaboration of an argument or challenge.
CHA	Annotates an utterance by a student challenging the merits, relevancy, validity, accuracy or plausibility of a presented argument (ARG) or challenge (CHA).
EVI	Annotates an utterance by a student providing proof or evidence to establish the validity of an argument or challenge.
CLA	Annotates an utterance by a student initiating a claim/statement.
NEW	Annotates an utterance by a student suggesting a new concept/idea.

The students were provided with this list of utterances, which were progressively modified and improved for successive iteration, based on issues identified at the end of each cycle.

Data was collected and analysed using both qualitative and quantitative methods, for classroom observation and content analysis of utterances respectively. Classroom observations were conducted and analysed by following qualitative methods. As students were grouped together and tasked to complete a case study assignment in the classroom, their behaviours were observed and recorded. The time spent on reading, discussing, and completing the case study, based on individual or group effort, was recorded by two independent observers. The records of the observation were compiled, verified and analysed at the end of the classroom session.

The students' inputs for each case study were also annotated with the utterance annotations as suggested by Jeong (2005). The annotations were symbols similar to those used by Jeong (2005) in his study on dialogic analysis of dialogic patterns on threaded discussions. However, these annotations were not exhaustive. The current study also included additional annotations. Content analysis of the dialogic patterns among these students resulted in the development of dialogic interaction analysis which uncovered and explained how different dialogic patterns corresponded to the students' cognitive engagement. Consequently, upon observing and recording of the dialogic patterns among the students, the analysis results of the dialogic schemes that led to adjustments of instructional strategies which aimed to improve cognitive engagement among students. For each iteration, analysis on the effectiveness of the introduced instructional strategies towards improving cognitive engagement was done, through examining and evaluating the patterns of dialogic schemes that inferred the presence and progressive improvement of cognitive engagements.

For each iteration of design and improvement of instructional strategies, all inputs entered by the students in their discussions of the case studies were collected. As mentioned in Chapter 2, it is suggested that for engagement through conflicts and debates, analysis should not be done from the ideas presented in one utterance alone using just one argument or claim (Jeong, 2005). As such, analysis for this study was made through the comparison of opposing ideas embedded in an utterance and responses to that utterance, and the conflicts produced in exchanges also help to trigger subsequent dialogues that aim to verify (argument → claim → evidence) and justify (argument → claim → explain) specified arguments and claims. As such, the students' interactions were analysed to determine the effect of the instructional strategies towards improving cognitive engagement, by analysing the utterance chains, and not singular isolated utterances.

In a group discussion, it is often necessary to have a student to ensure that the discussion proceeds in an orderly manner, and that all group members contribute to and benefit from the construction of knowledge or knowledge-change processes, which is the primary purpose of the discourse. Most often, after the sequences are initiated, they may also be extended by having "meta-comments" or cues of various kinds within the discourse. When students initiate a sequence, the other group members provide responses that, in function, are similar to the second and third utterances of a three-move exchange in a triadic dialogue (Nassaji & Wells, 2000). For this study, instructional strategies were used to facilitate the initiation and exchange of utterances. The utterance chains generated through online exchanges of utterances were then analysed, to evaluate the improvement in cognitive engagement that was brought about by the instructional strategies introduced to get the students to collaborate with other group members in collaborative learning.

A number of possible metrics were used to analyse and identify the level of cognitive engagement in the utterances, by using quantitative methods. This study introduced metrics for dialogic analysis, such as cognitive engagement median and probabilities. The former metric was computed based on an aggregated number of utterances, per student group or per utterance type, which occurred at specific cognitive modes. It was presented as a median of the cognitive engagement, with lower and higher quantiles. The later metric determined what percentage of the utterances occurred at specific cognitive modes. The cognitive engagement probabilities were determined by tabulating the frequencies of the cognitive modes for different student groups and utterance types. The observed frequencies were processed with relative frequencies to compute the transitional probabilities for each cognitive mode. These metrics described the level of cognitive engagement of the students, and of the different utterance types.

3.3 Conclusion

This chapter has put in place the methodological approach of educational design-based research, and the references to theories and models in order to design and conduct the current study of using instructional strategies to promote cognitive engagement of students in collaborative learning. The following chapter documents down the iterative processes of the study based on the approach presented in this chapter.

Chapter 4. Design-based Research Cycles

This chapter presents the four design-based research cycles that outlined this study on cognitive engagement of students with the use of instructional strategies in a collaborative learning environment. This empirical research was initially conducted in a classroom with a set of instructional strategies designed based on the components of collaborative learning for promoting cognitive engagement, for the module IS4234 Control and Audit of Information Systems. It was subsequently done online with improvements made in every progressive cycle. Cycles of the improvements were made across two academic years by revising the set of instructional strategies at the start of each cycle, to study the effectiveness of the instructional strategies on the cognitive engagement of the students.

This study followed the design-based research approach to: 1) design instructional strategies in a collaborative learning environment towards promoting cognitive engagement among students; and 2) analyse the effectiveness of the instructional strategies in promoting cognitive engagement.

The instructional strategies for each cycle were grounded on the components of collaborative learning for promoting cognitive engagement, namely *individual cognitive accountability, interdependent situations*, *influential interactions*, *reasoning and negotiations skills,* and *group cognitive processing*. These new instructional strategies were introduced at the start of each cycle. Students' inputs were subsequently collected, processed and analysed using the ICAP framework proposed by Chi and Wylie (2014). The instructional strategies were then improved at the start of the next cycle.

In this chapter, each cycle is introduced in detail. This chapter starts with the preliminary study of collaborative learning within a classroom environment in Section 4.1. This initial cycle looked into facilitating collaborative learning in pairs, focusing on the two important components of collaborative learning for promoting cognitive engagement, namely *individual cognitive accountability*, and *interdependent situations*. Section 4.2 presents the progression of introducing collaborative learning in an online environment, introducing an improved set of the instructional strategies with collaboration scripts as an enhancement to the initial first cycle. The third cycle is explained in Section 4.3, focusing on the introduction and use of epistemic and social scripts for subsequent components, namely *influential interactions*, *reasoning and negotiations skills*, and *group cognitive processing*. The final cycle is elaborated in Section 4.4, focusing on improving group cognitive engagement, as it was found to be lacking. A formative evaluation was done for each cycle, and the revision of the design from the results of the evaluation is presented at the end of each section.

4.1 The First Cycle

In order to start with a set of instructional strategies for students to be active learners in a collaborative learning environment, the first cycle involved the design of an assignment where the students reviewed a case study in pairs in a classroom setting. The discussion was arranged to be conducted in pairs as group size are normally kept small to support meaningful interaction (Johnson, Johnson, & Smith, 2007). The set of instructional strategies to be used within the collaborative learning environment were grounded based on the components of collaborative learning for promoting cognitive engagement.

4.1.1 Design. For the first cycle, instructional strategies based on *individual cognitive accountability* and *interdependent situations* components were introduced by facilitating collaborative learning in pairs, in an effort to examine their effectiveness towards cognitive engagement within a collaborative learning environment.

4.1.1.1. Individual cognitive accountability. The students enrolled in IS4234 were from different academic programmes and levels. Of the 35 students enrolled, a total of 32 students (16 pairs) participated in this cycle. Some of the students (34.29%) were foreign students and had their pre-university education outside of Singapore in their home countries. There were also a small number of students (8.57%) who were part-time postgraduates. Figure 4.1 shows the difference of the ages and study programmes for each pair of students. Although the majority of the students were full-time undergraduates from the School of Computing, the profile differences of the pairs of students were apparent with respect to country of residence (International (INTL), Singapore Residence (SPR) and Citizen(SC)) and age groups.

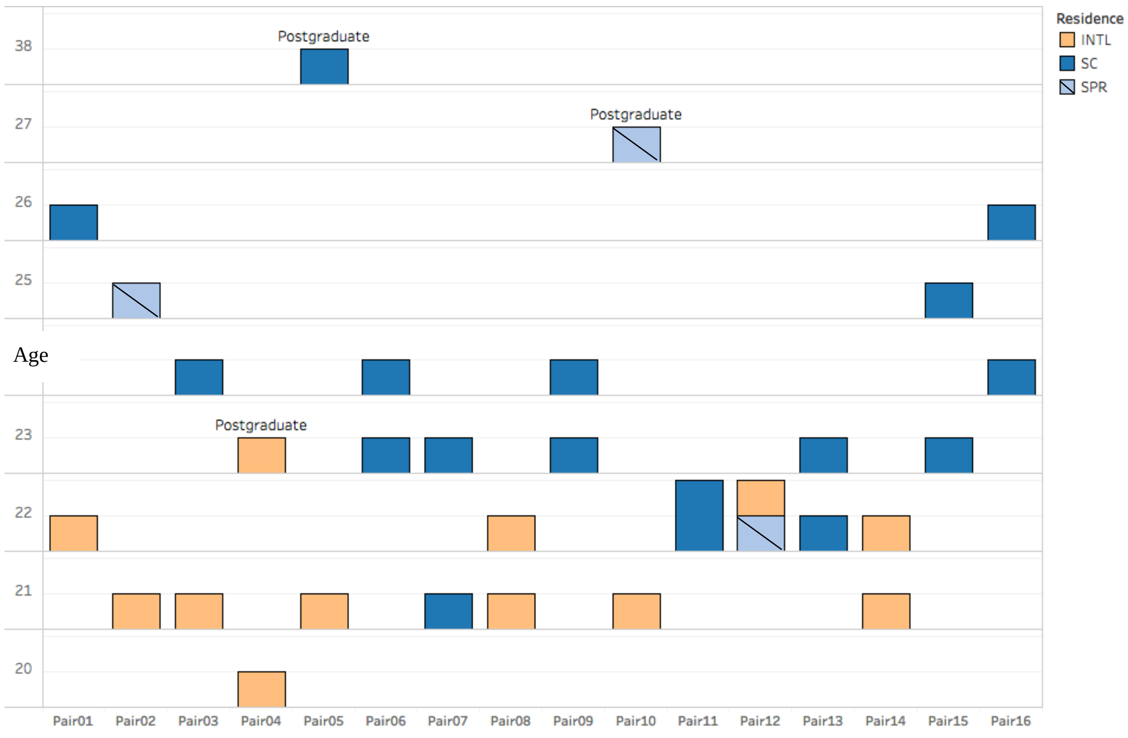

Figure 4.1: Difference of the ages and study programmes for each pair of students

According to the description of individual cognitive accountability, completing collaborative tasks requires significant contributions from each student, and each student has to be accountable for his or her share of cognitive effort. In an ideal setting, once individual cognitive accountability is established, students take ownership of the task at hand and their own learning (Kirschner, Strijbos, Kreijns, & Beers, 2004). However, the ownership of tasks does not happen automatically. Instructional strategies must be put in place to promote students to take ownership of their own learning (Rainer & Matthews, 2002). Literature suggests a series of strategies that can promote individual cognitive accountability, namely *designing meaningful tasks* (Arvaja, Häkkinen, Eteläpelto, & Rasku-Puttonen, 2000; Gillies, 2014), *establishing equality* among members (Aggarwal & O'Brien, 2008; Woolley, Aggarwal, & Malone, 2015), and *providing clear individual roles* for each student (Vuorinen, Tarkka, & Meretoja, 2000; Wang, 2009), which were introduced in this cycle to promote the presence of *individual cognitive accountability*.

Designing meaningful tasks is a strategy to promote *individual cognitive accountability*, as it allows members to see the value of the task and relevance to their needs (Arvaja, Häkkinen, Eteläpelto, & Rasku-Puttonen, 2000). It encourages students to take ownership for tasks and consequently contribute to the completion of a task. The nature of the task has also been shown to be an important factor as well. Besides promoting higher-level interaction, open-structured tasks have also been found to promote meaningful reasoning by individual students, and extent applicative and evaluative thinking (Gillies, 2014). There is also a greater range of learning outcomes for students who are engaged in more complex "open" cases than students with pre-structured "close" cases (Kopp, Hasenbein, & Mandl, 2014).

Another strategy is *establishing equality* in status among group members in terms of abilities and resources. It is found that with equality, group members will not only make equal contributions and be more willing to communicate with each other, they are also more likely to leverage on each other's skills and capabilities when all the members participate equally in a task (Woolley, Aggarwal, & Malone, 2015). On top of it, a sense of mutual accountability is also necessary to avoid free riding (Johnson & Johnson, 2009), which occurs when one or more group members are perceived by others as failing to contribute their fair share of the group effort (Aggarwal & O'Brien, 2008). However, with equality and equal rights to opinions, there is a risk of students to have conflicting views and are not able to establish a common agreement given a limited amount of time (Strom & Strom, 2002).

Additional, a strategy of *providing clear individual roles* and responsibilities of each student within the group can help to improve individual accountability (Slavin, 1999). It is also found that if the performance for each contribution by the individual student is assessed, individual accountability is often increased (Vuorinen, Tarkka, & Meretoja, 2000). Naturally, in both cases, individual cognitive effort will also improve. The detailed descriptions of the implementation of the above instructional strategies will be given in Section 4.1.2.

4.1.1.2. Interdependent situations. In order to bring about collaborative learning, situations where students are interdependent on each other can be crucial by promoting the quality of interaction and collaboration (Dillenbourg, 1999; Gully, Incalcaterra, Joshi, & Beaubien, 2002). Collaboration is usually increased in situations where interdependence exist among group members. This is possible only when students believe that the contribution of each member is crucial for the whole group to successfully complete the given task (Johnson & Johnson, 2009).

Literature indicates that many factors can enhance collaboration. There are planning factors with design characteristics, as well as facilitating factors with group-process characteristics (Scager, Boonstra, Peeters, Vulperhorst, & Wiegant, 2016).

For planning factors, studies have shown that groups are often kept small to obtain meaningful interaction (Johnson, Johnson, & Smith, 2007). However, apart from the size of the group, equal participation has also been highlighted to be crucial for students' performance. It is asserted that every student plays an important role and has to make equal amount of contribution to the group work, and not an unbalanced contribution of one student working for all (Wang, 2009). Students will benefit from the knowledge and skills of each other when the students are equally participative (Woolley, Aggarwal, & Malone, 2015). The balance of diverse perspectives and styles among the students has been known to improve learning, especially among students working together on assignments that require the need to create knowledge (Kozhevnikov, Evans, & Kosslyn, 2014).

For the current study, as there was an observable existence of diversity between the pairs of students engaging in collaborative tasks together, it was anticipated that the students could possibly share knowledge based on difference perspectives to complement each another by making shared contributions to complete the task (Jävelä, Häkkinen, Arvaja, & Leinonen, 2004). As such, an equal if not greater amount of emphasis was also placed on mediating factors affecting collaborative learning. For facilitating factors, studies have identified that interdependence is one of the most important component, in the context of collaborative learning, that enhances the quality of interaction (Gully, Incalcaterra, Joshi, & Beaubien, 2002; Johnson & Johnson, 2009; Slavin, 1999). Interdependence among students can induce collaboration, and is possible only when the students believe that the collective effort contributed by all students is critical for the group to successfully complete the assigned task (Johnson & Johnson, 2009). Furthermore, a strong sense of community within the group can also help to build and enhance interdependence among the students in a group (Kirschner, 2002). Other studies have shown that a good working relationship supplements this sense of community, and such relationship is usually established before the students work together (Kreijns & Kirschner, 2004; Rovai, 2001). In this study, three instructional strategies to promote interdependent situations within the groups were proposed, namely *promoting task interdependence through joined tasks, encouraging reward interdependence through collective grading,* and *establishing knowledge interdependence through knowledge sharing.*

It is asserted that interdependent situations can be created when individual task achievement through individual effort on the task is made contingent with the group task achievement, by *promoting task interdependence through joined tasks* (Peterson & Roseth, 2016). The basic premise of merely having each student contributing his or her own inputs in a group discussion does not stimulate sufficient interdependence, as the students hardly integrate their work. Students should also be encouraged to work together, to collectively produce a summary of their discussion and enhance collaborative perspectives, and achieve the common goal of developing a group product through active collaboration. In order for this to happen, research has suggested that students should specify and coordinate efforts for joint tasks (Fischer, Kollar, Stegmann, & Wecker, 2013; Strijbos & de Laat, 2010).

Besides task interdependence, *reward interdependence* has also been emphasized to be capable of inducing interdependence among students (Johnson, Johnson, & Smith, 2007). Reward interdependence allows individual grades to be dependent on the achievement of the entire group. However, it is asserted that collaborative learning is seldom effective without providing group rewards (Slavin, 1995). In order to raise reward interdependence, apart from individual marks, students are also awarded marks if group members collectively score above a certain level. However, in higher education, research has raised concerns that rewards may negatively stimulate extrinsic motivation, and result in the reduction of intrinsic motivation of individual student (Parkinson & St. George, 2003). Highly favourable incentives such as grades may motivate the student towards attaining the reward and reducing the task to be merely a means to an end, and should be avoided.

Literature also shows that *knowledge interdependence*, where students are dependent on other group members for information or knowledge which they themselves have not acquired, can promote interdependence such that students cannot develop a comprehensive mental model to perform the required task as individuals (Molinari, Sangin, Dillenbourg, & Nüssli, 2009). Studies commonly use this form of jigsaw technique, based on the principle of providing complementary knowledge or information to be acquired by different members in a group. These resources can be used as a whole to collaboratively solve tasks among students.

The collaborative process by which the students within a group use the complementary knowledge and information to build a mental model of their own and other group members' knowledge during social interaction has also been termed as a mutual knowledge modelling (MKM) process (Nova, Wehrle, Goslin, Bourquin, & Dillenbourg, 2007). MKM is described as a representation that students make of their group members' capabilities, skills, knowledge, objectives, motivations, perspectives, or feelings. MKM focuses primarily on building a representation of group members' knowledge, and it can play a critical role in collaborative learning. Studies have shown that students who build on their group members' knowledge obtained higher learning gain through a collaborative phase, and the availability of cues about their group members' knowledge enhances learning outcomes (Sangin, Molinari, Nüssli, & Dillenbourg, 2008).

This cycle focused on instructional strategies based on *individual cognitive accountability* and *interdependent situations* components. The following section will further elaborate on the implementation of these strategies in the instructional process.

4.1.2 Implementation. The first cycle was carried out within a 60-minutes class session in Week 2 of Semester 2, Academic Year 2015/16, for the students enrolled in the module IS4234 Control and Audit of Information Systems. The classroom face-to-face collaborative learning session was conducted with paper-based handouts, as shown in Appendix A. The students were asked to follow the instructions and complete the case study discussion. Details of instructional strategies and activities used in this cycle are provided as follows.

4.1.2.1. Designing Meaningful Tasks [S1.1]. The case study for the assignment described a scenario with reference to a prior lecture session of related topics on information Systems Audit, as provided in Appendix A. As the students were able to relate the questions of the assignment meaningfully to the topics previously covered in the lecture, they were able to conceptualise the case initially on their own, be more willing to take ownership to contribute and complete the group case study assignment. The required answer for each question was also designed in an open-structured format to accept free text inputs, with no requirements to provide high level of elaboration or details, apart from the necessity to keep the content of the discussion within the scope of the topics covered in the module.

4.1.2.2. Establishing Equality [S1.2]. The assignment was designed to be conducted in the classroom and completed in pairs. It was anticipated that instructing the students to freely discuss the case among themselves and record inputs contributed by each student collectively on a common worksheet would lead to some students dominating the discussion with lots of contributions, while others staying dormant or disengaged, commonly termed as “free riders”. There was also a risk of conflicting views not having sufficient time to be reflected upon and resolved by the end of the class. Thus, the assignment was designed to have a dedicated worksheet for each student, with an equal number of sections reserved for each student to provide their individual inputs for each question. The sections were clearly labelled as “Student A” or “Student B” and assigned to record the inputs from individual students within each pair.

4.1.2.3. Assigning Clear Individual Roles [S1.3]. In the case assignment, each student was instructed to identify himself or herself as Student A in their own worksheet, thus clearly designated individual roles and responsibilities towards the individual effort in the assignment. The roles and responsibilities of Student B will be explained in the next section. Additional information, such as the assignment contributing to 10% of their individual participation marks for the module, was also announced to the students. The allocation of marks for each designated question is shown in Appendix A as well.

4.1.2.4. Promoting Task Interdependence via Joined Tasks [S1.4]. The case assignment was designed to be completed within a 1-hour class session. Instructions were given for each pair of students to allocate twenty minutes for reading and reviewing the case study on their own, and to discuss the case study between them. Subsequently, the next twenty minutes were allocated for each student to assume the role of Student A, and to enter points and answers to questions based on the case study in the individual worksheets provided to each student. The final twenty minutes were for each student to exchange their worksheets with their partners and assume the role of Student B, where they would add feedback to the inputs their partner (Student A) had entered on the latter’s worksheet. This would ensure that collective inputs of the group were recorded in all the worksheets.

4.1.2.5. Encouraging Reward Interdependence via Collective Grading [S1.5]. The case assignment had two questions, namely Q1a and Q1b, to cover two different topics on Control and Audit of Information Systems. These questions were equally allocated four marks each and contributed primarily to individual grades. A final question Q2 was allocated two marks, and the average marks of all members in a group for this question would contribute to a common group mark, on top of their individual score for Q1a and Q1b. At the start of the class session, the students were informed of how the marks for each question would contribute to their grades. The instructions to the students were to complete all questions, so as to maximise their grades for the case assignment.

4.1.2.6. Establishing Knowledge Interdependence through Knowledge Sharing [S1.6]. The assignment was designed based on a case study relevant to the module topics. The diversity of prior experience and knowledge of each pair of students would account for the differences in perspectives and capabilities. To leverage on the diverse knowledge of the students, instructions were given such that after an initial stage of twenty minutes for discussion, each student was tasked to write down and share his or her inputs, which would be a representation of each student's understanding. After which, upon exchanging of worksheets, each student was tasked to read and give his or her feedback on the inputs by his or her partner, which would collectively be shared representation of knowledge of the pair. The complete set of activities for the collaborative learning session in the classroom was carried out as follows:

- The class started off with a short introduction by the teacher on the basic instructions for collaborative learning, especially the need for students to demonstrate collaborative effort in discussion towards gathering of information, understanding, viewpoints and conclusions as inputs.
- Students were told to complete the assignment within the 1-hour session in pairs.

- Each student was to work with the student sitting next to him or her.
- Instructions were given for the students to allocate twenty minutes to discuss the case study between each pair of students. Subsequently, the next twenty minutes was for each student to assign himself or herself as Student A, and to write down inputs and answers to questions based on the case study in the worksheets provided. The last twenty minutes was for students to exchange their worksheets with their partners. Their partners, taking the role of Student B, would add on to Student A's worksheet and provide feedback on the inputs of Student A. This ensured that collective knowledge of the pair would be recorded on all worksheets.
- Before submission, Student A's worksheet was returned to him/her for reflection.

The worksheets were collected, and the contents were analysed to evaluate the modes of cognitive engagement as a result of the instructional strategies introduced.

4.1.3 Formative Evaluation. At the end of the first cycle, a formative evaluation activity was carried out by the researcher and a research assistant. The evaluation focused on the effectiveness of the instructional strategies and activities, introduced at the start of the cycle, in promoting cognitive engagement in the collaborative learning environment. The main instruments used for the evaluation of the students' cognitive engagement were classroom observation and the students' inputs. This section provides the details on the evaluation of the data from the classroom observation, and content analysis of the students' inputs on their worksheets based on the ICAP framework. The sections will also include observed issues and areas of improvement to be addressed in the next cycle.

4.1.3.1. Classroom observation. A classroom observation was conducted during the hour-long classroom session. The researcher in the role of the teacher as well as an observer, and a research assistant as an independent observer, took notes on the behaviour of the students after the worksheets had been distributed and the instructions on how to complete the assignment explained to the students. The observation focused on the actions taken by the students in their efforts towards completing the given task on the worksheets. These actions involved mainly overt behaviour of the students during the three 20-minute long stages of classroom activities.

The majority of the students started the session by engaging in quiet reading of the case study, highlighting and underlining words in the given passage and making notes on their worksheets. From the highlights and underlines made by the students in the passages of the case study, it was apparent that by involving case study of relevance in relation to the topics covered in earlier lecture sessions, the students seemed to be able to articulate and conceptualise the case scenarios described in the case study meaningfully. It was also noted that most of the students took steps to mark and number the scenarios of the case study. From these behaviours, it appeared that the instructional strategy of *Designing Meaningful Task [S1.1]* had provided the initial condition for students towards *individual cognitive accountability* as they participate in active learning in the process of completing the worksheet.

During the initial twenty minutes of the session, most of the students did not attempt to communicate, or communicated very little, with their group members. After the students were informed that twenty minutes had passed, most of the students began to input their points on the allocated sections in their worksheets. Only a handful of students were observed to start the stage by engaging in brief discussions with their group members before they proceeded to writing down their inputs on their worksheets. Again, the majority of the students engaged in little or no communication with their group members. They were more focused on completing their worksheets as Student A. When the students were instructed to exchange their worksheets with their group members, most of the students did so without much delay. Once again, in the final twenty minutes of the session, the students seemed to be engaged in completing their parts as Student B of their group members' worksheets, and very limited discussions were observed.

The worksheets were collected and examined at the end of the session. The design of the worksheet had provided the students with equal opportunities in contributing their individual inputs, by means of giving each student a worksheet each with designated sections to enter their inputs. It seemed that there were no free riders, as all students were seen to have completed their worksheets in the allocated sections, except for one student who left a question unanswered. As such, the instructional strategy of *Establishing Equality [S1.2]* appeared to have also encouraged the students to be individually accountable for their own learning.

The students were also made aware of their individual responsibilities and individual participative roles as they were rewarded for the inputs entered for the designated questions. It was observed that all students completed their tasks in accordance to their individual roles (Student A, Student B). There was no lack of participation on the part of the students taking on their individual roles, except for one student, who left a question unanswered and was annotated as engaged in the *passive* mode. The clear instructions given to all students to take up the role of Student A and Student B helped students to be conscious of the expectations set upon them. It thus seemed that the instructional strategy of *Assigning Clear Individual Roles [S1.3]* had achieved its purpose of providing clear instructions that established clear individual roles that induced *individual cognitive accountability*.

However, the instructional strategies applied towards the equality in expression and the provision of individual roles through the designated questions on separate worksheets had caused an unforeseen problem. It was observed that during the classroom session, the students did not allocate adequate amount of time to discuss or resolve possible conflicting points. On reading the inputs from each pair of students, another critical observation was that with equal opportunities to contribute individual viewpoints, the students hardly engaged in referencing, reflecting, acknowledging or criticizing on their group member's inputs. The students were mainly engaged in the case study as an individual rather than as a team. All students generally completed their individual parts of the assignment independently.

It was further identified from the inputs that most of the students did not follow the instructions of having Student B to add inputs that were missed out by Student A's initial inputs, once the worksheets were exchange. Instead, the students worked independently on their own sections, filling up individual viewpoints as inputs, without discussing, debating, or making references to their group member's initial inputs. It became apparent that the students might not have read their group member's initial inputs at all, resulting in repeated and conflicting inputs between pairs. As such, the students displayed a strong preference towards working independently, and the strategy of *Promoting Task Interdependence through Joined Tasks [S1.4]* seemed to be ineffective. The practice of merely consolidating inputs onto the worksheets was observed in most of the worksheets.

4.1.3.2. Content analysis. The collected worksheets were scanned, and the contents were analysed by the researcher and the research assistant. A more detailed analysis was conducted based on the students' inputs to the questions provided about the case scenario in the worksheet. The unit of analysis used was the students' answer for each of the respective questions provided. Each unit was annotated with the ICAP modes (*Passive, Active, Constructive, Interactive*), depending on the characteristics of the input provided by the students as described in Table 4.1.

Table 4.1: ICAP modes, characteristics and examples

	Passive	**Active**	**Constructive**	**Interactive**
Characteristics	Receiving information without overt action	Manipulating information with focused attention	Generating additional externalised outputs	Dialoguing with utterances that generate knowledge
Knowledge-change	Storing	Integrating	Inferring	Co-inferring
Cognitive Outcome	Recall	Apply	Transfer	Co-create
Some Examples	• Paying attention without doing anything else	• Summarising by copy-and-delete • Making some form of motoric action • Manipulating parts of the learning material • Choosing a justification from a menu of options • Agreeing in brief • Selecting an answer from a menu of choices	• Producing outputs which contain new ideas that go beyond the information given • Providing justification for the step • Asking questions and posing problems • Comparing and contrasting cases • Making plans • Integrating texts and diagrams across multimedia resources • Giving mini lectures • Constructing time lines for historical phenomena	• Dialoguing with sufficient frequency of turn taking to generate knowledge beyond what was presented in the original learning materials and beyond what other group members said • Defending and arguing a position • Criticising each other by answering each other's questions • Explaining to each other • Elaborating on each other's contributions • Allowing for more frequent revisions or smaller components of knowledge

The students' inputs to each question were annotated as an appropriate ICAP mode of cognitive engagement as shown in Figures 4.2 and 4.3.

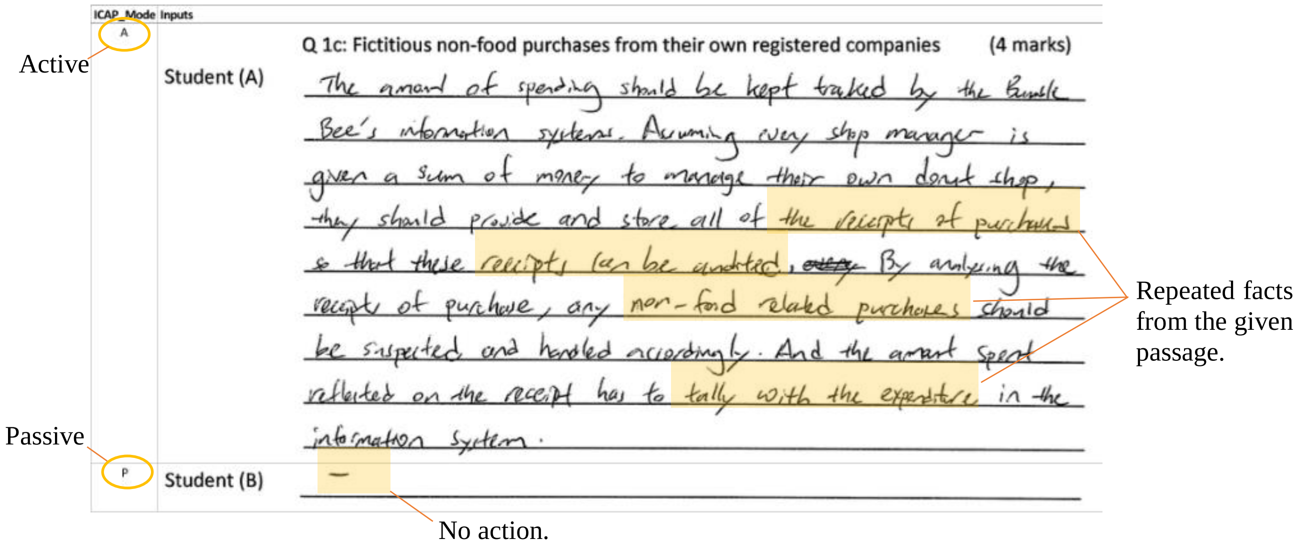

Figure 4.2: Inputs by Student A and Student B of Pair 1

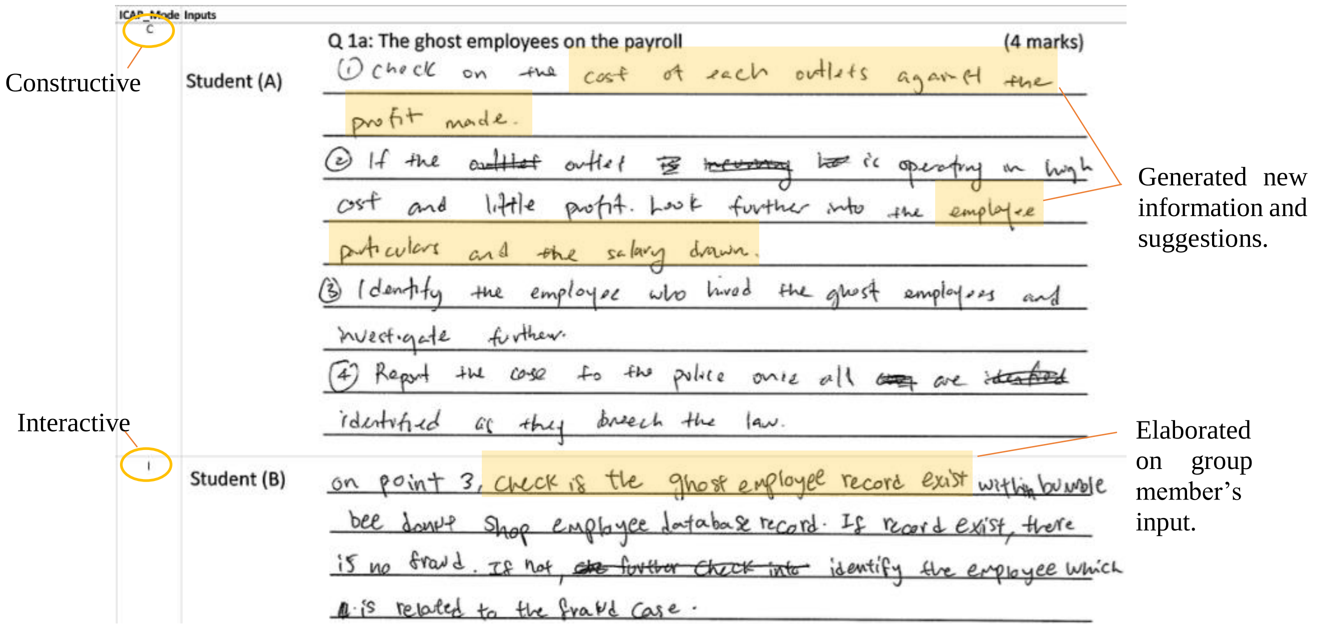

Figure 4.3: Inputs by Student A and Student B of Pair 15

The researcher and the research assistant annotated each unit, and the inter-rater reliability between the annotators was measured using Cohen's kappa κ (Cohen, 1960).

It can range from −1 to +1, where 0 represents the amount of agreement that can be expected from random chance, and 1 represents perfect agreement between the annotators. For this cycle, κ = 0.787, and values between 0.61-0.80 was taken as substantial in agreement (McHugh, 2012).

The distribution of the levels of cognitive engagement was subsequently generated as shown in Figure 4.4. The distribution was based on the annotations of the students' inputs using the ICAP modes. The number and the percentage of the inputs by the students across the ICAP modes were computed and displayed in Figure 4.4.

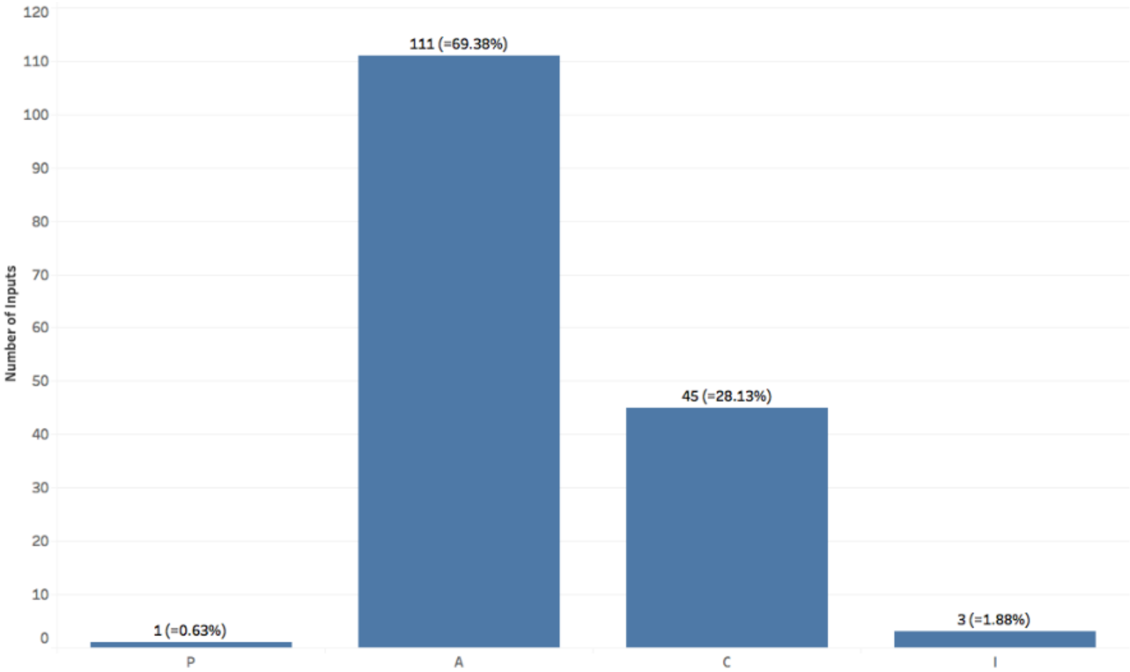

Figure 4.4: Number of inputs based on the ICAP modes

Figure 4.4 shows that, as a whole, the students were engaged at all the four levels of the ICAP modes. However, the number of utterances at each mode and the number of students engaged at each mode were distinctively different. Less than 2% of the inputs entered by the students attained the highest cognitive engagement mode of *interactive*. There was also a student who had left a question unanswered, thus contributing to a count towards *passive* learning. Although there were some students who managed to contribute towards the *constructive* mode, the majority of the students were only engaged at the *active* mode. This was attributed to the fact that the students were only underlining the details provided in the case study, and mechanically copied the highlighted facts as their inputs. The occurrences of cut-and-paste copying from the passage, and in some instances from their group member's inputs, were prevalent in the inputs, and thus the students were not able to get pass the *active* mode and into *constructive* mode.

Figure 4.4 also shows that about 28% of the inputs were tagged as the *constructive* mode, almost 69% of the students (22 out of 32) had at least one input that attained this level of cognitive engagement. This indicated that a slight majority of the students had the capacity to engage in knowledge construction, and not merely repeating the facts that were presented to them. However, their engagement in the *constructive* mode was overshadowed by their engagement in the *active* mode, which involved most of the students (27 out of 32). Furthermore, as the graph were generated from the inputs on the paper-based worksheets, the results were inadequate in determining if the instructional strategy of *Encouraging Reward Interdependence Through Collective Grading [S1.5]* had caused the students to be cognitively engaged in the above modes. Although the reward in the form of individual and group grades aimed to facilitate group knowledge sharing and cognitive engagement, it was not possible to determine if the designated questions with the shared grades were completed through individual effort or group interactions. This might be due to the limitation of the paper-based worksheet in its inability to synchronously record the inputs and identify the contributor within the pair, and the constraint of limited time to tightly coordinate the stages for discussion and inputs by the students. The limitation of time and coordination for a collective effort thus further weakened the effect of reward interdependence through collective grading.

Figure 4.4 further shows that only two students had cognitive engagement at the *interactive* mode. These students were from Pair 10 and Pair 15. Referring back to Figure 4.1, Pair 10 involved students from different programmes, where a postgraduate partnered with an undergraduate. The age gap between the students was also relatively wide compared to other pairs of students. Pair 15 involved undergraduate students from the same programme, with an age gap of two years. From these two examples, it seemed that the differences in programmes and age groups did not affect the students from achieving high cognitive engagement. However, for both pairs of students, only one from each pair added inputs at the *interactive* mode, as they made references to their group members inputs and compared them to their own. They made the effort to reflect on their group members' initial inputs and synthesized the shared knowledge with their own. Figure 4.3 above has illustrated how an input from Student B of Pair 15 managed to attain the *interactive* mode.

Apart from these two students, the rest of the students had not inferred and co-inferred from their group members' initial inputs. The majority of the students had independently included their own inputs without overtly reviewing what their group members had shared. The inputs between most pairs of students appeared to be disunited in terms of their assessments and perspectives of the given case study. It was thus conclusive that although there was a strong indicator that students were sharing knowledge at the *constructive* mode, the absence of inference and co-inferences had led to the inability in *establishing knowledge interdependence [S1.6]*, as students were not able to extend further attain the *interactive* mode of cognitive engagement.

The results from the first cycle showed, to some extent, that the instructional strategies were effective, as students were able to cognitively engage at moderate modes (*active* and *constructive* modes) through the analysis of their inputs in the case assignment. However, this cycle also revealed some issues which needed to be addressed. In summary, the following issues were to be addressed:

- The limitation of the paper-based worksheet in its inability to synchronously record inputs and identify the contributor within the group *[I1.1]*;
- The constraint of time to coordinate for more in-depth discussion *[I1.2]*;
- The inability of students to attain the *constructive* mode of cognitive engagement by progressing beyond mere highlighting and cut-and-paste activities *[I1.3]*;
- The inability of students to practice task interdependence and extend beyond merely consolidation of individual inputs *[I1.4]*; and
- The inability of students to attain the *constructive* mode of cognitive engagement by progressing beyond mere sharing of individual inputs *[I1.5]*.

These issues were addressed in the next cycle by revising the instructional strategies and introducing new ones.

4.2 The Second Cycle

For the second cycle, instructional strategies from the first cycle that were able to support cognitive engagement were used, and potential solutions were explored to address the problems identified in the first cycle. Similar to the first cycle, revised instructional strategies based on *individual cognitive accountability* and *interdependent situations* components were introduced by facilitating collaborative learning in groups, in an effort to examine their effectiveness towards cognitive engagement in a collaborative learning environment.

4.2.1 Design. The revised instructional strategies in this cycle were conducted together with the use of an online collaborative learning environment, as they were not implementable with paper-based worksheets. The limitation of the paper-based worksheet in its inability to synchronously record inputs and identify the student contributor as mentioned in *[I1.1]*, as well as the constraint of time to coordinate for more in-depth discussion among the students as highlighted in *[I1.2]*, especially for larger groups.

In the first cycle, the pairing of students to work together was initially arranged as the group size of two was shown to be small and students could easily communicate by face-to-face meetings rather than by using online tools (Wang, 2009). However, from the results presented at the end of the first cycle, there was a lack of higher modes of cognitive engagement between the students (*[I1.3]* and *[I1.5]*). As such, additional strategies for this cycle included making the group size bigger as suggested by Moallem (2003), by instructing the students to reorganise themselves to form groups of three to five students. With more students in a group to work on tasks, more diverse understanding could be shared during the discussion stage. However, this advantage can only be attained when all members within each group fully participate in the discussion, engage in deep deliberation essential for jointly solving a controversial problem, and expose each other to diverse knowledge and ideas (Levesque, Calhoun, Bell, & Johnson, 2017).

In order to improve students' cognitive engagement, it has been asserted that making tasks meaningful is one effective instructional strategy that allows students to see the value of the task and its relevance to their needs (Arvaja, Häkkinen, Eteläpelto, & Rasku-Puttonen, 2000). It has also been affirmed that realistic cases are commonly used in collaborative learning so as to make tasks meaningful for the students to relate theory to practice (Winter & McGhie-Richmand, 2005). Apart from designing open-structured tasks to promote meaningful reasoning and increase learning outcomes for the students, designing tasks based on Using *Realistic Case Scenarios [S2.1]* can also promote *individual cognitive accountability*. Using realistic case scenarios and situations also allows students to demonstrate individual skills in making direct references to personal narratives, sharing individual competences, gathering of relevant facts and information, and developing possible solutions, which are collaborative learning activities examined in a study on a virtual professional training (Kopp, Hasenbein, & Mandl, 2014). It also promotes cognitive engagement through the gathering of information in the form of entry logs and records for every input made by each student, together with opportunities for each student to explain his or her freshly gathered information, perspectives, or ideas to other group members (Millis & Cottell, 1998), enabling each student a means to infer and co-infer interpretation from the gathered materials with other members in the group. An instructional strategy of *Using Realistic Case Scenarios [S2.1]* was hence introduced as a possible solution to address the issues highlighted in *[I1.3]* and *[I1.5]*.

On top of the above strategies, in order to resolve the issue about students staying within the active mode of cognitive engagement as described in *[I1.3]*, it was necessary for students to self-manage and self-regulate their own learning by *Encouraging Autonomous Learning through Reference Contributions [S2.2]*, and not be restricted by the course materials provided. Such autonomous learning means independent learning, based on the idea of the individual student should not be resistant to external influence at all stages of their learning (MacDougall, 2012). While autonomous learning is largely self-managed and self-regulated, such learning might also be facilitated through interaction with peer students or by reflection on the views of peer students and teachers (Entwistle & McCune, 2004). In such a case, students use other students' perspectives to sharpen their own without compromising their personal contribution to knowledge construction, so that the external transmission of information is not their primary source of knowledge. In autonomous learning, students accept that it is through *individual cognitive accountability* and not that of peer students or the teacher, for the setting of goals, identification and use of resources in achieving these goals, and for the resulting perspectives they developed within a knowledge domain. It is also suggested that self-regulated autonomous students use effective writing strategies (Cho & Kim, 2013). They write messages, monitor the interaction process, and reflect their interaction by reading the messages posted by peer students (Cho & Jonassen, 2009; Cho, Shen, & Laffey, 2010). Based on the above reviewed literature, an instructional strategy of *Encouraging Autonomous Learning through Reference Contributions [S2.2]* was subsequently introduced in this cycle.

In order to address the inability of students to practice task interdependence and extend beyond mere consolidation of individual inputs *[I1.4]*, other forms of interdependence among the members of a group were explored, such as *Setting Goal Interdependence through Group Information Integration [S2.3]*. Apart from task interdependence, it is also highlighted that a favourable goal interdependence is crucial, as it allows students to clearly perceive that their goal is positively linked to the goal of their partners (Buchs & Butera, 2015). At the start of every collaborative learning activity, and throughout the learning process, the students in each group must identify common goals. They must also become aware of their complementarity in achieving their goals, such that they must accept that they can reach their goals only if the other group members also reach it. The common goals of the team must ensure that every member understands, masters, and integrates information and reference materials which the team is working on. For this to happen, the teacher must give clear task instructions that have firm structures to the team in order to promote goal interdependence (Buchs & Butera, 2015). Clear instructions and general ground rules for participation (e.g. a minimum number of postings per activity) are also essential and should be accepted by all participants (Ernest et al., 2013). Based on the above literature, *Setting Goal Interdependence through Group*

Information Integration [S2.3] was put forth as a possible instructional strategy to address the issue mentioned in *[I1.4]*.

The instructional strategy of *Assigning Clear Individual Roles [S1.3]* used in the first cycle had resulted in students' awareness of their own roles and responsibility as Student A or Students B. However, they seemed to misunderstand that the roles of their group members had to be in unison with their own towards completing the task as a group. As such, a new instructional strategy of *Establishing Role Awareness Using Scripted Roles [S2.4]* was included. In a study on roles of students in a collaborative learning environment, the concept of emerging and scripted roles is introduced by Strijbos and Weinberger (2010), in a study on how students structure and self-regulate their collaborative learning processes among the members in the group. It has been earlier asserted that the instructions and activities introduced together with the use of online tools for co-construction, information representation and case arguments among groups of students has enabled them to clearly present their understanding in discussions, and as a result acquire multiple perspectives on the subject (Andriessen, Baker, & Suthers, 2003; Weinberger, 2008). Such online learning environments provide the radical shift from the traditional roles of a teacher transferring knowledge to students, to the rising practice of knowledge construction communities where students take up active roles to be more in control of their learning processes.

Awareness of emerging roles in a group is crucial. Emerging roles are mostly static during short or single collaborative sessions or tasks (Strijbos & Weinberger, 2010). An issue that surfaced during such sessions is how students implicitly distribute roles without challenging or rotating roles once they have emerged (Dillenbourg, 2002). In small groups, there is often a risk of emerging roles resulting to unequal distribution of workload (Strijbos, Martens, Jochems, & Broers, 2007). In pairs, dyads working in front of a computer have also been observed to spontaneously develop and enact the roles of "typists" and "thinkers" throughout the collaborative session (Bruhn, 2000).

Collaborative scripts have been defined as explicit suggestions to students that specify, sequence, and distribute roles and workload to all members in the group (Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, & Fischer, 2007; Kollar, Fischer, & Hesse, 2006; Weinberger, 2008). On top of using collaborative scripts to facilitate coordination in the instructional strategy, scripted roles can also be specified in collaborative scripts for students to enact, as well as to facilitate role rotation for students to equally engage in the relevant collaborative activities. Scripted roles are necessary in many cases, as spontaneous collaborative learning online does not automatically lead students to assume functional and complementing roles that result to constructive discussions, knowledge sharing and argumentation (Jermann, Soller, & Lesgold, 2004; Pfister & Oehl, 2009). Scripts, such as those introduced in the instructional strategy, explicitly specify the roles expected of each student and help to structure the collaborative process.

Citing earlier works, Strijbos and Weinberger (2010) reiterated that scripts are able to specify a large variety of roles (Weinberger, Stegmann, Fischer, & Mandl, 2007), and can be content-oriented or process-oriented (Strijbos, Martens, Jochems, & Broers, 2007; Weinberger, Ertl, Fischer, & Mandl, 2005). For content-oriented roles, such as the role of a summariser, the focus is primarily on learning the content and thus lead to higher levels of knowledge construction (de Wever, van Keer, Schellens, & Valcke, 2007; Schellens, van Keer, & Valcke, 2005). For process-oriented roles, such as a project planner role, the focus is mainly to support individual responsibility and coordination (Strijbos, Martens, Jochems, & Broers, 2007). As such, an instructional strategy of

Establishing Role Awareness Using Scripted Roles [S2.4] to facilitate collaboration and improve cognitive engagement was introduced.

On top of establishing role awareness among the students within a group, the active use of prior knowledge for *constructive* mode of cognitive engagement by each student allows other students to process new information and effectively infer and integrate it with their own perspective and conceptual thinking. This would lead to students who were already within the *constructive* mode of cognitive engagement to extend their engagement further into the *interactive* mode, which addressed the issue described in *[I1.5]*. This could be done by *Raising Knowledge Awareness through Self Introduction [S2.5]*, so that students would know the prior knowledge of their team members. It is highlighted that different combinations of prior knowledge can trigger different interactions and learning processes (Gijlers, 2005). If most of the students in the group present prior knowledge that are overlapping, elaborated explanations and discussions might be unnecessary. However, if most of the students in the group share the same knowledge gaps, a phenomenon known as pooled ignorance will occur (Xin, 2002).

Therefore, the awareness of fellow students' depth and quality of prior knowledge is an important element of efficient interaction (Sangin, Molinari, Nüssli, & Dillenbourg, 2011). They suggest that communicators of prior knowledge draw on two distinct sources of information to formulate their understanding, namely initial volunteering of prior knowledge, and the reciprocal exchange of prior knowledge among students as providers and recipients of information. Based on the literature reviewed, an instructional strategy of *Raising Knowledge Awareness through Self Introduction [S2.5]* was subsequently introduced.

4.2.2 Implementation.

4.2.2 Implementation. In this cycle, the revised list of instructional strategies was introduced together with the use of Google Docs as an online collaborative learning environment for students to work together. The students were tasked to complete their case assignment online over a period of two weeks, by adding their inputs to a shared document which contained the case scenario and questions.

The second cycle was carried out online in Weeks 7-8 of Semester 2, Academic Year 2015/16, for the same set of students enrolled in the same module IS4234 as that in the first cycle. Unlike the first cycle, the collaborative learning environment for this cycle was online using Google Docs as a platform for asynchronous inputs. The students were asked to follow the scripted instructions and complete the new case study assignment.

The 2-week case study assignment was given to the students to be completed in groups of three to five students. The students were asked to form groups among themselves by teaming up with others whom they felt comfortable to work with. There were nine groups of students, 33 students in total, who participated in the second cycle. The names of the members in each team were then submitted to the teacher, who proceeded to arranged for group sharing via online access to a common Google Doc file, which contained the scripted instructions and case notes for the students to work on. The students were allowed to discuss the assignment face-to-face, but were instructed to post their discussions, as much as possible, in the shared document by adding comment tabs online as inputs. The members were able to discuss about the assignment by posting their comments tabs as inputs in the shared document asynchronously. The members within each group could only access the group's shared document and were not able to access the documents of other groups. At the end of the assignment, the entries and comments tabs in the shared document were submitted as deliverables for the assignment.

In order to improve cognitive engagement in collaborative learning, revised instructional strategies were introduced and evaluated, namely *using realistic case scenarios*, *autonomous learning*, *goal interdependence*, *role awareness* and *knowledge awareness*. The subsections below elaborate on the implementation of these instructional strategies.

4.2.2.1. Using Realistic Case Scenarios [S2.1]. In this cycle, an online assignment using Google Docs was created. Tasks were designed using a case scenario based on a real event. The students were instructed to discuss and complete five tasks, which were aligned to the topics covered in earlier lectures. The collaborative work was done outside of the class sessions, and the assignment was completed in two weeks. The students discussed online asynchronously using the comments tabs in the online document. Gathered information by individual students were shared on, and links to the information were presented in the comment tabs. The students were also required to explain their gathered information where necessary. The online document was set to track the inputs contributed by students, through their entries on the document and comments tabs, using entry logs and time stamps.

4.2.2.2. Encouraging Autonomous Learning through Reference Contributions [S2.2]. In this cycle, the instructions given to the students explicitly mentioned that the reading materials and slides covered in the lectures were not sufficient, and there should be other reference information available online or in prints to be collected in order to complete the assignment. Full autonomy was given to the students to coordinate among themselves to complete the assignment in the collaborative learning environment, including setting goals, using selected resources or forms of communication to the rest of the members in the group. The purpose was to coordinate all communications done online via a single platform.

4.2.2.3. Setting Goal Interdependence through Group Information Integration [S2.3]. The case assignment designed for the current cycle was structured into five distinctive sections, with each section giving clear goals for the team to collaborate and provide additional information and data that could be found on the internet, as some data was not initially provided in the case notes. The instructions of integrating collected information by all group members across all sections were set as the primary goals of the assignment, together with general rules for participation, where the minimum number of utterances per team was set to fifty, a limit set to allow the test for significant differences of modes in Chi-Squared test (Bolboaca, Jäntschi, Sestras, Sestras, & Pamfil, 2011).

4.2.2.4. Establishing Role Awareness Using Scripted Roles [S2.4]. The case assignment for this cycle was designed to be assessed using two different types of inputs from the students. Firstly, the students were tasked to complete compliance tables and audit reports for the control and audit findings of the case presented. The inputs contributed to the content-oriented role of the students, with respect to completing the five sections in the assignments. Secondly, the students were provided with instructional scripts to coordinate, plan, discuss, argue, and conclude their exchanges via inputs in the form of comment tabs with reference to the content of the case and the inputs from their fellow group members. This discourse contributed to their process-oriented role. The students were instructed to be aware of both roles, and the associated actions that were expected of both roles.

4.2.2.5. Raising Knowledge Awareness through Self Introduction [S2.5]. This instructional strategy was to facilitate prior knowledge exchange and awareness among fellow students. In the current cycle, just after the students formed groups, they were instructed to introduce themselves to their group members. In particular, the students had to elaborate on their prior knowledge obtained in prior courses, internship exposures and work experiences. This allowed the rest of the students to be aware of the area of expertise of each of their group members, as well as to be informed of the spread of expertise and competency in their group. For the students who were found to have related prior knowledge and experiences, they were also asked to discuss further among themselves, so as to understand the similarities and differences in their areas of expertise. The students were also informed that after the short session of introducing themselves, they had to introduce their group members to the rest of the class. If there was any form of misinformation or miscommunication during the initial introduction, the group member who was being introduced was allowed to provide the necessary corrections. This session aimed to build a strong sense of knowledge awareness among the members in each group.

4.2.3 Formative Evaluation. At the end of the second cycle, a formative evaluation was carried out by the researcher and the research assistant, focusing on the effectiveness of the revised instructional strategies in promoting cognitive engagement in the collaborative learning environment. In this section, the results from the formative evaluation are presented in detail. Content analysis of the students' inputs was conducted for the formative evaluation, focusing on the effectiveness of the instructional strategies introduced in the current cycle towards improving cognitive engagement. Each input added by the students in the form of a comment was taken as an utterance, which is the unit of content analysis. Figure 4.5 shows a string of utterances.

Once again, the researcher and the research assistant annotated each unit, and the inter-rater reliability between the annotators was measured using Cohen's kappa κ (Cohen, 1960). For this cycle, $\kappa = 0.853$, and values between 0.81-1.00 was taken as almost perfect in agreement (McHugh, 2012).

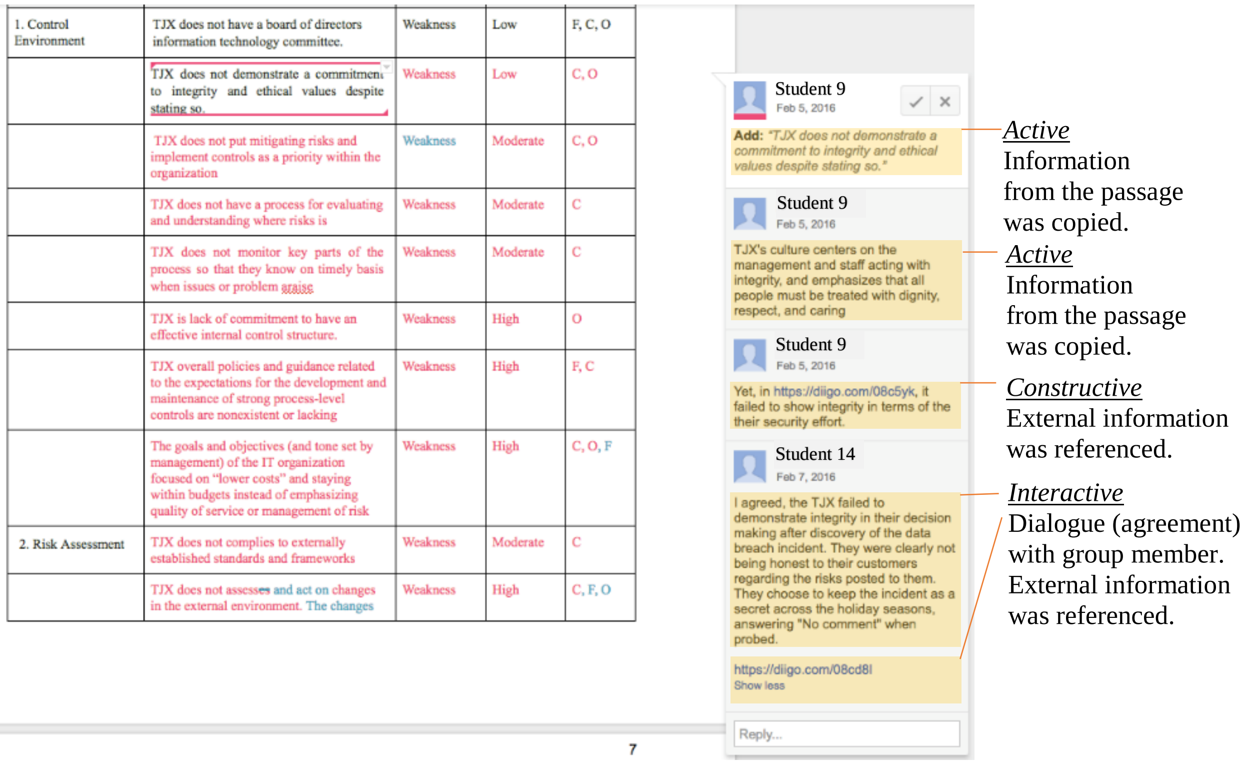

Figure 4.5: An example of an utterance chain made by students

Each of the utterances was subsequently annotated according to the characteristics of the ICAP modes provided in Table 4.1. Figure 4.5 shows an example of four utterances which formed a string of utterances. Each utterance was made by a student, by referring to a content in the online document. The first utterance was made by Student 9, as a place marker to indicate that the information was from the passage. The second utterance was also made by Student 9 as a form of elaboration to the first utterance. The information was again taken from the passage. As such, both the above utterances were annotated as the student engaged at the *active* mode. The same student subsequently made a third utterance and included external information in the form of a web address link. The utterance was annotated as the student began to engage at the *constructive* mode. A group member within the group, Student 14, added a fourth utterance, which included an agreement and a justification of the agreement, followed by external information. The utterance was consequently annotated as the student engaged at the *interactive* mode. Figure 4.6 shows the distribution of cognitive engagement of the whole class.

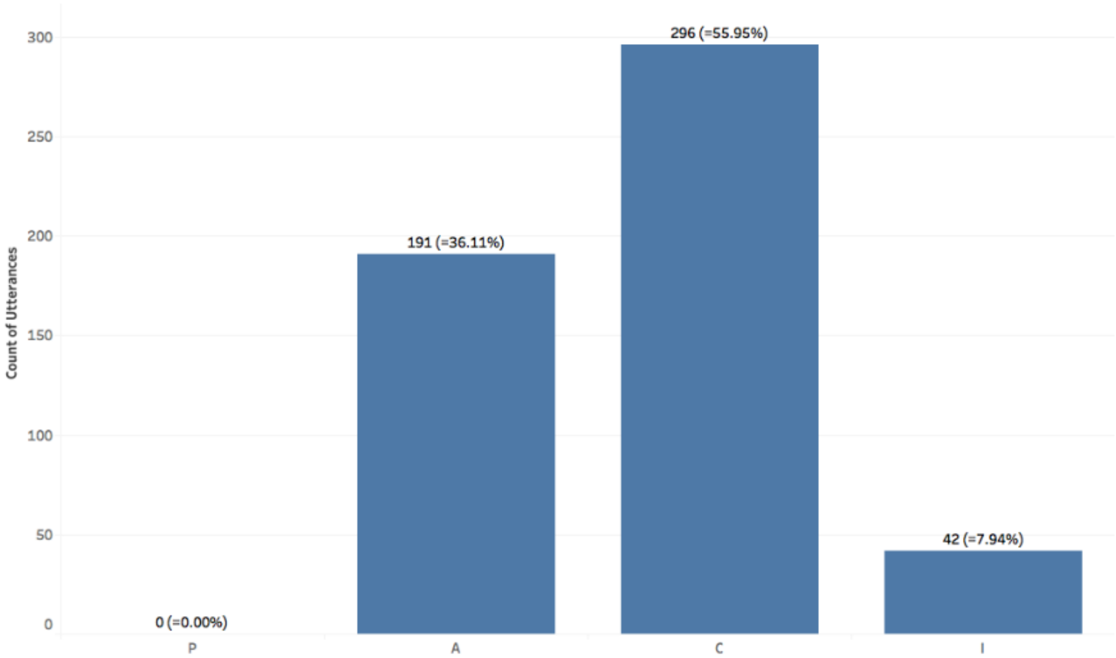

Figure 4.6: Number of utterances based on the ICAP modes

Figure 4.6 was based on the annotations of the students' utterances using the ICAP modes of cognitive engagement. The number and the percentage of utterances for the respective ICAP modes were computed and displayed at the top of the bars. In comparison with Figure 4.4 on the number of utterance by ICAP modes in the first cycle, Figure 4.6 presents a noticeable shift in the students' utterances towards higher modes of cognitive engagement, with the most number of engagements at the *constructive* mode. More than 55% of the students' utterances were engaged at the *constructive* mode, while the amount of utterances at the *active* mode had reduced to approximately 36%, a drop from 69% in the first cycle. The cognitive engagement of the students had improved, with the majority of the utterances at the *constructive* mode. The number of utterances at the *interactive* mode had also increased from less than 2% in the first cycle to nearly 8% in the current cycle.

On further evaluation, it was found that the number of students who had contributed in *constructive* mode utterances equalled those who had contributed in the *active* mode utterances. This balance in student numbers can be deduced as a positive indicator, by inferring that most of the students, if not all, who had engaged at the *active* mode would also engage in the *constructive* mode, and at a much higher occurrence rate. The utterances at the *interactive* mode were also contributed by 19 students (>57%).

Most of the utterances were made at the *constrictive* mode and was due to students generating more interpretations and information as they researched into the real-life case scenario. In this cycle, the case was an abstract of a real-life report about financial fraud, which was also in the news and online articles. Most students were more engaged in the case and had provided supplementary facts of the case via comment tabs in the shared document, which were not initially found in the given abstract. It appeared that the students were engaged constructively as they attempted to complete the assignment by asking more meaningful questions via comment inputs, providing answers to questions, and substantiating their inputs with additional links to external resources, such as news and other information provided online about the case. It was also inferred that the use of realistic case scenarios had allowed the students to start engaging in the *interactive* mode of engagement, by sharing online information and discussing in detail about the case, although the occurrences of *interactive* mode of engagement was lesser compared to the *constructive* and *active* modes. Based on these results, the instructional strategy of *Using Realistic Case Scenarios [S2.1]* seemed to have enhanced the level of cognitive engagement, as both the *interactive* and *constructive* modes had increased, and the *active* mode had dropped.

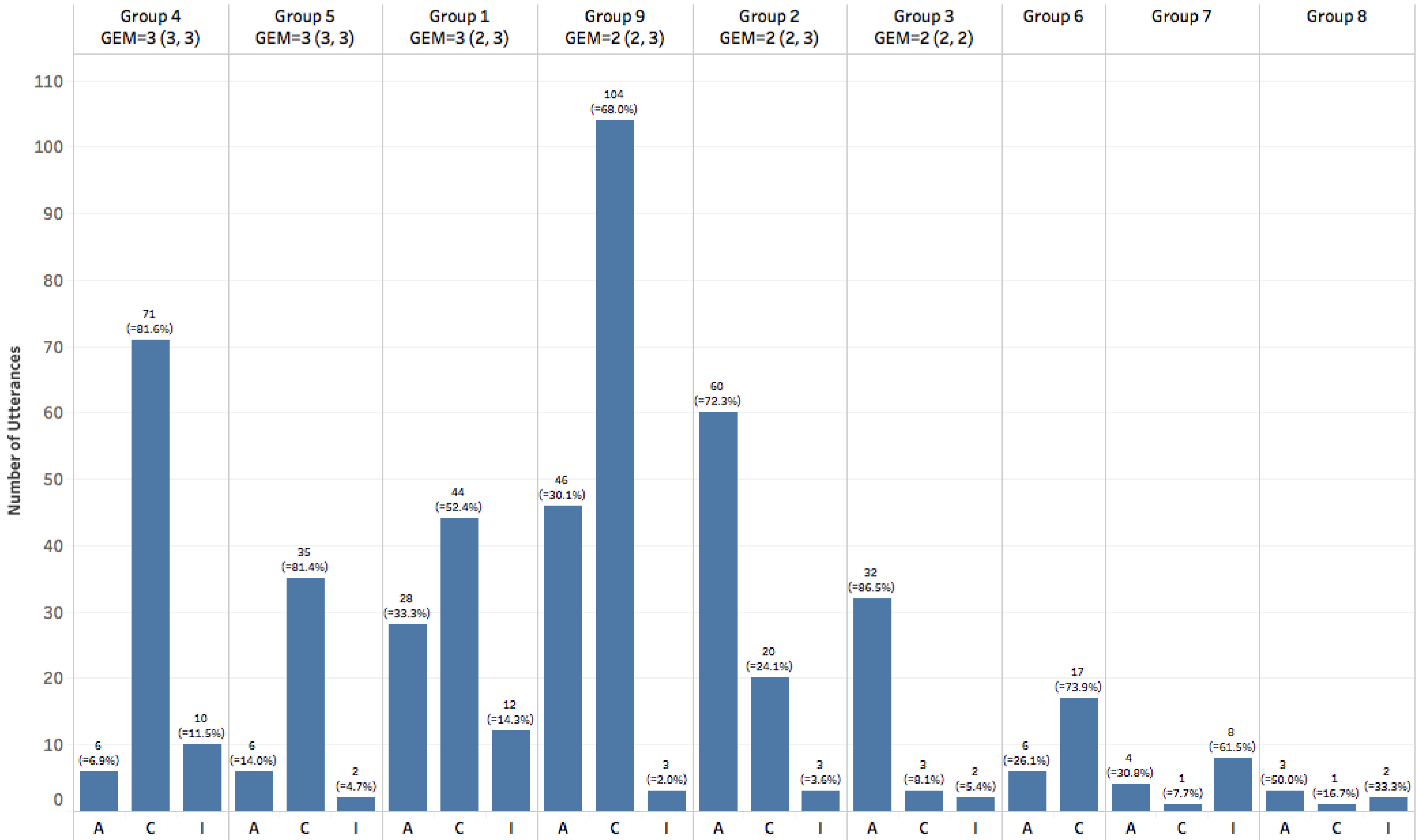

Figure 4.7: Number of utterances based on the ICAP modes for all groups

Figure 4.7 provides the amount of utterances by ICAP modes for each participating group. It displays the Group Engagement Median (GEM) values computed from the median of the group's cognitive engagement, by having each ICAP mode ranked as 1 for the *passive* mode, 2 for the *active* mode, 3 for the *constructive* mode, 4 for the *interactive* mode. The lower and upper quartiles of the GEM values were also presented as (Q_1, Q_3). The GEM values for Groups 6, 7 and 8 were not calculated as the total number of utterances for these groups were significantly lesser than the minimum number of utterance (=50) set for each group.

Group 4 was the only group that exhibited the highest form of cognitive engagement, having a high number of students engaged at the *interactive* mode and surpassed those at the *active* mode. The group also had all the students within the group (four students) engaged at both *interactive* and *constructive* modes. Group 1 also had students engaged at relatively high modes, with four and five students engaged at the *interactive* and *constructive* modes respectively.

The utterances that attained high levels of cognitive engagement were due to students sharing extensively external references about the case study. It seemed that the instructional strategy of *Encouraging Autonomous Learning through Reference Contributions [S2.2]* had motivated students to share and as a result enhanced their cognitive engagement. Groups 1, 5 and 9 had similar distributions of ICAP modes, with the majority of the students engaged at the *constructive* mode followed by the *active* mode. It was also found that more students in Groups 1 and 5 were more engaged at the *constructive* mode than at the *active* mode, while Group 9 had an equal number of students engaged in both modes. This result showed that the students in Groups 1 and 5 had extended beyond the *active* mode and were engaged at the *constructive* mode.

Groups 2 and 3, however, did not show any improvement as they displayed similar distributions of ICAP modes in their first and second cycles. It also appeared that the students in Groups 6, 7 and 8 were not engaged as a group, as the total number of utterances within each group was less than 30, which was observably low compared to the other groups. These findings meant that the students were not changing their approach to engage their group members and were also not actively interacting with their group members. They were more concerned with completing the assignment independently on their own.

The assignment for this cycle had different sections, which required the students to complete different approaches of risk assessment and map matrices used in the field of Information Systems Control and Audit. Although each section contained different requirements for different information to be filled, instructions were made to the students to highlight that the accumulated information contributed by all group members in all sections was the primary goal of the assignment. From the inputs made by the students, it seemed that most groups divided the tasks among themselves so that each group member focused on different sections while others provided feedback. It seemed that the same student would initiate utterance chains only in certain sections, while others focused on the other sections.

Figure 4.8 shows the number of utterance chains by the distinct participants (N) in each group. In Chapter 3, an utterance chain was described as a string of messages (for n number of inputs) where the students within a group would engage in a form of utterance exchange. Each utterance chain can be formed by a number of utterances, which would contribute to the length of the utterance chain. Figure 4.8, using an utterance chain as the unit of analysis, shows the number of utterance chains engaged by the number of participates in each group.

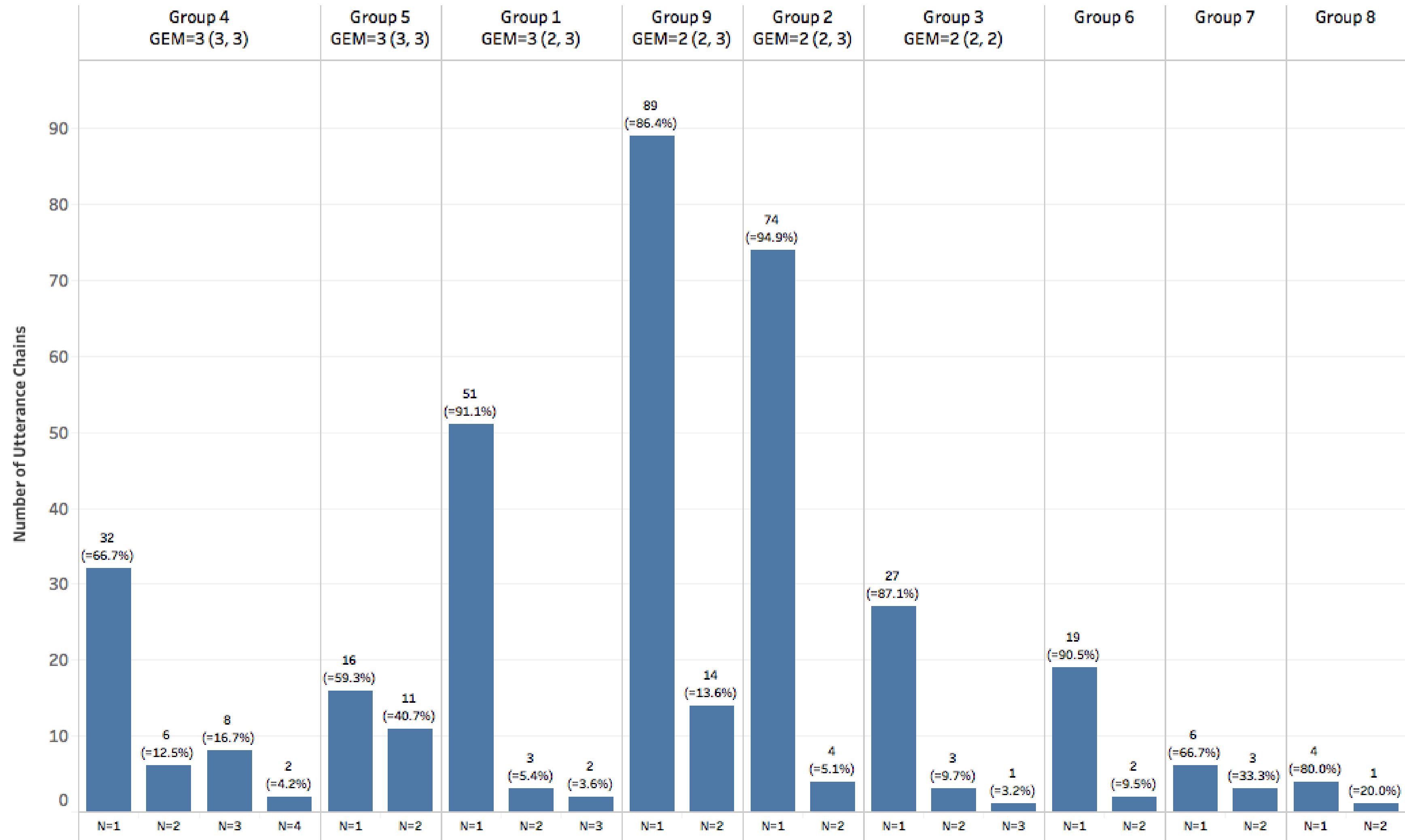

Figure 4.8: Number of utterance chains based on distinct participants for all groups

The figure shows how much cognitive engagement occurred within group discussions, by inferring from the distinct number of students participating in every utterance chain.

The percentage of the utterance chains that involved a larger number of students can infer the balance and mode of engagement within the group as a whole. Groups 1, 3 and 4 had utterance chains which involved three students and above, the highest among all the groups. It also appears that Group 4 had the highest mode of engagement in group discussions, achieving 16.7% and 4.2% of the group's utterance chains that involved three and four students respectively. Referring back to Figure 4.7, it seemed that the students in Group 4 were also cognitively engaged at the high levels of *interactive* and *constructive* modes, as well as having a greater mode of engagement among the students.

However, not all the groups were performing well. The engagement levels among the members in Groups 2, 6 and 8 were low, with Group 2 having 94.9% of its utterance chains with only one student participant. For such utterance chains, the initial utterances were followed by utterances from the same student or were left as a single utterance without further exchanges. In most cases, the entries would stop at the first input by the initial student who contributed to his or her own utterance. This result clearly indicates that the students within these groups were not participating in the exchange of information or constructive discussion in length and depth, and as a result attained a lower level in cognitive engagement.

For Groups 2, 6 and 8, the instructional strategy of *Setting Goal Interdependence through Group Information Integration [S2.3]* was not effective. Although the assignments were completed, the submissions were done by different group members and were simply submitted together in one document. High levels of cognitive engagement were not observed, although some scattered inputs of suggestions and comments were seen in selected sections where group members volunteered their viewpoints and provided links to new reference materials. These sections seemed to be predominantly viewed as the responsibilities of other group members who were initially assigned to focus on. It was apparent that the only form of goal interdependence for these three groups was reduced to the shared goal of completing all sections of the case study assignment and submitted it on time.

For Groups 1, 2 and 6, where the percentages of utterance chains with single student participation were higher than 90%. It seemed that the student's participation in the utterances chains were focused only on selected sections and appeared to limit his or her inputs, comments and other useful information about the case in other sections. These other sections might be predominantly viewed as the responsibilities of the other group members to focus on. These results, apart from having constructive discussions and exchanges of information, seemed to suggest that the students were also not willing to take up the roles of coordinating, planning, summarising or facilitating engagement among their group members. These issues would be addressed in the next cycle.

For the purpose of evaluating the effectiveness of the instructional strategies in improving cognitive engagement, a questionnaire was conducted at the end of the evaluation phase of the current cycle. The questionnaire was sent out via email to all students at the end of the semester, where the students were able to provide detailed feedback on the effectiveness of the instructional strategies.

The questionnaire was designed to evaluate the students' experience in cognitive engagement through the use of the instructional strategies provide in the group assignment. The list of items are as follows:

1. The instructions for the case assignment using the online shared document help you to:

   (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

1.1 Be conscious of your own understanding in the topics.

1.2 Discover and learning new knowledge from your group members.

1.3 Know how the topics were understood by your group members.

1.4 Be motivated to contribute new knowledge to your group members.

1.5 Raise awareness of errors highlighted among your group members.

1.6 Discuss and verify misconceptions with your group members.

1.7 Improve cooperation through information exchanges among your group members.

1.8 Enhance communication with group members using the collaborative environment.

2. If your answers in Question 1.x are Strongly Disagree, Disagree or Neutral, kindly elaborate on what could be done to improve the underlying purpose.

3. If your answers in Question 1.x are Agree and Strongly Agree, kindly elaborate on what was done well to support the underlying purpose.

4. Kindly provide other positive or negative feedback for case-based collaborative learning using co-editing online platform Google Docs.

A total of 32 students participated in the questionnaire. From the data collected, the results generated from the responses for Q1.1 - Q1.4 were placed together, as they represented feedback of the usage of instructional strategies based on *individual cognitive accountability*. The responses for Q1.5 - Q1.8 were also compared together, as they were towards instructional strategies based on *interdependent situations*. Table 4.2 shows the results from the students' responses.

Table 4.2: Results of students' responses from the email questionnaire

Components of collaborative learning for promoting cognitive engagement	Qn No.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Individual cognitive accountability	**1.1**	0 (0.00%)	2 (6.25%)	4 (12.5%)	**22 (68.8%)**	4 (12.5%)
	1.2	0 (0.00%)	1 (3.13%)	6 (18.8%)	**22 (68.8%)**	3 (9.38%)
	1.3	0 (0.00%)	1 (3.13%)	7 (21.9%)	**18 (56.3%)**	6 (18.8%)
	1.4	0 (0.00%)	1 (3.13%)	5 (15.6%)	**22 (68.8%)**	4 (12.5%)
Interdependent situations	**1.5**	0 (0.00%)	1 (3.13%)	4 (12.5%)	**19 (59.4%)**	8 (25.0%)
	1.6	0 (0.00%)	**6 (18.8%)**	10 (31.3%)	**15 (46.9%)**	1 (3.13%)
	1.7	0 (0.00%)	4 (12.5%)	8 (25.0%)	**10 (31.3%)**	10 (31.3%)
	1.8	0 (0.00%)	2 (6.25%)	7 (21.9%)	**18 (56.3%)**	5 (15.6%)
		0 (0.00%)	18 (7.03%)	51 (19.9%)	**146 (57.0%)**	41 (16.0%)

The student feedback from the questionnaire yielded significant insights into how effective the instructional strategies introduced in the current cycle were able to promote cognitive engagement. From the responses received, the majority of the students (57.0% Agree; 16.0% Strongly Agree) felt that the instructional strategies and activities introduced together with the use of shared documents online had facilitated in collaborative learning through the sharing of information and inputs. Some students also pointed out that the features online, such as highlighting and identifying of specific information on the shared text, had allowed them to efficiently gather every group member's viewpoint, specific discussion topics, misconceptions or erroneous inputs. The instructional strategies used in the online environment also allowed some students to be conscious of their own understanding of the topics, and some students expressed an increase in awareness of knowing how their other group members understood the topics. The feedback was reflected in the high rates (>70% agree & strongly agree) for Q1.1 - Q1.4, which implied positively to the use of instructional strategies for encouraging cognitive presence through *individual cognitive accountability*. These factors were also perceived to help increase cognitive engagement among the students in the process of completing the assignment. One student (in Q3) asserted this, saying,

> *The comments feature highlights the parts where the team has different opinions. The comments are easy to be read by other members, who can discuss and comment further below each comment. Doubts are clarified with the use of this feature. It also shows effort from every member and gives pressure to everyone to contribute more.*

However, some students also highlighted that debating online had not readily occurred in their groups. The responses from Q1.6 also reflected relatively low ratings towards how students viewed discussions, debates and verifications of misconceptions, at 46.9% and 3.1% for "agree" and "strongly agree" ratings respectively. One student explained this (in Q4), saying,

> *Most of us will just do our own parts and read through other people's comments on their parts hastily. Perhaps we will make slight comments, but this is relatively insignificant, and it is only perhaps for participation marks*.

The above findings implied that there was a strong need to explore other instructional strategies that could enhance communication among the students, which are closely related to the subsequent three components of collaborative learning for promoting cognitive engagement. The next cycle in the following section would thus involve the use of other instructional strategies based on the remaining three components, namely *influential interactions*, *reasoning and negotiations skills*, and *group cognitive processing*, to evaluate on improvement made towards cognitive engagement.

The results in the second cycle showed that the issues from the first cycle, such as the constraints of time to share inputs, external information and discussions, had been addressed and resolved, to some extent, through the revision of the instructional strategies. However, some additional issues had also surfaced. In summary, the following issues needed to be further addressed in the next cycle:

- Lack of coordination among students *[I2.1]*;
- Lack of social skills on how to work in a group on a given collaborative task *[I2.2]*; and
- Lack of a process to guide students to reflect among themselves within their group *[I2.3]*.

These issues would be looked into in the next cycle by revising the list of instructional strategies, based on *influential interactions*, *reasoning and negotiations skills*, and *group cognitive processing*.

4.3 The Third Cycle

It was highlighted in the second cycle that the students had benefitted significantly by working collaboratively on the case study assignment online. The use of online shared documents with instructional strategies had resolved some of the issues which surfaced during the in-class face-to-face collaborative session in the initial cycle on paper-based medium.

Although it was asserted that the initial two components were supposed to elicit social and academic support from group members and encourage students to participate in constructive interactions through information exchange and co-construction of knowledge, the instructional strategies suggested in the above two cycles still lacked in promoting high level cognitive engagement in collaborative learning. Students had exhibited *cooperative learning* by simply split up the tasks, independently worked on their separately assigned tasks, and presented the group submission as a compilation of individual efforts. The resources and information gathered, although shared by group members, were seldom referred to, commented upon or discussed by other students in the same group. The multi-authored works in the previous cycle were seen to lack significant group engagement.

Therefore, to improve the cognitive engagement in collaborative learning among the students, new instructional strategies based on the subsequent components of collaborative learning for promoting cognitive engagement were implemented. The current cycle focused primarily on improving collaborative and social interaction among the students, and as such, the new instructional strategies designed in the third cycle were based on *influential interactions, reasoning and negotiations skills*, and *group cognitive processing* components. Instructional strategies from the earlier cycles that were identified to support cognitive engagement without issues were also implemented.

4.3.1 Design. Similar to the prior two cycles, instructional strategies for collaborative learning were introduced into the learning environment and the effectiveness on cognitive engagement were studied in this cycle. Efforts were also made to analyse the combination of utterances types that were believed to reflect the effectiveness of these instructional strategies in promoting cognitive engagement in collaborative learning. Such overt behaviours were recorded and analysed to determine the effectiveness of the instructional strategies in promoting cognitive engagement. Evaluation was conducted based on the four modes of cognitive engagement with reference to the ICAP framework, namely; *passive*, *active*, *constructive,* and *interactive* modes.

The following subsections provide a brief literature on *influential interaction, reasoning and negotiations skills,* and *group cognitive processing* components. It is followed by the implementation of revised and new instructional strategies based on these components, towards enhancing cognitive engagement among the students. The evaluation section that follows covers the analyse of cognitive engagement using the ICAP framework.

4.3.1.1. Influential interaction. This component is adapted from promotive interaction, which is a set of characteristics in the tasks or learning activities that requires students to engage in ongoing conversations, dialogues, exchanges and mutual supports (Johnson & Johnson, 2005). Students learning together need to promote each other's learning and success by sharing resources, helping each other, reviewing each other's work, and supporting, encouraging and applauding each other's efforts. These activities must also involve cognitive elements for them to be meaningful, and not simply providing trivial responses. As such, the degree of interactivity among the students should not be defined by the frequency of interactions, but by the extent to which these interactions influence the cognitive processes of peers (Dillenbourg, 1999).

In collaborative learning, students are expected to learn academic subject matter from the task, and also from interpersonal and small group interaction through teamwork. However, there are expected situations of communication breakdowns and conflicts that arise during discussions, where coordination to seek a common understanding or resolution among students with strong individual views can be extremely difficult. Having appropriate instructional strategies for coordination might help to address the lack of coordination issue *[I2.1]*.

To address the issue about the lack of coordination, a new instructional strategy of *Designing Collaborative Scripts for Coordination [S3.1]* was implemented. When learners coordinate their interactions by operating on the reasoning of their peers, they are more likely to elaborate on the learning materials, to take advantage of the knowledge of their partners, and to arrive at a shared understanding (Weinberger, 2011; Weinberger & Fischer, 2006). It is also highlighted that coordination is much needed for individual accountability and interdependence among students (Wang, 2009). Coordination is closely studied as a support especially for interdependence, as it plays a crucial role in orchestrating and synthesizing all individual effort towards the same direction, thus ensuring all students make coherent contributions.

Similar to the instructional strategy of *Promoting Task Interdependence Through Joined Tasks [S1.4]*, where a set of instructions that specify and coordinate interaction, roles and activities for face-to-face collaboration, this cycle looked into the design of collaborative scripts, commonly used to structure and coordinate collaborative processes (Dillenbourg, 2002; Hämäläinen, 2008).

A collaborative script is generally a set of instructions suggesting how students can collaborate and interact together to complete a common task (Dillenbourg, 2002). With scripted collaboration, the students can follow the instructions and undertake shared learning tasks (Weinberger, 2003). It has been asserted that the use of a collaborative script helps students to reduce uncertainty about coordination efforts (Mäkitalo, Weinberger, Häkkinen, Järvela, & Fischer, 2005), by establishing collaborative norms indicating what is expected from the students working together in a group (Schoonenboom, 2008; Zahn, Krauskopf, Hesse, & Pea, 2012). A collaborative training with rules to collect task-related information, to structure and to coordinate tasks, or to determine steps necessary for task solutions has also been found to facilitate collaborative learning, increase performance, and reduce variation in performance (Paechter, Kreisler, & Maier, 2010).

It has also been highlighted that the use of collaborative scripts can involve different emphases; on the learning process itself, or on representing knowledge (Pfister & Mühlpfordt, 2002). These emphases were looked into with more detail later in providing *Epistemic Scripts [S3.2]* and *Social Scripts [S3.3]*.

There are several studies on collaborative scripts, some providing instructional steps in detail, while others specify simple and general instructions. One such recent study by Peterson and Roseth (2016) uses a set of collaborative scripts and focuses on producing a summary of a case study. Step-by-step instructions are provided for students to:

- Identify the main points raised in the discussion
- Determine how to organise the ideas
- Draft a written summary
- Review the draft summary for brevity and accuracy
- Submit final summary

As the current study also required the students to work on case studies by providing overviews of the scenarios, an instructional strategy with similar steps to those described above would address the issue about the lack of coordination *[I2.1]*, by providing an instructional strategy of *Designing Collaborative Scripts for Coordination [S3.1]* based on the use of collaborative scripts to primarily represent and build knowledge.

4.3.1.2. Reasoning and negotiations skills. Students must learn to communicate effectively with their fellow students for maximum academic success. They must know how to maintain a sense of synchronicity of reasoning while, to some extent, argue for their viewpoints, justify, negotiate and attempt to convince others (Dillenbourg, 1999). However, students are not able to automatically interact effectively with other members in the group, especially during collaborative learning. The novel use of collaboratively working online using co-editing tools made interacting even more unnatural.

Thus, to address the issue about the lack of social skills *[I2.2]*, students need to know what is expected of them in order to communicate effectively and productively on the group assignment. They need instructions on how to share and present information and interpretation to the rest of the group. They also need to display the skill of listening to others and manifest their learning in their replies and inputs. Appropriate instructional strategies, using collaborative scripts such as *Epistemic Scripts [S3.2]* and *Social Scripts [S3.3]* would promote social skills among students, and subsequently facilitate collaborative learning.

There was also a need to address the issue about a lack of a process to guide the students to participate in knowledge construction. On a didactical level, students should be supported with cognitive tools to support the co-construction of knowledge development and understanding (Häkkinen, 2003). It has been suggested that collaborative scripts help to facilitate collaborative learning processes and guide students' interactive activities. With scripted collaboration, students would be able to follow instructional directions and undertake shared learning (Weinberger, 2003).

As mentioned briefly above, Pfister and Mühlpfordt (2002) suggested that the use of scripts might emphasize on the learning process itself, or on representing information and interpretation. Hämäläinen (2008) identified these two branches of scripts, namely epistemic and social scripts. The following paragraphs elaborate mainly on the scripts.

Epistemic scripts provide students with instructions on how to deal with their tasks in an online learning environment. The primary aim is to structure individual knowledge construction activities by providing the students with instructions and guidelines for interaction with other students in their group, which will ultimately help all students to achieve the intended learning outcome.

Although epistemic scripts are able to provide students with instructional strategies to solve cases (Fischer, Kollar, Mandl, & Haake, 2007), it is cautioned that empirical findings from collaborative learning studies using epistemic scripts are relatively lacking, particularly in learning and achieving better knowledge construction

(Hämäläinen, 2008). There is also a need for further research on the limitations and possibilities of epistemic scripts, especially with regards to complex tasks in which students are solving complicated real-life problems in social situations (Hämäläinen, 2008). Based on the above literature, the instructional strategy of *Providing Epistemic Scripts through Structured Questions [S3.2]* was introduced in this cycle.

Other than providing epistemic scripts, a second type of scripts known as social scripts is identified (Hämäläinen, 2008). This type of scripts is designed to instruct students on how they should interact with other group members in the online learning environment. As epistemic scripts aim to affect collaborative learning by pre-structuring the learning task in order to facilitate knowledge construction activities, social scripts attempt to facilitate collaborative learning by structuring the interaction of the students.

In practice, social scripts, in the form of annotations, specify and sequence interaction of students, such as eliciting information from each other by commenting and asking critical questions. These specific social interaction patterns are believed to motivate elaborative exchanges and activities, which in turn foster learning (Weinberger, Ertl, Fischer, & Mandl, 2005). It was asserted that social scripts can foster elaborative discussions and critical negotiations, so as to avoid false consensus among students.

Social scripts enable students to focus more on content and knowledge development activities in addition to reducing the number of coordination activities (Weinberger, 2003). Social scripts, with the intention to enhance team cohesion and engagement, are also found to be effective in providing instructional support for group activities (Hämäläinen, Häkkinen, Järvelä, & Manninen, 2005; Stegmann, Weinberger, Fischer, & Mandl, 2005). Based on the literature, an instructional strategy of *Providing Social Scripts through Utterance Annotations [S3.3]* was proposed, to address the issue about the lack of social skills among the students *[I2.2]*.

4.3.1.3. Group cognitive processing. As there are benefits for students to collaborate and work together on case-based assignments, it is important to facilitate the students to display their extent of knowledge and skills attained from the shared experience, and instructional strategies such as *Conducting Reciprocal Teaching and Learning [S3.4]* would address issues relating to a lack of a process for group reflection *[I2.3]*. In the literature, such display of group learning and knowledge consolidation from collaborative activities has been performed through different approaches. Some studies have found that it is beneficial for teachers to apply instructional activities of reciprocal teaching and learning in small groups (Beishuizen, 2008; Brown & Palincsar, 1989; Palincsar & Brown, 1984). Citing earlier works, Beishuizen (2008) explained the study done by Brown and Palincsar (1989), who design instructions on reading comprehension strategies for 12-year-old students. The training is directed towards the acquisition of four strategies: summarising a paragraph, raising questions about a paragraph, predicting what the next paragraph might entail, and clarifying difficult statements in the paragraph. During the first part of the training the teacher demonstrates the four reading comprehension strategies to groups of two to seven students. During the second part of the training, the students and teacher apply the strategies consecutively and comment on each other's approach. During the third part of the training the students work independently, and the teacher take part as adviser. This reciprocal training method can produce considerable and stable improvement in the application of the acquired strategies and lead to significant progress in performance on standard reading comprehension tests.

Beishuizen (2008) highlighted the role of the teacher in providing explicit instructional process, acting as a model, encouraging peer interaction, and providing clearly defined feedback. Moreover, teachers should gradually share the responsibility of teaching and learning with the students, establishing in a reciprocal learning environment.

In addition, citing earlier works by Dewey (1933), Strahm (2007) reemphasized reflection as the main factor between knowledge sharing and knowledge transforming. This critical element of Dewey's theory supports the idea that reflection is an integral part of learning, and highlights reflection as a purposeful activity and a means of both knowledge construction and empowerment. Strahm (2007) continued to cite the models of reflection by Schön (1987) and van Manen (1991). These models bind knowing and thinking together in a student's action, and this becomes more relevant in a setting based on interaction among students who are engaged in collaborative learning. It is concluded that such consolidated reflection in *group cognitive processing* is a powerful learning tool. For the purpose of constructive feedback by group members, Strahm (2007) suggested that group members should write reflective comments and share them. Fink (2003) described this process of "learning how to learn" as one of key components that contribute significantly to the learning experience. It enables students to become better by inquiring about a subject, constructing knowledge and becoming self-directed.

Based on the literature, the current cycle implemented an instructional strategy of *Conducting Reciprocal Teaching and Learning [S3.4]* to establish group cognitive processing through reciprocal teaching and learning through facilitating reflective comments by students in their groups.

4.3.2 Implementation. The third cycle was carried out for a class of 21 students enrolled in same module (IS4234) in the following academic year, after the batch of students who participated in the first and second cycles. Similar to the second cycle, the collaborative learning session in this cycle was done online using a shared document as the platform for asynchronous input. The students were again asked to follow the instructions to complete the case study discussion. For the third cycle, the collaboration learning session in the classroom was carried out in the following steps: A 2-week case study assignment was given to the students to be completed as group work. Similar to the second cycle, the students were also asked to form groups among themselves by teaming up with others whom they felt comfortable in working with. The student groupings were submitted to the teacher, who immediately arranged for the online access to the shared document, which contained scripted instructions for the students to work collaboratively.

The students were allowed to discuss face-to-face but were instructed to input their exchanges, as much as possible, in the form of comments in the shared document. The members were able to complete the collaborative assignment by contributing their inputs in the document asynchronously. The members within each group could only access the group's shared document and were not able to access the documents of other groups. At the end of the assignment, the entries on the shared document and the comments tabs were submitted as deliverables for the assignment.

In the literature, based on the components of collaborative learning for promoting cognitive engagement, a number of instructional strategies specifically for collaborative learning have been designed to promote cognitive engagement in the collaborative learning environment. The following subsections elaborates on the instructional strategies introduced in the current cycle, followed by the activities for the instructional strategies.

4.3.2.1. Designing Collaborative Scripts for Coordination [S3.1]. For this cycle, a case study was used for students to review and analyse in small group discussions, and the students were given a similar variation of the collaborative scripts provided by Peterson and Roseth (2016). The students were briefed on the use of the collaborative scripts, which were in the form of steps for them to work together as a team to complete the case study assignment. The assignment, which encompassed separate sections, was scripted to have tables, comments/discussion examples and formatting, to guide the students along.

4.3.2.2. Providing Epistemic Scripts through Structured Questions [S3.2]. In order to implement the use of epistemic scripts for the current cycle, the collaborative environment for collaborative learning by groups of students was set up similarly to that in the second cycle, except for the additional provision of epistemic scripts. The epistemic scripts aimed to facilitate the students in each group to work through the learning task together. The epistemic scripts were in the form of pre-structured guide about how to analyse the case, which were designed to prompt the group members to identify new case information and interact with other members as they continued to share such information with others. An example of an epistemic script designed to prompt for inputs on Risk Assessment was given as "Risk Assessment: Analyses risks, considering the likelihood and impact as a basis for how risks should be managed".

4.3.2.3. Providing Social Scripts through Utterance Annotations [S3.3]. Similar to the second cycle, the students in this cycle were assigned an identical case study to analyse as a group, except that they were also provided with social scripts. The social scripts were aimed to foster elaborative discussions and critical negotiations, and to avoid quick and convenient consensus among the students. Therefore, on top of the process-oriented roles in *Role Awareness [S2.4]*, where students were required to be mindful of when they engaged in collaborative activities, the students were also asked to annotate their utterances, in accordance to the type of input they contributed in the discussion.

The utterance annotations were aimed to support collaborative activities by providing a form of prompting through the use of annotations as social scripts, where they became part of the utterance shared by each student. Apart from facilitating students to understand their roles, annotations also helped to prompt others to participate in the flow of discussions among their group members. Table 3.1 presents the utterance annotations.

4.3.2.4. Conducting Reciprocal Teaching and Learning [S3.4]. The teacher paced the students through different stages, starting from the teacher demonstrating collaborative learning with examples, to students engaging in self-directed learning. Before the start of the assignment, for a predefined session of one hour, the teacher assumed the role of a student peer among a group of students. The demonstration was done in the classroom, on a sample case study that was made accessible to all students in the classroom session. All participating students were asked to analyse the case and provide reflective comments. Other students would comment on the initial inputs or provide comments on other parts of the case. The teacher would also provide examples of reflective comments and explained to the class giving justifications for each input as the online discussion of the case progressed on. At the end of session, the expectation of what *group cognitive processing* entailed was given.

4.3.3 Formative Evaluation. At the end of the cycle, a formative evaluation was carried out by the researcher and the research assistant, focusing on how the instructional strategies, based on *influential interaction*, *reasoning and negotiations skills*, and *group cognitive processing* components, promoted cognitive engagement in the collaborative learning environment. In this section, the formative evaluation activities are described.

Similar to the evaluation done in the second cycle, content analysis of the students' inputs was the main form of the formative evaluation, focusing on the effectiveness of the instructional strategies introduced in the current cycle towards improving cognitive engagement, as the students completed the given assignment using the shared document platform as the collaborative learning environment. Similarly, each input added by the students in the form of a comment was taken as an utterance, which was the unit of analysis for this cycle. Each utterance was subsequently annotated according to the characteristics on the ICAP modes provided in Table 4.1 in Section 4.1.3. The mode of cognitive engagement based on the ICAP framework was evaluated, followed by a discussion on the issues that were identified at the end of the cycle. Figure 4.9 shows the number of utterances across the ICAP modes. The subsequent paragraphs summarise the findings of the third cycle.

Similar to the first two cycles, the researcher and the research assistant annotated each unit, and the inter-rater reliability between the annotators was measured using Cohen's kappa κ (Cohen, 1960). For this cycle, $\kappa = 0.864$ suggested that the agreement of the annotations by the annotators was almost perfect (McHugh, 2012).

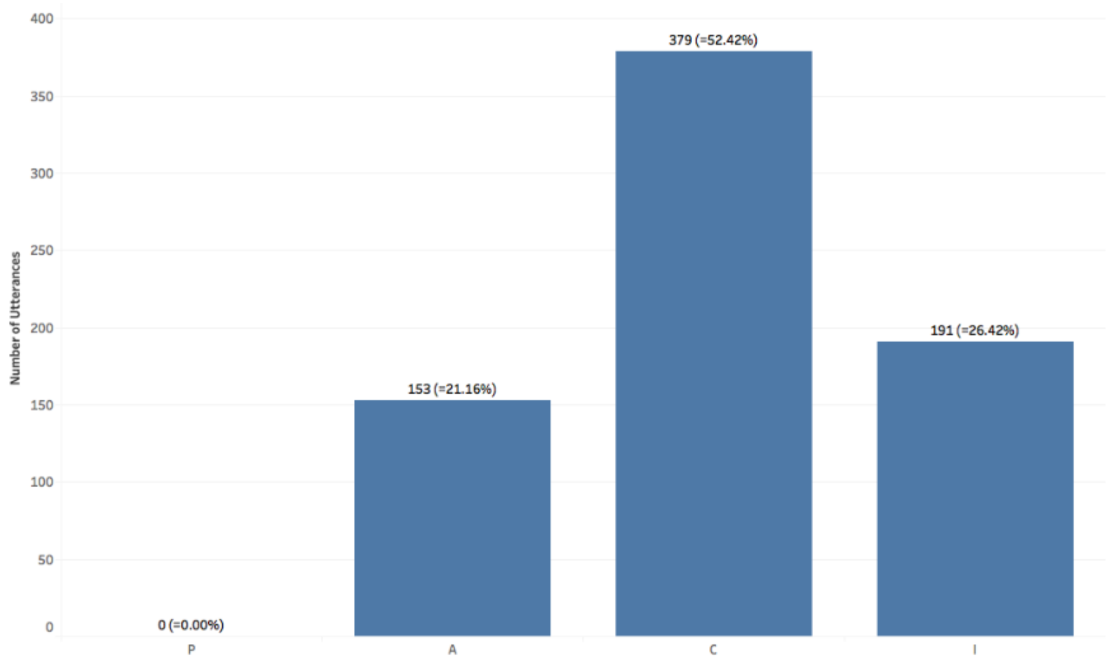

Figure 4.9: Number of utterances based on the ICAP modes

Figure 4.9 shows that the students in general in this cycle were cognitively engaged at a relatively higher level, which is in the *interactive* mode, when compared with the students in the previous cycles. The percentage of utterances where students were engaged in the *interactive* mode had increased from less than 8% in the second cycle (see

Figure 4.6) to more than 26% in this cycle. The percentage of the students engaged in the *interactive* mode was the highest at 100% for this cycle, compared to 57.6% of the students who were at the same mode of engagement in the previous cycle. On further analysis, it also seemed that although the percentages of the utterances in *constructive* and *active* modes did not differ obviously, the percentages of the students participating in the utterances increased significantly. The percentages increased from 78.8% for both modes to 90.5% and 95.2% respectively. These results showed that the students were more coordinated than those in the last cycle, as almost all the students were engaged at the *interaction* and *cognitive* modes. Figure 4.10 describes the distribution of utterances across the ICAP modes by groups, together with their GEM values.

Figure 4.10 shows that Groups 1, 2 and 8 were leading all other groups in terms of engaging high levels of cognitive engagements. It can be seen that for Groups 1 and 2, the engagements at the *interactive* mode had surpassed those at the *constructive* and *interactive* modes. The cognitive engagement in Group 8 seemed to be lagging, with utterances at the *interactive* mode slightly below the *constructive* mode. Groups 5, 7 and 9 appeared to display similar patterns as the high performers in the second cycle, with the majority of the groups' utterances at the *constructive* mode. However, not all the groups were performing well. Group 3 had very few utterance exchanges (<30). The GEM value was not computed, as the total number of utterances within each team was less than the minimum set value of fifty. Group 4 also seemed to be slightly underperforming, with most of the utterances at the *active* mode, which were slightly more than the *constructive* mode. For these two underperforming groups, it might be due to the fact that they were teams of two students. The initial problem of having too few students to participate in debates and discussions might have contributed to the low count of utterance exchanges. Group 6 decided to withdraw from the study, and opted for face-to-face discussion.

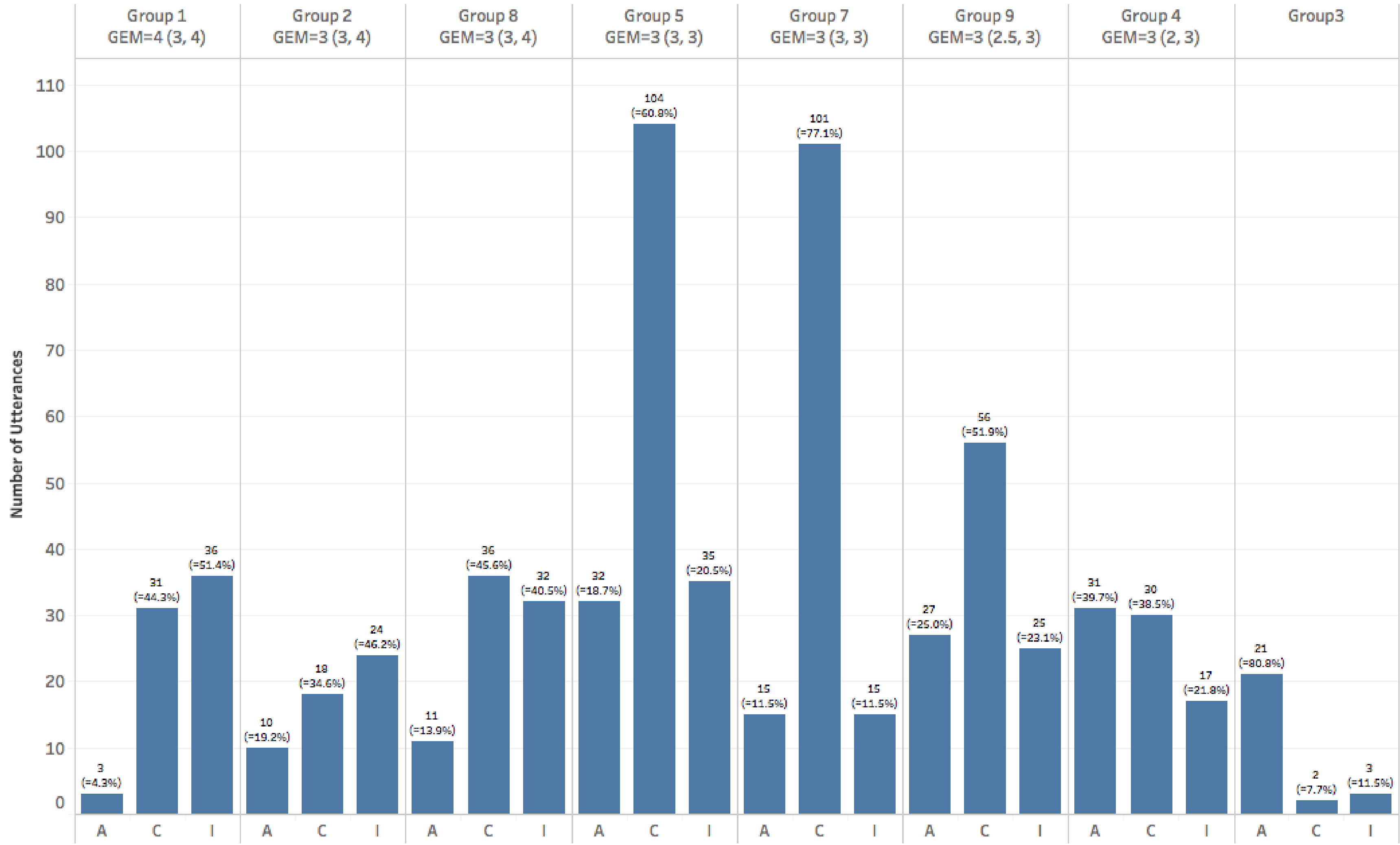

Figure 4.10: Number of utterances based on the ICAP modes for all groups

In order to test if the distributions of the cognitive engagement modes were significantly different, the Kruskal-Wallis test was used. The Kruskal-Wallis Chi-Squared test statistics value was 80.27 with 7 degrees of freedom and a p-value of 1.214e-14. As the value of the test statistics was higher than 14.07 (the 95th percentile of the Chi-Squared distribution with 7 degrees of freedom), and the p-value was less than the significance level 0.05, it was conclusive that there were significant differences in the distributions among the groups. Next, a post-hoc analysis was performed to determine the level of differences in distributions among the groups. The Dunn test was used, as this test was most appropriate with groups having unequal numbers of observations (Zar, 2010). The test was conducted with the threshold set at an alpha of 0.05, and the results showed that the groups fell into three clusters, where the levels of cognitive engagement of Groups 1, 2 and 8 were not significantly different, and those of Groups 4, 5, 7 and 9 were also not significantly different. Group 3 was in a cluster on its own.

Figure 4.11 shows how much cognitive engagement occurred within group discussions, by inferring from distribution of the number of utterance chains by the distinct participants (N) in each group.

On closer inspection of Figure 4.11, Group 1 seemed to show that most students (60%) within each group participated in an utterance chain with at least another group member (>1 distinct student count). The effect of using collaborative scripts towards coordination and engagement of the students in completing each task seemed to be reflected in this positive outcome.

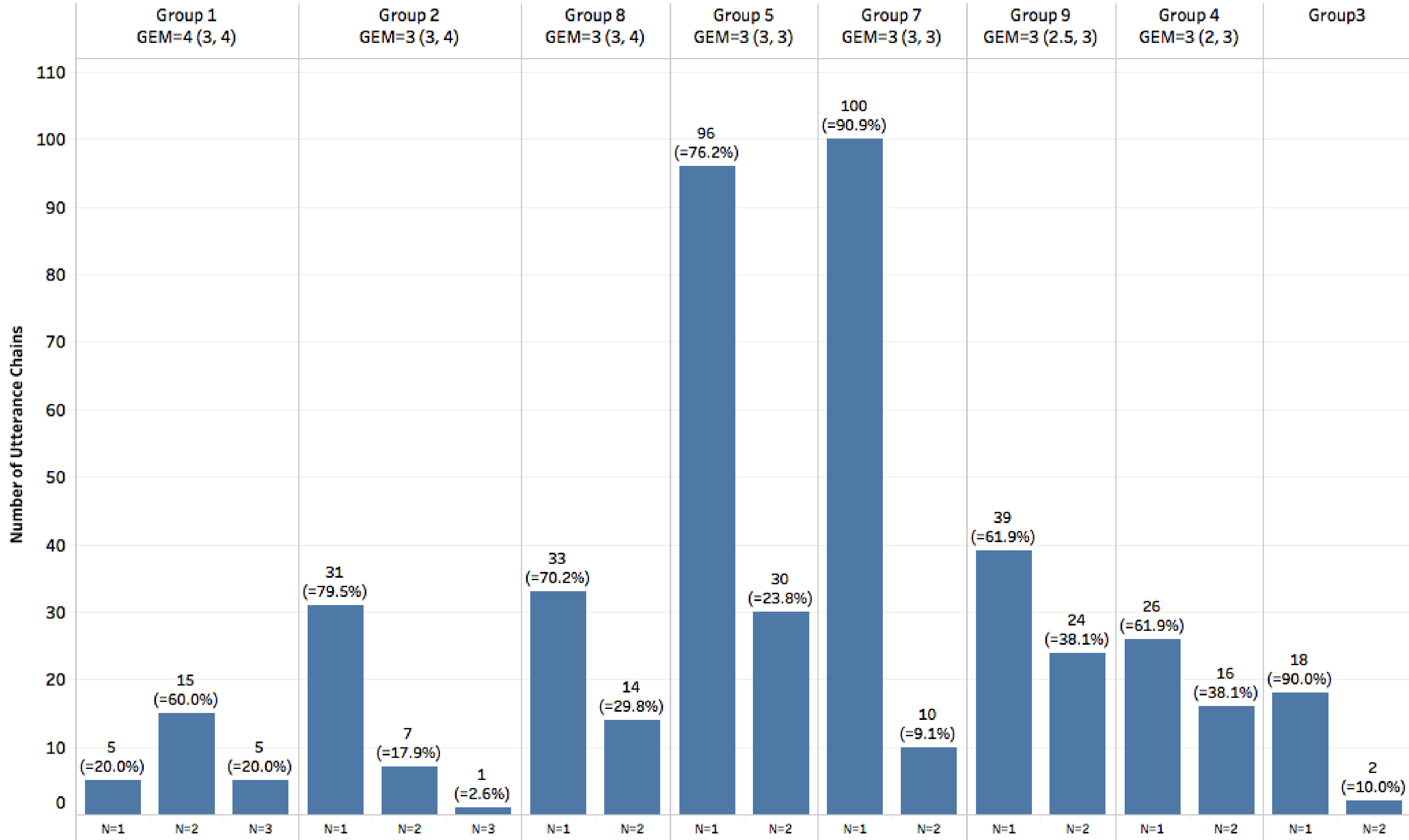

Figure 4.11: Number of utterance chains based on distinct participants for all groups

However, this positive effect did not occur for the other groups. For Group 7, 90.9% of the utterances were by a single participant with no further discussions. This means that although the utterances at the *constructive* mode amounted to 77.1% as shown in Figure 4.10, the students in this group engaged in providing extensive external information and references but lacked in interactions and discussions on the information shared by other group members. Group 5 also displayed a similar group behaviour with high single utterance at 76.2%, where the students were perceived to be giving mini-lectures to their group members, without any form of argument or debates from other group members. It seemed that the students fell short in reflecting on the utterances shared by their group members and forming argumentative discussions. They were more focused in providing external sources to new understandings.

With the introduction of epistemic scripts, it seemed that most groups were able to start their assignments efficiently, by following the epistemic scripts, which were in the form of question prompts. It appeared that discussions and debates, whenever they occurred, were raised within the groups after answers to the question prompts were added, thus helping to initiate the discussions. The epistemic scripts also became focal points of discussions for most groups and helped in building up discussion points and reflective comments. Although the epistemic scripts were seen to help the students to find their footing in collaborative learning, it must be cautioned that students could become heavily reliant on such scripts and would be lost if they were to conduct case analysis without the help of question prompts.

The 1-hour session to demonstrate how to collaborate with the use of reflective comments while building contents on the shared document was crucial, as it allowed the students to observe how the reflective comments could facilitate cognitive engagement among their group members. The students who attended the session observe from the teacher's demonstration how providing comments could propagate the rest of the students in the group to respond, either by engaging in asking for further clarifications of the teacher's comments, or by contributing online links which helped other members understand the discussions better. The online environment was also a suitable reciprocal space, as students were able to reciprocate what was observed and experienced in the 1-hour session to their group members, who were engaged together with them in the collaborative learning environment for the assignment. By conducting the face-to-face demonstration session and showing on real-time online interaction among the students and the teacher, the students appeared to develop a deeper understanding of how interaction and collaboration could help to enhance engagement. The aim of the instructional strategy was met as well, when the students were engaged at higher cognitive modes through *influential interactions* and *group cognitive processing*.

Social scripts were also introduced in an attempt to facilitate collaborative learning by providing a process for interaction among the students. For this cycle, the students were instructed to annotate their utterances, in accordance to the type of inputs they contributed in the course of the discussions. All students appeared to diligently annotate their comments. It seemed that with an overt display of participation by their group members online, other members in the group were motivated to participate in the discussions. This resulted to the production of long trails of utterances that specified clearly the chain of thought of the students as they learnt together as a whole. Therefore, in order to evaluate the modes of the students' cognitive engagement in relations with the utterance types, the number of utterances by ICAP modes for each utterance type was generated as shown in Figure 4.12.

Figure 4.12 identifies the utterance types which strongly promote cognitive engagement.

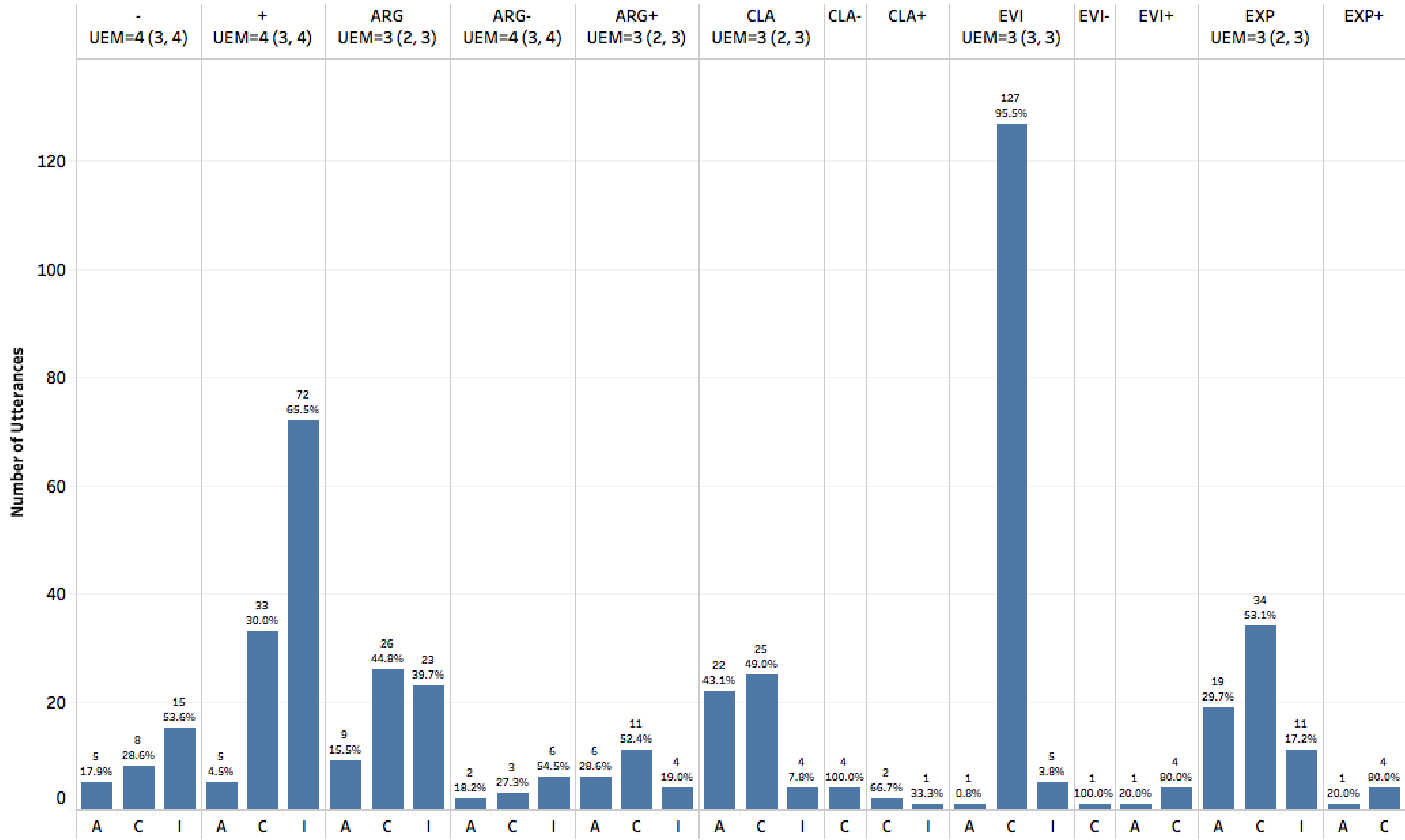

Figure 4.12: Number of utterances based on the ICAP modes for all utterance types

Similarly, it displays the Utterance Engagement Median (UEM) computed from the median of the cognitive engagement occurring at each utterance type, by having each ICAP mode assigned a value of 1 for *passive* mode, 2 for *active* mode, 3 for *constructive* mode, 4 for *interactive* mode. The lower and upper quartiles of the UEM values are also presented as (Q_1, Q_3). UEM values with low numbers of utterances were not computed.

Figure 4.12 shows that most of the utterance chains were categorised at the *constructive* and *active* modes. Only a handful of utterances were in the *interactive* modes. Also, the annotations were not uniform, as the graph shows that the majority of the students were tagging their utterances mostly as EVI (evidence) and relatively low in numbers for the rest of the annotations. Furthermore, although the utterance type with the highest UEM value was ARG-, the number of utterances in this category was low (=11). This imbalanced distribution of the utterances across the ICAP modes strongly suggested that the design of the annotation table was not efficiently utilised, and its wide range of annotations might not be suitable for the students learning together in a collaborative learning environment. This issue would be addressed in the next cycle.

The results in the third cycle have presented further improvements in the students' cognitive engagement. More students in the groups were increasingly engaged at the higher modes of cognitive engagement, namely the *interactive* and *constructive* modes. It can be deduced that the revision of the instructional strategies to address the issues from the second cycle had, to some extent, improved cognitive engagement among the students. However, only one group (Group 4) were engaged at a GEM value of above 3, which was approximately the weighted value for the *constructive* mode. Students in other groups were, however, not equally engaged at high modes as discussions were not deeply and openly reflected on by their group members. In conclusion to the findings at the end of the third cycle, the following were issues that needed addressing in the next cycle:

- The absence of argumentative discussions among students *[I3.1]*;
- The lack of deep reflections in the interactions among students *[I3.2]*; and
- The need of a suitable utterance annotation table for a collaborative learning environment *[I3.3]*.

Another cycle was hence conducted to address the above-mentioned issues.

4.4 The Fourth Cycle

The primary purpose of the fourth cycle was to improve the effectiveness of the instructional strategies introduced into the collaborative learning environment towards deepening cognitive engagement of the students learning in groups.

From the findings of the third cycle, it appeared that although the students had improved in their cognitive engagement relatively to prior cycles, the mode of the groups' cognitive engagement had largely not advanced beyond the *constructive* mode, with only three out of nine groups demonstrating relatively higher numbers of utterances at the *interactive* mode. This issue about a low count of utterances at the *interactive* mode seemed to be due to an absence of argumentative discussions that can lead to knowledge construction *[I3.1]*. It was also identified that students were extremely engaged in gathering and providing new understanding as a group but failed to engage in deep reflection for group processing *[I3.2]*. The initial design of the utterance annotation was also inappropriate for effective use in a collaborative learning environment *[I3.3]*. This cycle thus aimed to revise the existing instructional strategies and introduce new ones to address these issues. All instructional strategies from the earlier cycles that were identified to support cognitive engagement without issues were also implemented.

4.4.1 Design. The literature presents many positive effects of collaborative argumentation-based learning on a variety of learning mechanisms (van Amelsvoort, Andriessen, & Kanselaar, 2007). However, by simply telling learners to argue with each other, it will not be sufficient to attain the potential of cognitive engagement and hence it does not entirely guarantee successful learning (van Amelsvoort, 2006). To address the issue about an absence of argumentative knowledge construction *[I3.1]*, a new instructional strategy to regulate and manage argumentative discussions, conflicts and other potential controversies, namely *Facilitating Peer Instruction for Structured Academic Controversy [S4.1]*, was introduced. The relation of argumentative knowledge construction and learning is highly dependent on the way in which the conflicting views among the students are developed and processed, as suggested in studies on socio-cognitive and social influence (Buchs, Butera, Mugny, & Darnon, 2004; Quiamzade & Mugny, 2001). It is proposed that learning proceeds from argumentative activities among students, and that conflicts are regulated to allow them to appreciate conflict as a chance to develop knowledge and not a struggle for competence (Buchs & Butera, 2015).

In the analysis by Buchs and Butera (2015), it is stated that there are three main forms of regulation, namely epistemic conflict regulation, protective relational regulation, and competitive conflict regulation. The epistemic conflict regulation focuses on the resolution of the divergence regarding the task at hand, such as gaining knowledge and understanding of the points of views of others, and favours cognitive progress through deep processing and integration of information (Darnon, Muller, Schrager, Pannuzzo, & Butera, 2006). Collaborative learning environments should ideally support students such that epistemic conflict regulation takes place, with confrontation lading to a better understanding of the problem, deep processing of information, reconceptualization and knowledge creation.

However, the next two forms of regulations focus on social comparison based on student competence (Sommet et al., 2014). Protective relational regulation occurs when students recognise that they are less competent compared to their fellow students, and are likely to solve confrontation through compliance, by taking the point of view of others uncritically. This form of regulation results in students not achieving cognitive engagement because they choose not to fully process the information provided by others.

On the other end of the spectrum, competitive conflict regulation occurs when students are motivated to defend their own competence, and they are likely to compete and demonstrate that they are right while others are wrong (Sommet, Darnon, & Butera, 2015). As such, this form of regulation forces individual students to solely focus on closed-minded adherence only to their own point of view and severely reject all other propositions by other students. This is highly detrimental to cognitive and collaborative progress of the group as a whole (Johnson & Johnson, 2009).

It has been observed that students working on complementary information, such as using the jigsaw strategy, demonstrated positive results in collaborative learning (Buchs, Butera, & Mugny, 2004). Each student knows that others are dependent on oneself for accessing some information, and that oneself is also dependent on the others to access other information, thus directing the students to be more involved in information exchange. Furthermore, the importance of a complete representation of the complementary knowledge encourages the students to collaborate as an appropriate strategy to interact and work together (Gruber, 2000).

Students working on identical information might also engage in confrontation and comparison of points of views, as students accessing the same information might have different or conflicting perspectives and confront the positions of others. However, it is argued that this is due to students socialising in highly competitive and individualistic societies and education systems (Buchs & Butera, 2015; Kasser, Cohn, Kanner, & Ryan, 2007; Schwartz, 2007). As it is easy for such students to switch to a competitive comparison of competences even in a collaborative situation, distributing identical information will likely produce competitive conflict regulations.

An approach to inhibit social comparison of competence is for the teacher to stress the importance of understanding the perspective of other group members and effort of sharing, rather than providing good answers (Meece, Anderman, & Anderman, 2006). Teachers must favour students' mastery towards learning and improvement, rather than performance through demonstration of achievement and competence (Darnon, Butera, & Harackiewicz, 2007).

It is highlighted that written assignments in collaborative learning are represented by individual efforts coarsely stapled together, and multi-authored works lack significant group enhancement (White, 2002). Writing is seen as fundamentally a private activity, and it takes "structured critique and revision cycle with conscientious input to generate seamless documents of substance written by groups" (White, 2002, p. 196). It is suggested that instead of laboriously orchestrating students writing collectively on one case study, each student can write individually on a topic as a progressive disclosure of a case study, identify the important concepts to be developed, organise them and create an engaging narrative to be presented to the rest of the group. The rest of the students then take on opposing views and debate on the original case. This approach not only taps on the diverse perspectives of other students in the team, the student that initially writes the case study is also able to put himself or herself in the role of a teacher designing a collaborative learning environment, by reflecting on the constructivist pedagogy and thereby developing into a better collaborative student.

In peer instruction, the teacher prepares a conceptual scenario for each student to provide a solution completely on his or her own, and then in pairs or teams (Mazur, 1997). Peer instruction promotes individual cognitive accountability by first instructing for individual effort to provide a solution, before providing an interactive environment in which individual students can provide and explain their answers, receive feedback from others, and subsequently obtain consensuses on the best agreed solution possible.

Nathan and Lee (2004), citing the works of Johnson and Johnson (2007), also designed a similar concept known as Structured Academic Controversy (SAC). This concept is a useful instructional strategy when a group of students is confronted with a conceptual conflict as a result of a planned process whereby their beliefs, ideas and perceptions of an issue are tested with evidence of a diametrically opposite perspective. The five steps in SAC require students to: 1) research and prepare for a position; 2) present and advocate their position; 3) engage in open discussion, refute the opposing position and rebut attacks on their own position; 4) reverse to the perspectives of others; and 5) reflect and integrate the best evidence and reasoning into a joint position.

Buchs and Butera (2015) had also adapted three targeted rules from the original controversy in a dyad setting, namely: 1) listening to the partner's ideas and trying to understand all ideas even if one does not agree; 2) criticising ideas but not people; and 3) finding the best solution together rather than proving one's right. They found that pupils who had benefited from this specific work on preparation for cooperation with targeted cooperative rules demonstrated more social support and more attention towards their partner, and they asked more questions. Overall, the preparation for cooperation enhanced the general quality of cooperation for dyads. Based on the literature, the current cycle thus introduced a similar adaptation of the three targeted rules from the original controversy in a group setting towards enhancing *group cognitive processing*, by implementing the instructional strategy of *Facilitating Peer Instruction for Structured Academic Controversy [S4.1]*.

Other issues raised at the end of the third cycle were the lack of deep reflection in the interactions among the students within the groups *[I3.2]* and the need for a suitable utterance annotation table used for a collaborative learning environment *[I3.3]*. A new instructional strategy of *Designing Clear Utterance Annotations to Promote Group Reflection [S4.2]* was introduced to address these issues. The act of writing out gathered information and interpretation by individual students can provide the opportunity for deep reflection and revision of ideas (Lee, 2007). Sharing the writings among peers will make the students' tacit knowledge public. Through such social sharing of understanding, faulty thinking, misconceptions, and errors in understanding are likely to be found and corrected (Klemm, 2002). It is further claimed that an online learning environment incorporating asynchronous interactions among students allows them to have more time to think critically and reflectively (Robinson & Hullinger, 2008).

In this cycle, the exchange of internal thoughts as a form of deep reflection by students as they engage in completing a task was encouraged. However, for a group task that required more than one person to complete, an improvement to the design of the utterance annotations based on *transactivity* had to be made for the students to effectively communicate their reasoning to their group members (Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2013). Transactivity is a term that is introduced into the context of collaborative learning by Teasley (1997) to mean a form of reasoning based on the reasoning of the others. Transactivity indicates to what extent learners build on, relate to, and refer to what their learning partners have said before. As such, the range of utterances annotations initially introduced in the previous cycle was improved to focus towards increasing communicative reflexivity in the students' utterances.

4.4.2 Implementation. This cycle was carried out for the same group of students who enrolled for the module IS4234 in the third cycle. A total of twenty students participated. Similar to all the cycles before, this cycle had also designed and conducted the collaborative learning session online for asynchronous input. The students were again asked to follow the instructions and complete the case study discussion.

The collaborative learning session for the class was carried out in the following steps: A 3-week case study authoring assignment was given for the students to complete in groups of about three students. The students were asked to form groups among themselves by teaming up with others who they felt comfortable in working with. The names of the members in each team were then submitted to the teacher, who arranged for shared online access to online shared case document, which contained scripted instructions for the students to work collaboratively.

Similar to prior cycles, the students were allowed to discuss face-to-face, but were instructed to input their discussions as many as possible comments in the shared document. The members were able to complete the collaborative assignment by contributing their inputs in the online document asynchronously. The members within each group could only access the group's shared document and were not able to access the documents of other groups. At the end of the assignment, the entries on the shared document and the comments tabs were submitted as deliverables for the assignment.

In this cycle, the coverage of instructional strategies was similar to the third cycle which was based on *influential interaction*, *reasoning and negotiations skills,* and *group cognitive processing* components. The purpose for the cycle was once again to evaluate the effectiveness of the revised instructional strategies in promoting and improving cognitive engagement, taking reference from the ICAP framework. In the following sections, carefully designed activities for the instructional strategies were implemented.

4.4.2.1. Facilitating Peer Instruction for Structured Academic Controversy [S4.1]. The current case assignment differed from the approach of collaborative learning in the previous three cycles, where the case scenarios were provided by the teacher. The assignment was to be completed in two stages across three weeks. In the first stage, each student was instructed to author a case on audit trail, from any internship or work experience they had. The cases were then shared to all group members at the end of Week 1 on the shared document. In the second stage, other group members would take opposing sides and provide inputs via comments, queries, or arguments, on the case scenarios provided by their group members who were the original authors. They would be engaged in debates online for a period of two weeks, by which the case scenarios would be improved and submitted. It was emphasized that the assignment was not a display of competency in the content, but an avenue for engagement in discussions among the students. It was also emphasized that the students should be focusing on understanding the concepts put forth by other group members by asking constructive questions, challenging and querying unclear statements and claims, and providing alternative perspectives where appropriate.

4.4.2.2. Designing Clear Utterance Annotations to Promote Group Reflection [S4.2]. Similar to the initial list, the revised utterance annotations were aimed to support collaborative activities by providing a form of social scripts, particularly for the purpose of communicating internal thoughts. These annotations highlighted the thoughts and intentions posted as inputs by each student. The objective was also to prompt other students to follow or counter-propose their deliberations to the rest of their group members. The initial list also included ambiguous utterance annotations, which confused the students in the previous cycle. They were removed from this cycle, and the list of utterance annotations was made simpler for students to comprehend the meaning and purpose of each annotation. Table 4.3 shows the modified table of annotations.

Table 4.3: Utterance annotations and descriptions

Annotations	Description of Annotations
ARG ARG+/-	Identifies an utterance that presents an argument or reason. The utterance can also support or oppose a prior utterance.
CHA CHA+/-	Identifies an utterance that questions or challenges the merits, relevancy, validity, accuracy or plausibility of a presented argument (ARG) or challenge (CLA). The utterance can also support or oppose a prior utterance.
CLA CLA+/-	Identifies an utterance by a learner assigned to the team initiating a claim or statement about a new concept or idea. The message can also support or oppose a prior utterance.
EVI EVI+/-	Identifies an utterance that provides proof or evidence to establish the validity of a prior utterance.
EXP EXP+/-	Identifies an utterance that provides additional support, explanation, clarification, elaboration of a prior utterance.

4.4.3 Final Evaluation. At the end of the current cycle, a final evaluation was carried out by the researcher and the research assistant, to assess the effectiveness of the instructional strategies implemented in the collaborative learning environment towards deepening the cognitive engagement of the students. The results presented at the end of the previous cycles, including those in the current cycle, showed that the cognitive engagement of the students had gradually improved as instructional strategies were progressively introduced and enhanced. The effectiveness of these instructional strategies in promoting cognitive engagement across the groups of students were also evaluated in detail, which resulted in findings that could conclusively provide answers to the research questions. The current cycle was the final cycle of the study.

In addition, an online questionnaire was conducted at the end of the semester for the purpose of assessing the effectiveness of the instructional strategies. All the students enrolled in the module participated in the online questionnaire. The questionnaire included 5-point Likert scale and open-ended questions, as shown in Appendix D. The following paragraphs provide details of the data collection, the analysis approaches and the results.

For the current cycle, similar to the approach for the third cycle, the evaluation of the improvements of the students' cognitive engagement was done by focusing on analysing the utterances, the unit of analysis, which were inputs by students as they completed their review on the given case study. The researcher and the research assistant annotated each unit, and the inter-rater reliability between the annotators was measured using Cohen's kappa κ (Cohen, 1960). For this cycle, κ = 0.827 suggested that the agreement of the annotations by the annotators was almost perfect (McHugh, 2012). To further evaluate the effectiveness of the instructional strategies in promoting cognitive engagement, the cognitive engagement of the students is shown in Figure 4.13.

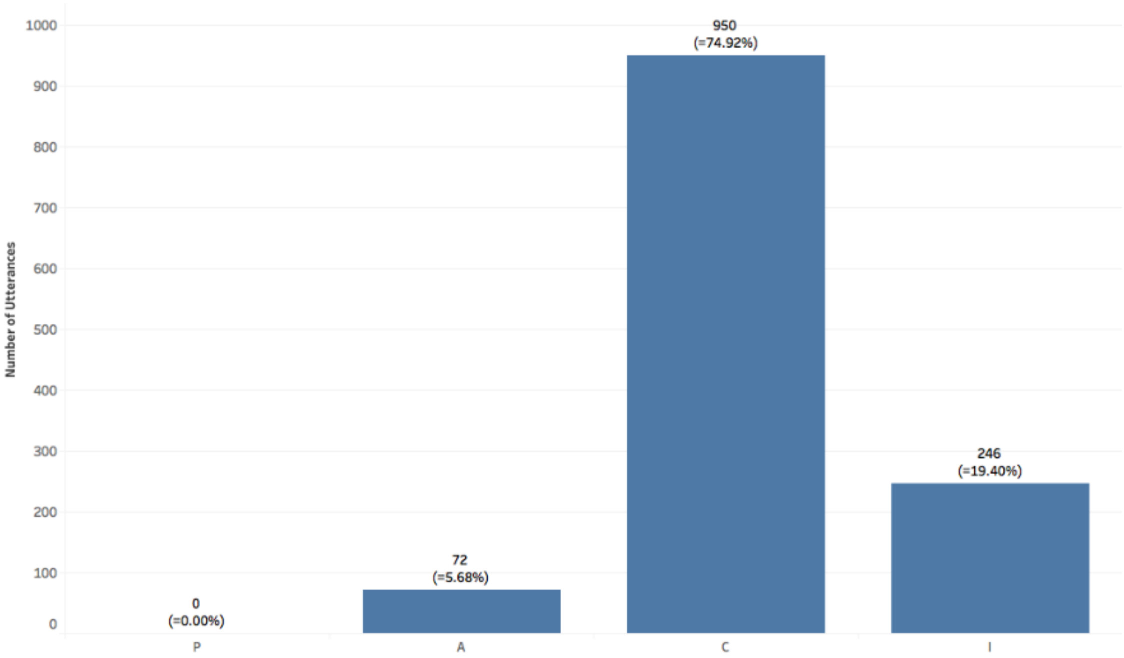

Figure 4.13: Number of utterances based on the ICAP modes

Figure 4.13 shows that the percentage of the utterances at the high cognitively engaged *constructive* mode, computed based on the utterances exchanges made in the course of the assignment among the students across all groups, has significantly increased to almost 75%, compared to the same mode at 52.4% from the earlier cycle (Figure 4.9).

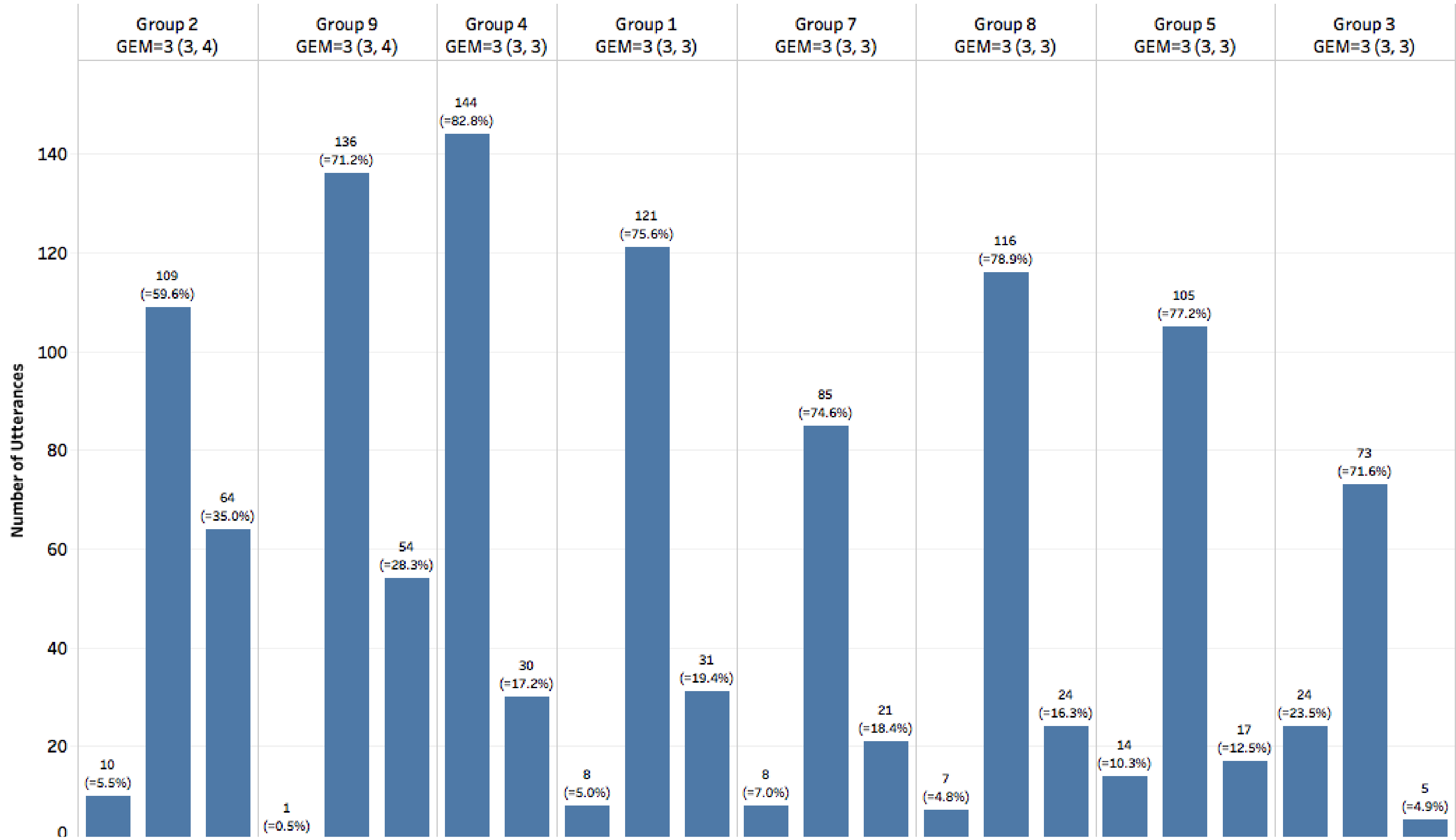

Figure 4.14: Number of utterances based on the ICAP modes for all groups

All the students who participated were also engaged at the *constructive* mode in at least one of their utterances. There was a significant drop in utterances at the *active* mode, from the value of 21.2% in the past cycle to 5.7% in this cycle. There was also a significant number of utterances made by their group members in the *interactive* mode (19.4%), which were due to students seeking viewpoints from their group members on the subject matter. Although slightly lower than that in the third cycle as displayed in Figure 4.9 (26.4%), the utterances at the *interactive* mode nonetheless displayed repeated occurrences of deep reflections among the students as they attempted to share their deliberations and stances with their group members and established common concurrences within the group.

The cognitive engagement among the students in each group is shown in Figure 4.14. Similar to the computation of Group Engagement Median (GEM) in the third cycle, the GEM values were computed using the groups' median in this cycle. The groups were subsequently sorted according to their respective GEM values. The graph shows that most of the groups (all groups except Group 3) displayed similar characteristics in terms of ICAP cognitive engagement distribution. The characteristics were formed by having the utterances at the *active* mode as the least, while the utterances at the *constructive* mode were the highest. These groups also indicated that all the students within the group had utterances at the *interactive* and *constructive* modes. Group 3 had also improved in their group cognitive engagement at GEM=3 in the current cycle compared to the previous cycle, where there were an insufficient number of utterances.

Similar to the tests conducted in the third cycle, in order to test if the distributions of the cognitive engagement modes were significantly different, the Kruskal-Wallis test was used. The Kruskal-Wallis Chi-Squared test statistics value was 83.36 with 7 degrees of freedom and a p-value of 2.837e-15. As the value of the test statistics was higher than

14.07 (the 95th percentile of the Chi-Squared distribution with 7 degrees of freedom), and the p-value was less than the significance level 0.05, it was conclusive that there were significant differences in the distributions among the groups. Next, a post-hoc analysis was performed to determine the level of differences in the distributions among the groups, and the Dunn test was conducted. The test was conducted with the threshold set at an alpha of 0.05, and the results showed that the groups fell into five clusters, where the levels of cognitive engagement of Groups 1, 7 and 8 were not significantly different, and those of Groups 2 and 9 were also not significantly different. Group 3, 4 and 5 were in separate clusters on their own. To evaluate the mode of group cognitive engagement, the number of utterance chains by distinct participants (N) in each group is generated in Figure 4.15.

Groups 2, 4, 5, 7 and 8 had increased significantly in the number of utterance chains which involved discussions with more than one of its members, compared with the distribution shown in the previous cycle in Figure 4.11. This implies that the students were more involved in discussions and debates than before, as they appeared to take charge of the mitigation of different or conflicting opinions among their group members in their discussions. As a result, many conflicting opinions were regulated and resolved by the end of each utterance chain. This positive outcome also seemed to imply that the students were making significant efforts in adding utterances, and they developed strong communicative reflections as they shared their deliberations with others before making any decisions or taking action. Most of the utterances also began immediately with the *constructive* mode, where students' shared deliberations seemed to have facilitated the sharing of new knowledge that go beyond prior information shared by the group. Other groups, such as Groups 3 and 9, also managed to remain constant and did not show any increase or decrease of distinct student involvement in utterance chain discussions.

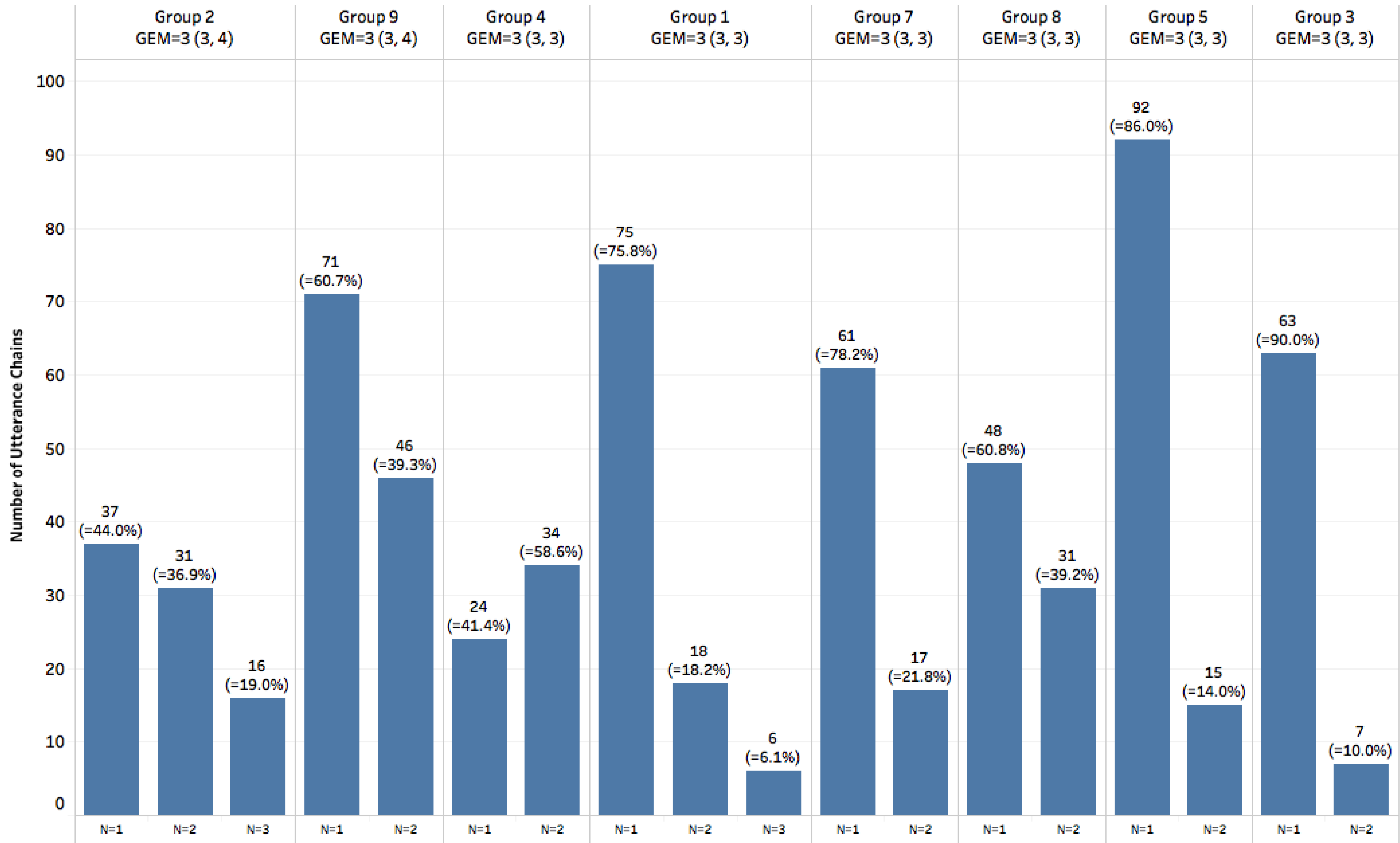

Figure 4.15: Number of utterance chains based on distinct participants for all groups

However, Group 1 seemed to have taken a step backwards, with a huge increase in single utterances of 20% in the third cycle to almost 75% in this cycle. This indicates that the students in this group were more into sharing their own views and not forthcoming in reflections and discussions with their group members. In order to evaluate the modes of the students' cognitive engagement in relations with the annotated utterance types, the ICAP modes for all utterance types were shown in Figure 4.16.

Figure 4.16 shows that categories such as CLA, EVI and ARG+ display a high concentration of *constructive* mode utterances, where students provided external evidences and explanations respectively. This indicated that the students tended to use these categories of utterance types to share new information and understandings, which usually did not require further debates or discussions.

The category of CLA also seemed to have an extremely high collection of *constructive* mode utterances at 95.9% within the category itself. This indicates that the majority of the claims were not able to extend further into the *interactive* mode. The students simply stopped after they made an individual utterance that comprised of a single claim. This is undesirable in collaborative learning, as erroneous inputs or misconceptions have a potential of not being corrected. Perhaps an improvement in the granularity of the utterance types would help induce more argumentative discussion and construction of knowledge.

Another important result is that the utterances that were categorised as ARG-, ARG and ARG+ involved the highest amount of utterances in the *interactive* and *constructive* modes within their respective categories. These categories are also shown to have the highest UEM values, with ARG- having the highest median value of 4. This indicates that students were extremely high in cognitive engagement when they produced utterances that opposed prior arguments.

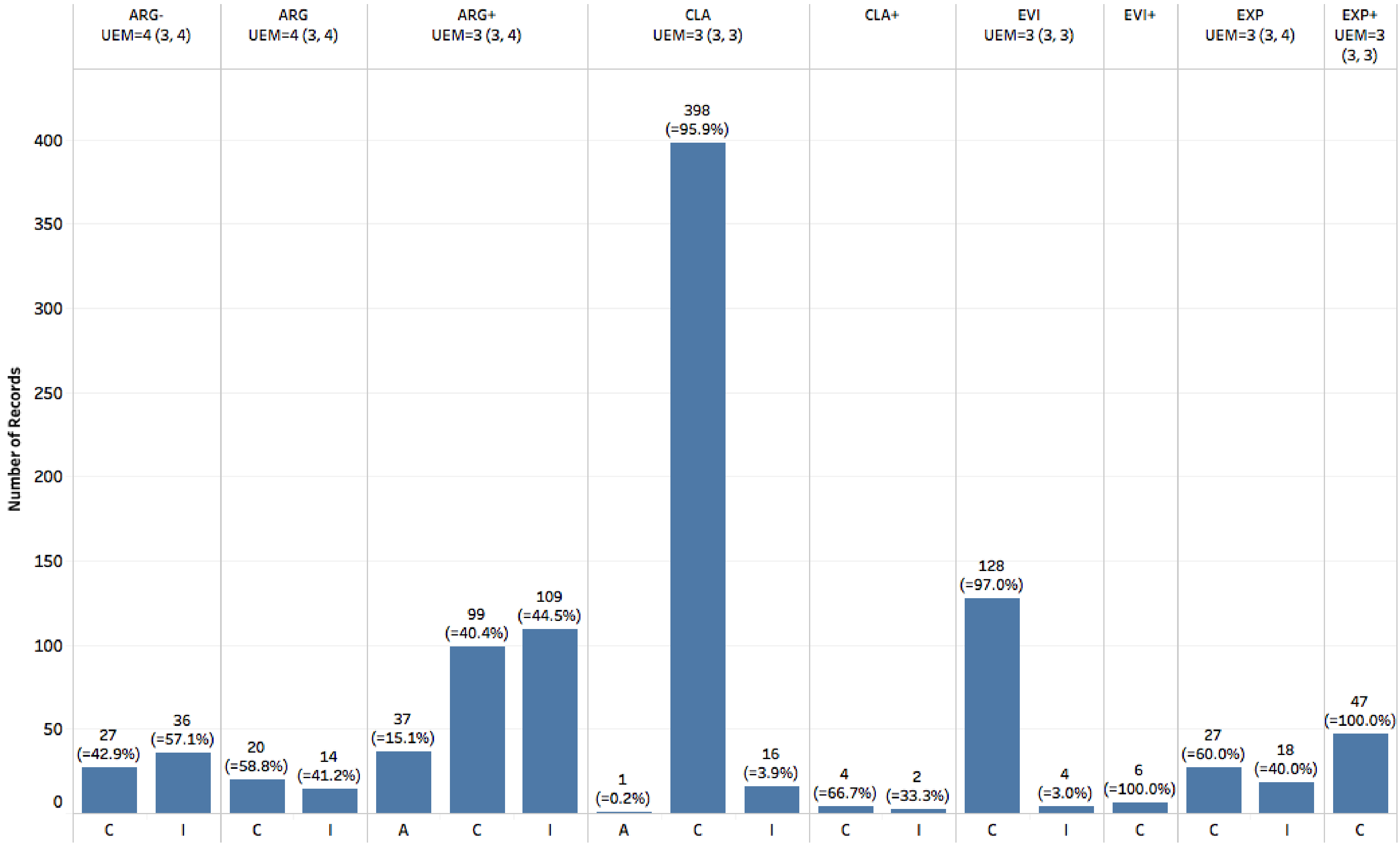

Figure 4.16: Number of utterances based on the ICAP modes for all utterance types

On further evaluation, the utterance chains that were categorised at the *interactive* mode visibly involved different intensities of cognitive contents. There were utterance exchanges that tend to promote interactions and propagations of factual information exchanges. There were also other exchanges that displayed cognitive engagement through forms of deep reflections not present in the others that were categorised similarly under the *interactive* mode.

Perhaps an even *higher mode of cognitive engagement* was present, where students characteristically shared their deliberations with other students while taking action. These students could be identified as providers of utterances that were tagged at the *interactive* mode with deep reflections of their deliberations, such as argument (ARG-, ARG and ARG+). An argument was presented when a different perspective was communicated after reflecting upon a prior statement, although the new perspective and the prior statement might not be in conflict. An additional + and - added more supporting or opposing deliberations to the argument. The three variations of the ARG were deliberate forms of annotations used by students who communicated their inner reflections to their group members, which provided new perspectives which differed from prior discussions. As a result, the modes of group cognitive engagement were raised to an even higher level beyond the *interactive* mode.

Table 4.4 shows the responses of the students from an online questionnaire, on facilitators that promote cognitive engagement with respect to the components of collaborative learning for promoting cognitive engagement. An evaluation of the inputs from the online questionnaire conducted at the end of this cycle also yielded insights into the effectiveness of the instructional strategies for the collaborative learning environment in facilitating and promoting cognitive engagement among the students (See Appendix D).

Table 4.4: The results of the students' responses from the online questionnaire

Components of collaborative learning for promoting cognitive engagement	Instructional strategies help to	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Individual Cognitive Accountability	Recall prior learning	0 (0.0%)	0 (0.0%)	3 (15.8%)	**11 (57.9%)**	5 (26.3%)
	Stimulate thinking	0 (0.0%)	0 (0.0%)	1 (5.26%)	**12 (63.2%)**	6 (31.6%)
Interdependent Situations	Enquire shared knowledge	0 (0.0%)	0 (0.0%)	0 (0.0%)	**11 (57.9%)**	9 (47.4%)
	Uncover misconceptions	0 (0.0%)	0 (0.0%)	2 (10.5%)	**14 (73.7%)**	3 (15.8%)
Influential Interactions	Coordinating interactions	0 (0.0%)	1 (5.26%)	4 (21.1%)	**12 (63.2%)**	2 (10.2%)
	Introduce new concepts	0 (0.0%)	1 (5.26%)	2 (10.5%)	**12 (63.2%)**	4 (21.1%)
Reasoning and Negotiations Skills	Encourage debates	0 (0.0%)	0 (0.0%)	2 (10.5%)	**12 (63.2%)**	5 (26.3%)
	Exchange critical views	0 (0.0%)	0 (0.0%)	5 (26.3%)	**8 (42.1%)**	6 (31.6%)
Group Cognitive Processing	Process shared information	0 (0.0%)	1 (5.26%)	0 (0.0%)	**14 (73.7%)**	4 (21.1%)
	Conceptualise discussions	0 (0.0%)	0 (0.0%)	1 (5.26%)	**13 (68.4%)**	5 (26.3%)

From the responses received from the questionnaire, the majority of the students selected "Agree" across the range of enhancement and felt that the use of collaborative learning had facilitated in cognitive engagement for both individual and group learning. There were also indications that the students were significant more prepared to engage with other members in their group, as they grew more conscious of the capability of their group members and increased their understanding in the procedures and purposes of the current assignment through the instructions and interventions in the current cycle.

One student summarized his experience positively in the questionnaire's open-ended question, saying,

> *Reviewing our fellow group members' scenarios helped us to solidify our understanding of the concepts we learnt in class. I feel like the collaboration and asking of questions also pushed us to look at things from more angles. Giving explanations to our fellow group members' questions or comments also helped me in phrasing my explanations to them and makes me go through my own understanding to see if I got my idea right.*

From the relatively high rating of students' feedback on Conceptualising Through Discussions (68.4%), It also seemed that most of the students agreed that using utterance annotations as highlights and identifications of specific points with their shared utterances allowed them to efficiently gather every group member's attention to specific discussion topics, misconceptions or erroneous inputs. The instructional strategies which encouraged argumentative discussions also allowed the students to be conscious of their own understanding of the topics, and some had expressed an increased awareness in knowing how other group members understood the topics. These helped significantly in the level of engagement among students while completing the assignment. One student supported this claim in the questionnaire, stating,

> *The comments feature highlights the parts where the team has different opinions. The comments are easy to be read by other members, who can discussion and comment further below each comment. Doubts are clarified with the use of this feature. It also shows effort from every member and gives pressure to everyone to contribute more.*

However, it was highlighted by some students that face-to-face discussions were still preferred. A student mentioned that discussing online "was good, only that our team preferred to meet up in person to work on the assignments". Another student reiterated this, saying, *It's good to discuss the audit case first by having group discussion or debate face-to-face, so that the learning journey will be more interesting.*

Other groups of students also found that having face-to-face discussions were still the most effective and efficient approach for bouncing off and generating ideas.

From the results, it was deduced that there was still a need to find the balance between face-to-face discussions and online collaborative work. Nonetheless, the set of instructional strategies was able to promote student engagement in the collaborative learning environment. Most students had also agreed strongly that the methods used in the assignments had helped in improving cognitive engagement towards learning in a group, and that the experience of cognitive engagement was more intensive in the latter assignment compared with the former. In summary, the students felt that there was an improvement in cognitive engagement among their group members as they progressed through their group assignments.

4.5 Conclusion

This chapter documented down the four iterative cycles of the study based on the design-based research approach. At the end of each cycle, the issues identified were addressed by improving existing instructional strategies, and/or introducing new ones. The ICAP framework was also used to measure the levels of cognitive engagement, and it was concluded that the instructional strategies had promoted cognitive engagement for most of the groups in each cycle, while improved the students' cognitive engagement progressively through the cycles.

The results presented at the end of the four cycles showed that the cognitive engagement of the students had gradually improved as instructional strategies were progressively introduced and improved. As the findings were able to conclusively provide answers to the research questions, the study ended after four cycles.

Chapter 5. Summary and Discussion

This chapter summarises and discusses the main results from this study, in the use of instructional strategies to improve cognitive engagement of students in a collaborative learning environment. Section 5.1 begins with a summary of the study. Section 5.2 provides a reflection on the design-based research approach used in the study. Section 5.3 presents the design principles summarized from this study. Section 5.4 offers some recommendations for further research related to the current study. Lastly, Section 5.5 concludes the study with some closing remarks.

5.1 Summary

Four cycles of design-based research were conducted to analyse the use of instructional strategies to improve the cognitive engagement of students in a collaborative learning environment. For the cognitive engagement activities conducted in the study, groups of students were tasked to complete case study assignments. However, due to the diverse nature of the students, who were from different domain fields in pursuit of an assortment of academic programmes and had varied academic disciplines and experiences, the groups of students became an assembly of individuals with wide knowledge gaps and different study approaches. Very often, such conditions are ignored or overlooked, and the students are often tasked to resolve these differences among themselves as they participate in the case study discussions as a group. However, the current study identified problems in cognitive engagement as a consequence of such unresolved differences, and subsequently proposed the use of instructional strategies in the collaborative learning environment to address the issues. The study also sought to evaluate the effectiveness of the instructional strategies in improving cognitive engagement in the collaborative learning environment.

The design-based research approach was used as presented in Section 3.1. In the course of following this approach, four cycles of iterations were conducted in sequence across two academic semesters, leveraging on the academic calendar spanning a 2-year period in which the Information Systems module was offered. A total of 52 students were involved.

This section summarises the answers to the main research questions for this study. The main research questions were as follows:

1. *What are the characteristics of instructional strategies for the purpose of promoting cognitive engagement in a collaborative learning environment?*
2. *How effective are the instructional strategies in promoting cognitive engagement?*

In order to answer the first research question, a total of 17 instructional strategies were introduced across the four cycles to assess if they promoted cognitive engagement among the students working together in a collaborative learning environment. Some of the instructional strategies were identified to have issues and had to be addressed and improved in the subsequent cycle. One of those with issues was the instructional strategy of *Designing Meaningful Tasks [S1.1]* in the first cycle, which lacked realistic case scenarios, and was improved by introducing a new instructional strategy of *Using Realistic Case Scenarios [S2.1]* in the second cycle. Another instructional strategy of *Providing Social Scripts through Utterance Annotations [S3.3]* in the third cycle which lacked clear utterance annotations, was also improved by a revised instructional strategy of *Designing Clear Utterance Annotations to Promote Group Reflection [S4.2]* in the fourth cycle. The instructional strategies without issues remained to be implemented in the subsequent cycles.

Other issues identified were also addressed by introducing new instructional strategies together with the above improvements in the next cycle. The level of cognitive engagement of the students was progressively analysed to determine if the instructional strategies had promoted and improved cognitive engagement. It was concluded that the instructional strategies introduced in the four cycles had varied effectiveness in promoting cognitive engagement of the students in collaborative learning, from the issues identified and addressed in the subsequent cycles as shown in Figure 5.1. Section 5.1.1 provides the details of these instructional strategies as the study progressed through the cycles, the issues at the end of each cycle, and the new and improved instructional strategies proposed to address the issues. The characteristics of the instructional strategies are summarised in the form of design principles in Section 5.4.

In order to answer the second research question, the results from the questionnaire conducted at the end of the second cycle showed that the majority of the students (57.0% Agree; 16.0% Strongly Agree) felt that the instructional strategies and activities introduced together with the use of shared documents online had promoted cognitive engagement in collaborative learning through the sharing of information and inputs (See Section 4.2.3). Some students also pointed out that the features online, such as highlighting and identifying of specific information on the shared text, had allowed them to efficiently gather every group member's viewpoint, specific discussion topics, misconceptions or erroneous inputs. The instructional strategies used in the online environment also allowed some students to be conscious of their own understanding of the topics, and some students expressed an increase in awareness of knowing how their other group members understood the topics.

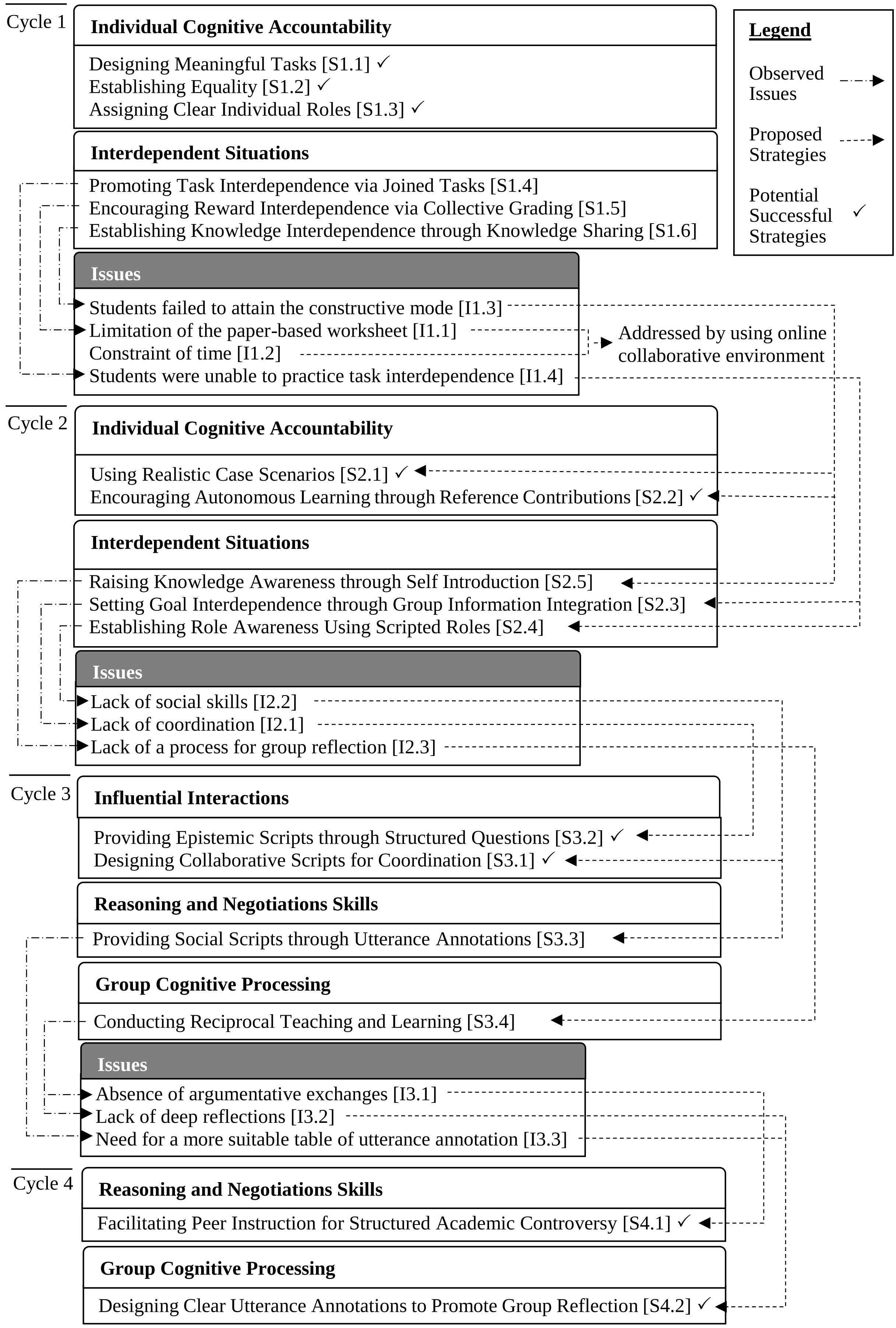

Figure 5.1: Instructional strategies and their effect on cognitive engagement

The results from the Kruskal-Wallis test at the end of the third cycle also showed that the instructional strategies introduced had promoted cognitive engagement across the groups with different effects (See Section 4.3.3). The groups were shown to fall into three distinct clusters, where the cognitive engagement of Groups 1, 2 and 8 were at the highest level, followed by Groups 4, 5, 7 and 9 at a moderate level, and Group 3 trailing behind on its own.

To provide further insights to the second research question, the effectiveness of the instructional strategies towards improving the cognitive engagement across the four cycles was also generated and illustrated in Figure 5.1. It shows the comparison in the percentages of utterances by ICAP modes across the four cycles.

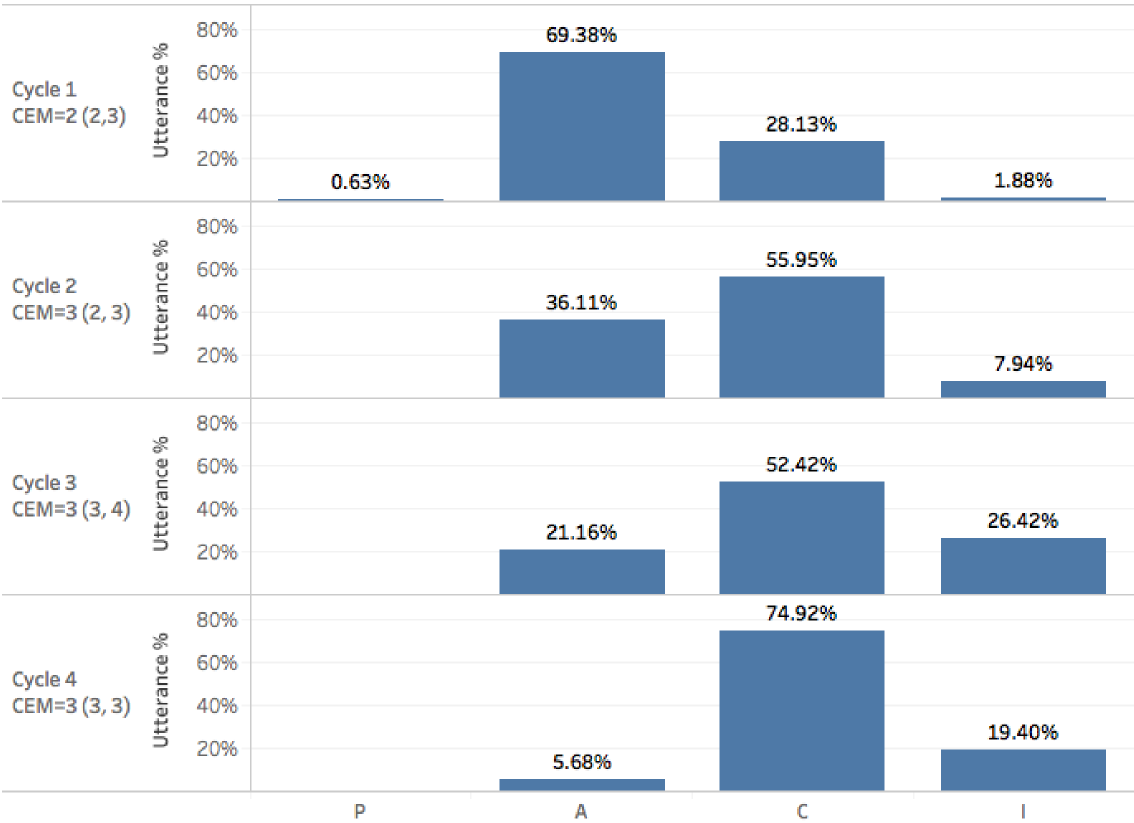

Figure 5.2: Percentage of utterance chains based on the ICAP modes for all cycles

In Figure 5.1, the trend shows that as the instructional strategies were improved for every successive cycle, and the students progressively shifted their cognitive engagement towards the higher modes. The progressive Cycle Engagement Median (CEM) values for the four cycles, together with the lower and upper quartiles of the CEM values presented as CEM (Q_1, Q_3), are 2 (2, 3), 3 (2, 3), 3 (3, 4) and 3 (3, 3) respectively. From these results, it was concluded that the improvements made to the list of instructional strategies had enhanced the cognitive engagement of the students from Cycle 1 to Cycle 4. Notably, in Cycle 4, the students created their own audit scenarios which included creating new ideas, providing justifications and explanations, and giving mini lectures to their team members. All these activities are examples under the *collaborative* mode, which explains why the median and quantiles of the last cycle focuses primarily at 3, the value given for the *collaborative* mode.

The Kruskal-Wallis test was used to test if the distributions of the cognitive engagement modes among the cycles were significantly different. The Kruskal-Wallis Chi-Squared test statistics value was 379.1 with 3 degrees of freedom and a p-value of 2.2e-16. As the value of the test statistics was higher than 7.815 (the 95th percentile of the Chi-Squared distribution with 3 degrees of freedom), and the p-value was less than the significance level 0.05, there were significant differences in the distributions across the cycles. A post-hoc analysis was subsequently performed to determine the level of differences in distributions among the cycles. The test was conducted with the threshold set at an alpha of 0.05, and the results showed that all the distributions of cognitive engagement in the four cycles were significantly different from each other, which meant that progressively the cognitive engagement of the students were distinctively improving.

The four cycles that were conducted to design instructional strategies based on the components of collaborative learning for promoting cognitive engagement. At the end of each cycle, the issues identified were summarised and addressed in the subsequent cycles by revising the instructional strategies and introducing new ones if needed.

The ICAP framework proposed by Chi and Wylie (2014) was used to evaluate the modes of cognitive engagement of the students learning as a group. Using the ICAP framework, the learning activities of the students and their resulting overt behaviours were categorised into one of four modes, namely; *interactive*, *constructive*, *active*, and *passive*. The results at the end of the cycles not only indicated that cognitive engagement was measurable using these four modes, it was also used to evaluate the modes of cognitive engagement of the students within the groups and among those who used particular utterance types. The results also suggested that an additional new *reflexive* mode could be added to further enhance the ICAP framework.

The following section provides a summary of the instructional strategies used in each cycle, the results collected, and the issues identified and addressed in the next cycle through improvements made to the list of instructional strategies.

5.1.1 Design of Instructional Strategies. The first cycle was designed to engage students by facilitating collaborative learning among diverse students from varied academic disciplines, through the implementation of instructional strategies based on *individual cognitive accountability* and *interdependent situations*, the two most essential components which are salient features of collaborative learning (Wang, 2009), and are also generally seen to possess crucial characteristics for realizing collaborative learning in an effective way (Ruys, Van Keer, & Aelterman, 2012). The instructional strategies aimed to increase the students' cognitive engagement while reviewing a case study together in pairs, in contrast with working on the case study alone. The instructional strategies for *individual cognitive accountability* introduced in the first cycle were:

- *Designing Meaningful Tasks [S1.1]*: The case study for the assignment described a scenario with reference to prior lecture sessions which covered related topics on information Systems Audit. The students were able to relate the subject matter covered in the tasks meaningfully to the topics covered in prior lecture sessions.
- *Establishing Equality [S1.2]*: The assignment was designed such that each student within a pair would have a dedicated worksheet, with an equal number of sections reserved for each student to provide their individual inputs for each question. The sections were clearly labelled as "Student A" or "Student B" and assigned for the inputs from individual students within each pair.
- *Assigning Clear Individual Roles [S1.3]*: Each student was instructed to identify himself or herself as Student A in their own worksheet, thus clearly designated individual roles and responsibilities towards the individual effort in the assignment.

The instructional strategies for *interdependent situations* were as follows:

- *Promoting Task Interdependence via Joined Tasks [S1.4]*: Within a 1-hour class session, instructions were given for each pair of students to allocate twenty minutes for reading and reviewing the case study on their own, and to discuss the case study between them. Subsequently, the next twenty minutes were allocated for each student to assume the role of Student A, and to answer the given questions in the assignment based on the case study. The final twenty minutes were for each student to exchange their worksheets with their partners and assume the role of Student B, where they would add feedback to the inputs which Student A had entered on the latter's worksheet.
- *Encouraging Reward Interdependence via Collective Grading [S1.5]*: Q1a and Q1b contributed primarily to individual grades. The average marks of Q2 for the

students in each pair contributed to the common group mark, on top of their individual marks scored for Q1a and Q1b.

- *Establishing Knowledge Interdependence through Knowledge Sharing [S1.6]*: Upon exchanging of worksheets, each student within each pair was tasked to read and give their feedback on the inputs by their partner, and to construct shared knowledge between them, so as to establish interdependence of knowledge within each pair.

The worksheets were collected and the inputs by the students were analysed to measure the level of cognitive engagement of the students using the ICAP framework. At the end of the first cycle, there were five issues identified, namely:

- The limitation of the paper-based worksheet in its inability to synchronously record inputs by each student *[I1.1]*;
- The constraint of time to coordinate for more in-depth discussion *[I1.2]*;
- The inability of students to attain the constructive mode of cognitive engagement by progressing beyond mere highlighting and cut-and-paste activities *[I1.3]*;
- The inability of students to practice task interdependence and extend beyond merely consolidation of individual inputs. *[I1.4]*; and
- The inability of students to attain the constructive mode of cognitive engagement by progressing beyond mere sharing of individual inputs *[I1.5]*.

As such, some improvements were made to the list of instructional strategies to address these issues. While some of the previous instructional strategies, such as *Designing Meaningful Tasks [S1.1]*, *Establishing Equality [S1.2]*, and *Assigning Clear Individual Roles [S1.3]* worked well and thus remained in the second cycle, other new instructional strategies for *individual cognitive accountability* were introduced:

- *Using Realistic Case Scenarios [S2.1]*: Tasks were designed using a case study based on a real event. The students were instructed to discuss and complete five tasks, which were aligned to the topics covered in earlier lectures. This instructional strategy was introduced to address issues *[I1.3]* and *[I1.5]*.
- *Encouraging Autonomous Learning through Reference Contributions [S2.2]*: The instructions given to the students explicitly mentioned that the reading materials and slides covered in the lectures were not sufficient, and there should be other reference information available online or in print to be gathered in order to complete the assignment. This instructional strategy was also used to address issue *[I1.3]*.

Some new instructional strategies for *interdependent situations* were further introduced as follows:

- *Setting Goal Interdependence through Group Information Integration [S2.3]*: The instructions of integrating gathered information by all group members across all sections were set as the primary goals of the assignment, together with ground rules for participation. The minimum number of utterances per team was set to fifty. This instructional strategy was added to address issue *[I1.4]*.
- *Establishing Role Awareness Using Scripted Roles [S2.4]*: Firstly, the students were tasked to complete compliance tables and audit reports for control and audit findings of the case presented. The inputs contributed to the content-oriented role for the students with respect to completing the five sections in the assignments. Secondly, the students were provided with instructional scripts to coordinate, plan, discuss, argue and conclude their exchanges via utterances on comment tabs with reference to the content of the case and the inputs from their fellow group members. This discourse contributed to their process-oriented roles. The students

were instructed to be aware of both roles, and the associated actions that were expected of both roles. This instructional strategy was used to enhance the instructional strategy of *Assigning Clear Individual Roles [S1.3]*.

- *Raising Knowledge Awareness through Self Introduction [S2.5]*: After the students formed groups, they were instructed to introduce themselves to their group members. The students had to elaborate on their prior knowledge obtained in prior courses, internship exposures and work experiences. This allowed the rest of the students to be aware of the area of expertise of each of their group members, as well as to comprehend the level of competency in the prior knowledge claimed by other members. This instructional strategy was also introduced to address the issue *[I1.5]*.

The case study assignment of the second cycle was conducted using an online platform over a 2-week period, which was done to address the issues *[I1.1]* and *[I1.2]*. The utterances made by the students were collected and analysed in order to assess the level of cognitive engagement of the students. Although collectively it was evident that there was an improvement in the level of cognitive engagement, there were new issues which were identified at the end of the second cycle which needed to be further resolved. These issues were as follows:

- Lack of coordination among student *[I2.1]*;
- Lack of social interactions on how to work in a group on a given collaborative task *[I2.2]*; and
- Lack of a process to guide students to reflect among themselves within their group *[I2.3]*.

Hence, more improvements were made to the list of instructional strategies to address these issues. The above issues, especially issues *[I2.2]* and *[I2.3]*, required a need to design instructional strategies based on *influential interactions, reasoning and negotiations skills,* and *group cognitive processing*, the subsequent three components of collaborative learning for promoting cognitive engagement. While all instructional strategies in the last cycle which were without any issues and remained in the third cycle, other new instructional strategies for *influential interactions* were introduced:

- *Designing Collaborative Scripts for Coordination [S3.1]*: The students were given step-by-step instructions to identify the main points raised in the discussion, determine how to organise the ideas, draft a written summary, review the draft summary for brevity and accuracy, and submit the final summary. The students were briefed on the use of the collaborative scripts, for them to work together as a team and complete the case study assignment. The assignment was further scripted to have tables, examples and format, for the students to be guided in providing their inputs. This instructional strategy was added to address issue *[I2.1]*.

Some new instructional strategies for supporting social interactions were also introduced as follows:

- *Providing Epistemic Scripts through Structured Questions [S3.2]*: The epistemic scripts were provided to facilitate the students in each group to work through the learning task together. The epistemic scripts were in the form of pre-structured guide about how to analyse the case, which aimed at prompting the group members to identify relevant case information and interact with each other as the information continued to be shared within the team. This instructional strategy was added to address issue *[I2.2]*.
- *Providing Social Scripts through Utterance Annotations [S3.3]*: The students were provided with social scripts aimed to foster elaborative discussions and

critical negotiation and to avoid quick and false consensus among the students. The students were instructed to annotate their utterances, in accordance to the type of utterance they contributed in the discussion. This instructional strategy was also added to address issue about the lack of social skills among the students *[I2.2]*.

A new instructional strategy for *group cognitive processing* was introduced:

- *Conducting Reciprocal Teaching and Learning [S3.4]*: Before the start of the assignment, for a predefined session of one hour, the teacher assumed the role of a student peer among the students. The demo was done in the classroom, on a sample case study that was made accessible to all students in the classroom session. All participating students were asked to analyse the case and provide reflective comments on their viewpoints. Other students would comment on the initial input or provide comments on the other parts of the case. The teacher also provided examples of reflective comments and explained to the class the justification of each input as the online analysis of the case progressed on. At the end of the session, an explanation of the development of group cognitive processing was given. This instructional strategy also addressed issue *[I2.3]*.

The utterances made by the students were once again collected and analysed in order to assess the level of cognitive engagement of the students. Although the third cycle was conducted with a new batch of students in the following academic year, the level of cognitive engagement of the students was found to be at a relatively higher level with respect to the previous cycles. Although the improvements of the instructional strategies seemed to increase cognitive engagement in the students, additional issues continued to surface in the third cycle. These issues were as follows:

- The absence of argumentative discussions among students *[I3.1]*;
- The lack of deep reflection in the interactions among students *[I3.2]*; and

- A need for a suitable utterance annotation table *[I3.3]*.

A final improvement was made to the list of instructional strategies to address these issues. While some instructional strategies in the last cycles, namely *Designing Collaborative Scripts for Coordination [S3.1]*, *Providing Epistemic Scripts through Structured Questions [S3.2]* and *Conducting Reciprocal Teaching and Learning [S3.4]*, were without issues and remained in the current fourth cycle, other new instructional strategies based on *influential interaction*, *reasoning and negotiations skills*, and *group cognitive processing* components were introduced to improve cognitive engagement:

- *Facilitating Peer Instruction for Structured Academic Controversy [S4.1]*: The assignment was divided into two stages. In the first stage, each student was instructed to author a case on audit trail, from any internship or work experience they had. The cases were then shared online via a document sharing platform to all group members at the end of Week 1. In the second stage, the other group members took opposing sides and provided inputs in the form of utterances, on the case scenarios provided by their group members who were the original authors. They engaged in debates online for a period of two weeks, by which the case scenarios were improved and submitted. This instructional strategy was added to address the issues *[I3.1]* and *[I3.2]*.
- *Designing Clear Utterance Annotations to Promote Group Reflection [S4.2]*: The initial list also included ambiguous utterance annotations, which confused the students in the previous cycle. They were removed in this cycle, and the list of utterance annotations was made clearer for students to comprehend meaning and purpose. This instructional strategy was added to address the issue *[I3.3]*.

Similar to the analysis in the previous cycles, the utterances made by the students were collected and analysed in order to assess the scope and level of cognitive engagement. The results showed that the level of cognitive engagement of the students continued to increase. Out of eight groups of students in the fourth cycle, seven groups had demonstrated high cognitive engagement. The cognitive engagement attained together with different utterance types were also analysed. Students were engaged in utterances tagged at the *interactive* mode, displaying deep reflections of their internal deliberations, such as arguments (ARG-, ARG and ARG+). It was further deduced that the modes of group cognitive engagement were raised to the highest level due to a high level of deep reflections among these students, as these students engaged in cognitive conversations about their own deliberations and exchanged them among their group members.

5.2 Deep Reflections and Reflexivity

In the final evaluation of the Fourth Cycle in Section 4.4.3, it was mentioned that an even higher mode of cognitive engagement emerged from the results, where students characteristically shared their deliberations with other students while taking action. These students were identified as providers of deep reflections through their utterances that were tagged at the interactive mode with deep reflections of their deliberations, such as argument (ARG-, ARG and ARG+).

Archer (2003) analysed how exchanges of deep reflections among students engaged in group projects and joint tasks are underpinned by *reflexivity*. To a student, reflexivity refers to the ordinary mental capacity to consider oneself in relation to one's social setting, which is also referred to as an internal deliberation. If a student is to prioritise participating in group projects and joint tasks, the student will deliberate on the ways in which the action of interacting relates to one's social context within the group. Archer (2003) identified different modes in which students engage in internal deliberation, thus identifying students with distinctive modes of reflexivity. These modes are communicative reflexive, autonomous reflexive, meta-reflexive and fractured reflexive.

The students who are categorised as communicative reflexive characteristically share their deliberations with others before taking action. The students who are autonomous reflexive are less likely to share their deliberations with others and instead typically have complete internal conversations within themselves, which then lead to actions that are focused and performative achievement for oneself. Meta-reflexive students are characteristically reflexive about their own deliberation, thus resulting to a higher level of awareness about the impact of their actions. Fractured reflexive students undertake internal conversations fuelled by anxiety, leading to an absence of purposive action, and to decision making in an essentially passive manner.

In order to understand the difference between reflection and reflexivity, Woolgar (1988) identified a continuum of reflexivity ranging from radical constitutive reflexivity to benign introspection (or reflection). Benign introspection, also known as reflection, occurs when the learner maintains a real and objective distinction between object and representation of knowledge, and thereby aims to present a true representation of the accounts or information offered by other learners, while radical constitutive reflexivity takes the postmodern stance that reality is constructed contemporaneously, and no account or information from any learner can be valued over another (Shaw, 2010). What separates reflexivity from reflection is that reflection is a more general set of thoughts concerning largely with process and verification, ensuring that measures are taken to represent the knowledge from the learners in their true form. Reflexivity, on the other hand, is an explicit evaluation of the learner himself. In effect, reflexivity involves reflecting one’s thinking back to oneself. When two or more learners interact in a group, they communicate, interrelate and engage in a dialogic relationship that constructs multiple versions of reality, thus resulting to the co-constitution of meaning.

For a group of learners to experience communicative reflexivity, the internal deliberation of the learners must be mutually held or pursued (Kahn, Everington, Kelm, Reid, & Watkins, 2017). Communicative reflexivity is thus a characteristic that occurs when two or more students deliberate about the emergent effects of their collaborative relationship. Finlay (2003) explained this effect of making oneself transparent to others:

> *Our understanding of "other-ness" arises through a process of making ourselves more transparent. Without examining ourselves, we run the risk of letting our unelucidated prejudices (unexplained biasness or partialities) dominate. New understanding emerges from a complex dialectic between knower and known, and between the self-interpreted co-constructions of both (participants). (p.108).*

Hence, a *reflexive* mode can be introduced as an enhanced classification of cognitive engagement that identified an overtly higher grade of reflexivity known as *communicative reflexive*. This mode can be added into the ICAP framework, potential resulting to a new RICAP framework aimed at completing the theoretical structure of understanding student engagement in collaborative learning.

Table 5.1 below shows the characteristics, knowledge-change, cognitive outcome and examples of the proposed reflexive mode.

Table 5.1: Proposed reflexive mode

Mode	Reflexive
Characteristics	Reflecting on the thinking of oneself and of others
Knowledge-change	Co-reflecting
Cognitive Outcome	Co-constitute
Examples	Exchanging cognitive internal conversations about their own deliberations among their group members
	Concluding a discussion with more than one truth
	A student trying to make sense of their group members' perspective of trying to make sense of his/her inputs

5.3 Reflections on Design-based Research

This study used the design-based research approach. The following subsections cover the benefits and challenges of this approach experienced in this study.

5.3.1 Benefits. The main benefits of using the design-based research approach were the adaptability and flexibility of generating instructional strategies that are responsive to field data (McKenney, Nieveen, & van den Akker, 2006), the means to construct and contribute to knowledge through the design principles (Reeves, 2006), and the ability to build professional development for the researcher (Wang & Hannafin, 2005).

The study started off with the identification of the practical problem of improving cognitive engagement of students in a collaborative learning environment. Appropriate instructional strategies were introduced and implemented by the researcher, which were responsive to field data and experiences as acceptable moments during the course of a study (McKenney, Nieveen, & van den Akker, 2006). It was through the iterative cycles of evaluation of the cognitive engagement of the students, and the improvements from identified issues addressed in the subsequent cycles, that the generation of high quality instructional strategies was progressively achieved.

Reflections on the results were also done to contribute to knowledge by producing design principles. The design principles generated from this study will enable other researchers to design instructional strategies for the purpose of improving cognitive engagement of students in other collaborative learning environments. It is aligned with one of the fundamental principles of design-based research, which is to integrate known and hypothetical design principles with theoretical and technological advances to render plausible solutions to complex problems (Reeves, 2006). The design principles for this study is provided in Section 5.4.

Finally, the ability to build professional development for the researcher was possible, as the design-based research approach provided the researcher with a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among the researcher (teacher) and practitioners (students) in real-world settings, and led to contextually-sensitive design principles (Wang & Hannafin, 2005).

5.3.2 Challenges. There were also some challenges identified in this study, as the implementation of the study was conducted using the design-based research approach across the two academic years for a designated module.

Firstly, for the module involved in this study of using design-based research approach to introduce instructional strategies for improving cognitive engagement across numerous semesters, the researcher needed to be the module coordinator with full control of the learning environment and the revisions of the instructional design processes. According to Plomp (2007), design-based research is a systematic educational and instructional design processes, which is cyclical in character. Analysis, design, evaluation and revision activities are iterated until a satisfying balance between the intended ideas (instructional strategies to promote and improve cognitive engagement) and realisation has been achieved. However, the assignment of the modules to the academic staff was usually done only for one academic year. This meant that it was not possible to predetermine the module, or the students involved in the research. If the cycles involved different semesters, there might be unknown confounding variables that would affect the results. In the case of Bower's (2008) research, the iterations were conducted over three university semesters with study cohorts where Bower was the instructor. For this study, the researcher was able to conduct the four cycles as he was assigned as the module coordinator for two academic years with two study cohorts. For future studies, researchers must be aware of this limitation and schedule the cycles for their research within the confinements of their academic assignment or prepare to work closely with the assigned module coordinators.

Secondly, this study collected a large amount of data from the students' utterances. The data was mainly in the form of online discussions and exchanges among the students working in teams, in the course of analysing given case scenarios. The utterances were collected, annotated, classified and analysed so as to understand the effectiveness of the instructional strategies towards enhancing the level of cognitive engagement. The work done using qualitative methods across the iterative cycles were tedious, resource intensive and time consuming. To ensure that the results of the analysis were reliable and unbiased, there was also a need to process and review the utterances by two, or more, independent researchers. However, researchers using design-based research often lack the resources to conduct large scale research studies and consequently focus on micro studies with relatively small class size, which may be more manageable and achievable (Kennedy-Clark, 2013). A more efficient method of analysis can help in the analysis of such data, especially for larger number of students and with more iterations in the design.

Thirdly, the current study examined the use of students' utterances in collaborative learning to analyse the modes of cognitive engagement present in the learning environment through iterative cycles. Each of these cycles was stand-alone that focused on fine-tuning a particular aspect of the study with a formative evaluation being the most important research activity at the conclusion of each cycle (Kennedy-Clark, 2013). The formative evaluation was aimed at improving the instructional strategies from issues identified. However, the improvements could only be conducted in the subsequent cycle, and the results were not immediately known. This delay hindered the pace of the study, and could not progress forward swiftly.

Lastly, the researcher took on several roles simultaneously in this study, which can be seen as both beneficial as well as challenging. These roles included the role of a teacher who facilitated and implemented the instructional strategies and class activities, a designer who designed class activities taking reference from instructional strategies and redesigned these activities after each cyclical improvement, and a researcher who collected and analysed the students' inputs and evaluated the results. Very often in educational design-based research, the same individual is simultaneously the researcher, developer, facilitator, and/or evaluator of the intervention (McKenney & Reeves, 2012). It can be seen as beneficial for the designer to participate in the implementation and testing of interventions, as he/she gains deeper and often sharper insights into the underlying assumptions and the aspects of the design that result in success or failure. Such inputs for redesign are immediate and often more powerful than second-hand findings. It is also beneficial for the researcher to be involved in the design as he/she can understand how well instruments are measuring the phenomenon that they intend to measure. It would thus be most apparent to someone who understands both the design intentions and the research goals to make the effective adjustments to the methodology, design and implementation of the study.

The critical challenges of the researcher simultaneously taking on multiple roles are the issues of biases in the data and in the evaluation, specifically when it concerns the conflicting roles of advocate (designer) and critic (researcher) (Design-Based Research Collective, 2003). On the issue of biases in the data, the risk of socially desirable responses may increase when participants know that the researcher is also the designer. Participants may react differently due to the designer's presence (McKenney, Nieveen,

& van den Akker, 2006). For instance, if they know how much effort the designer has put into the design of the prototype, they may hesitate to be fully critical of it (Nieveen & Folmer, 2013). Another form of bias is due to the Hawthorne effect, where knowing that the teacher is involved in research influences the participants' behaviour due to their awareness of being observed (McKenney & Reeves, 2012). This effect often leads to hypothesis guessing where participants try to guess what the researcher seeks and react accordingly, and diffusion where participants who know how the research is carried out influences other participants. For this study, in order to mitigate bias due to the Hawthorne effect, the researcher started with gauging the student participants, and the classroom and online settings, on whether it was suitable to conduct the research. The researcher also gave the students detailed information and introduction on how to engage with members in their group through their utterances, explained to them that the purpose of the utterances was mainly for engagement and not for grading so as to create a non-threatening perspective, and established rapport with the students through weekly classroom sessions. These steps echoed the crucial parts of a protocol that has been developed to overcome and avoid the Hawthorne effect in research (Oswald, Sherratt, & Smith, 2014).

On the issue of biases in the evaluation, it is asserted that internal evaluation using the design-based research could be criticized, due of the biases involved when the researcher is also the designer and the teacher (McKenney & Reeves, 2012). The designer may unintentionally be less receptive to critique (McKenney, Nieveen, & van den Akker, 2006), the teacher represents the interest of the institution will want to conduct the class and evaluate the students' inputs as quickly as possible, while the researcher may resist such quick evaluation and will want to carry out a detailed program of testing before further variables and improvements are tinkered with (Phillips, 2006). However, it is highlighted that articulating and critiquing the design rationale is critical to this kind of research (McKenney & Reeves, 2012). It is asserted that in order to advance the understanding of what constitutes to a good design and how to achieve the research goals, the decisions that are made in the design work must be transparent. It is also suggested that it is extremely useful to include someone from outside of the research team to help facilitate the evaluation process. In the current study, all decisions made towards the improvement of the instructional strategies were justified and documented. A research assistant who was not involved in the design and the implementation of the study was also included into the research team to help evaluate the students' behaviour and utterances. The addition of the research assistant as an independent assessor provided more credibility to the evaluation, and increased the objectivity and balance to the evaluation process.

5.4 Design Principles

Design principle is an important yield of design-based research, as the major knowledge to be gained from such research in education is in the form of generated design principles (van den Akker, 1999), for educators and practitioners in education to follow when they design and implement similar learning environments (Wang, Quek, & Hu, 2017).

It is proposed by van den Akker (1999) that design principles can be presented in the following format:

If you want to design <intervention X> for the <purpose Y> in the <context Z>, then you are best advised to give that <intervention X> the <characteristics A, B, and C> [substantive emphasis], and to do that via <procedures K, L, and M> [procedural emphasis], because of <arguments P, Q, and R> (p. 9).

By following this format, the design principles from this study are presented as follows:

If you want to design instructional strategies for the purpose of improving cognitive engagement of students in a CBCL environment, then you are best advised to give the instructional strategies specific characteristics for the learning environment, and to do that via the design-based research approach, because its iterative cycles allow for the analysis of practical problems, the development of solutions informed by existing design principles and emerging new issues to be addressed, the testing and improvement of the solutions in practice, and the reflection to produce new design principles and to enhance the proposed solution.

Based on the summary of instructional strategies presented in Section 5.1, the characteristics of instructional strategies are generalised as follows:

a. The case study assignment must include meaningful tasks that the students can relate to topics which are covered in prior lessons. *[S1.1]*

b. Each student must be given an equal opportunity to provide their inputs and feedbacks to their group members' inputs, as well as participate in discussions with their group members. This can be achieved by providing sufficient time, and adequate input entries for each student. *[S1.2]*

c. Student must be given clear roles and responsibilities towards completing the assignment, which must be agreeable to everyone in the group. *[S1.3]*

d. Clear goals must be set for students to integrate the gathered information together, by discussing, debating and making reference to the inputs from other group members. *[S1.4][S2.3]*

e. Sufficient rewards, such as marks, must be awarded for both individual and group effort to encourage interdependence. *[S1.5]*

f. Students must share information to others within the group, who may not have acquired such information, to develop more comprehensive mental models. *[S1.6]*

g. Realistic case scenarios must be based on real events, so that the students can gather and share reference information available online or in prints. *[S2.1]*

h. Students must be encouraged to engage in autonomous learning, by sharing additional information through reference contributions. *[S2.2]*

i. Scripted roles can be used to make the students aware of their roles of providing the content and participating in the discourse with their group members to coordinate, plan, discuss, debate and conclude their views. *[S2.4]*

j. At the start of the collaborative learning exercise, activities such as self-introduction can be initiated so that the students are aware of the area of expertise of each of their group members. *[S2.5]*

k. Collaborative scripts, epistemic scripts, and social scripts can be included into the assignment to scaffold the students to coordinate and work together. These scripts can be in the form of step-by-step instructions, question prompts and annotations used in the discussion respectively. *[S3.1][S3.2][S3.3]*

l. The teacher should demonstrate how the students should be sharing their inputs and discussions online using the collaborative platform selected for collaborative learning. *[S3.4]*

m. Peer instructions can be used, where each student provides a solution completely on his or her own, before taking on opposite views in an interactive environment in argumentative discussions, conflicts and other potential controversies. *[S4.1]*

n. The annotation table and the given instruction of how to use it must be clear and easy to understand. The students must also be taught how and when to use the appropriate annotations in their discussions. *[S4.2]*

5.5 Limitations and Future Studies

There were also some limitations identified in this study, which would be addressed in future studies.

Firstly, getting students who were unfamiliar with each other to start and subsequently continue to engage in discussions online was apparently difficult. Preparations to get the students to know each other and work together required considerable amount of effort by the teacher. For large online classes with students across geographical borders, such preparations may be extremely difficult and impractical.

Secondly, the comments inputted by the students as utterances were free text format, and thus did not restrict the utterances to comply to any specific format. Although instructions were given to students to self-annotate and include an utterance annotation at the start of their utterance, some students had omitted this requirement and left their utterance without an annotation. This resulted in incomplete data, and the records had to be either removed or edited. This process of data cleansing would affect the accuracy of the analysis to some degree.

Lastly, also mentioned as one of the challenges of the design-based research approach, the manual work done in collecting, extracting, annotating, classifying and analysing the large amount of data from the students' utterances was tedious, resource intensive and time consuming. The time and effort required for this work resulted in considerable delays between successive cycles.

For future studies, it is recommended that computational linguistics would be able to provide a more efficient method of analysing student engagement, compared to the manual process used in the current study. Computational linguistics, also known as *Natural Language Processing (NLP)*, is a subdomain within the field of computer science which focuses in using computational techniques to learn, understand, and analyse human language content. Advancements in NLP research has leveraged on the development of social media, which has revolutionized the amount and types of information available today to NLP researchers. Data available from sources such as Twitter, Facebook, YouTube, blogs, and discussion forums make it possible to examine relations among user demographic information, language use, and social interaction (Russell, 2013). Development to automate computation and analysis of large amount of data, using database technologies in Hadoop and computer languages such as Google Apps Scripts, Python and R, has enabled NLP researchers to efficiently use such resources to quicken their pace in NLP advancements. NLP has also evolved into a practical technology that is increasingly being integrated into telecommunication products, such as Apple's Siri and Skype Translator.

The use of NLP mentioned above can automate the analysis of students' utterances and used as enhancement for future studies into *Intelligent Tutoring Systems (ITSs)*. ITSs are computerized tools that apply systematic procedures for enhancing learning (Aleven & Koedinger, 2002; Gertner & VanLehn, 2000). These systems engage with students online in one-on-one tutoring, an effective means of promoting active knowledge building supplemental to textbooks and conventional classroom environments (Corbett, 2001). A subgroup of ITSs also employ elements of conversational dialogue that use computational linguistic algorithms to translate and respond to natural language input from the student by connecting the appraised text to particular feedback actions. Thus, the efficacy of an ITS relies on the supporting algorithmic architecture that allows the system to assess students' input and adaptively respond, which can provide an interactive guide for free text inputs, or proficiently scaffold instructions for the learner (Rus, Lintean, McCarthy, McNamara, & Graesser, 2008).

Different cognitive styles of the students with diverse levels of cognitive engagement can also be further analysed and classified. Cognitive style, which is a term used in cognitive psychology, describes the way individuals think, perceive and remember information, or their preferred approaches to using such information to solve problems (Mampadia, Chena, Ghineaa, & Chen, 2011). The use of classification mechanisms can effectively classify and identify students' cognitive styles (Chang, Kao, Chu, & Chiu, 2009), in order to automatically adapt to the learners by suggesting fully tailored learning objectives and activities to the learners based on the learners' characteristics, such as cognitive style, knowledge level and preferences (Garridoa, Moralesb, & Serinac, 2016; Klašnja-Milićević, Vesin, Ivanovi, & Budimac, 2011; Lo, Chan, & Yeh, 2012).

In future studies, the use of chatbots to stimulate communication may provide a possible enhancement. Recent studies in *chatbot artificial intelligence* (AI) has shown that people who communicate with chatbots do so for longer durations than they do with another human (Hill, Ford, & Farreras, 2015), increase their awareness of critical thinking and enable them to form inquiring mindsets (Goda, Yamada, Matsukawa, Hata, & Yasunami, 2014), and are more likely to initiate clarification of misunderstandings or misconceptions when speaking to an artificial conversational agent represented by a human body interface (Corti, & Gillespie, 2016).

However, the Human-AI communication still lacks much of the richness of vocabulary found in conversations among people, exhibiting notable differences in the content and quality of such conversations as people tend to be more open, more agreeable, more extroverted, more conscientious and self-disclosing when interacting with humans than with AI (Mou & Xu, 2017). Another study also shows a significant drop in students' interest in the tasks and the course over time when they pair up with a chatbot as a partner and not a human (Fryer, Ainley, Thompson, Gibson, & Sherlock, 2017). Nevertheless, with an increasing computational resources and a better understanding of the structure of the language used in discussions, research efforts into AI for collaborative learning will have the potential to bring this study forward.

5.6 Closing Remarks

The aim of this study was to develop instructional strategies to facilitate and improve cognitive engagement of students in a collaborative learning environment. Research work for the study started by covering the increase in diverse students enrolled in degree courses in a wide spread of domain areas and subject matters. The students who enrolled in such courses were individuals who were also equipped with a range of diverse skillsets and abilities, cognitive capability, knowledge capacity and domain expertise. These students were enrolled in classes where collaborative learning was widely conducted, in which their differences hindered their progress towards collaborative learning. As such, a need for a set of instructional strategies and activities was proposed and investigated, and the results were presented in the current study.

Through the iterative cycles using the design-based research approach, sets of instructional strategies and their accompanied activities were proposed and implemented. The behaviours of the students were also observed, recorded and analysed to examine the effectiveness towards cognitive engagement. At the end of each cycle, issues which hindered cognitive engagement among the students were identified and addressed by adding new and/or improved instructional strategies in the subsequent cycle.

The set of design principles generated in this study can be used by teachers who are planning to use collaborative learning in their courses. Although these design principles are applicable for online collaborative learning, and the activities are designed to leverage on collaborative learning using an online environment, teachers can also make minor alterations to be used in other learning environments.

For future extensions in research, the findings from this study can also be used, examined and extended with emerging technology-enhanced education. With the pervasive use of mobile technology in teaching and learning, and the rising use of artificial intelligence and machine learning in educational analytics for enhancing student engagement and performance, the research work done in this study lays the foundation for future designs and improvements of instructional strategies to increase the cognitive engagement of students with the use of emerging technology.

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Appendices

Appendix A Paper-based Assignment in Pairs

A case scenario designed as a paper-based assignment for students to work in pairs. The fictitious case scenario was relevant to a lecture session of related topics on information Systems Audit.

Names: (A)______________ /(B)_______________ Matric Numbers: (A)_________ /(B)_________

You are an IT Auditor at the Headquarters of the Singapore based Bumble Bee donut shop chain. It started in 1991 and now has over 2,000 outlets that open 24 hours a day, 365 days a year in Singapore, Malaysia, Indonesia, Philippines and Thailand. Majority of these individual donut shops are directly owned and managed by the Bumble Bee. Due to its vast geographical presence and many of these shops are located in remote countryside, the manager of each of these shops has high degree of autonomy and is seldom visited by anyone from the Headquarters.

The success of this business is its secret recipes of the dough and low operating costs. The flour is pre-mixed in its own factories located in each of the countries it operates. But this rapid growth is not without pain. Many of these shop managers take advantage of the situation and end up defrauding this company. To name a few of the problems, they add ghost employees such as their family members including small children on the payroll but they never work there, they make fictitious non-food purchases from the companies they set up, using Bumble Bee's time and food supplies to support their own donut shops nearby, to hire illegal immigrants to work for an under-the-table kickback for each hired so that these people can get health insurance from Bumble Bee. These illegal immigrants buy a national identity number in the black market. These identity numbers are usually the identities of un-reported death in remote areas.

There are 15 people working in the Internal Audit Department. It has been estimated that it will take 13 years to complete one round of high level audit to all of the shops. The Head of Internal Audit asked that you think of a cost effective way leveraging on the information technologies and your data analytics skills to hone in on the more serious violators. Fortunately, most of the business processes are done online and you can pay to the governments to compare your employee identity with their data base. Describe in details how you use your data analytics skills for this audit to tackle each of the following problems:

Q 1a: The ghost employees on the payroll (4 marks)

Student (A)

Student (B)

Q 1b: The hiring of illegal immigrants (4 marks)

Student (A)

Student (B)

Student (A) Q 2: One other problem you believe exist within the company (2 marks)

Appendix B Cover Pages for Online Assignment in Groups

A case scenario designed as an online assignment using Google Docs for group work. The case study of a real-life event was relevant to a lecture session of related topics on information Systems Audit.

IS4234 Group Assignment 1 (10%)

Instruction: Completed this assignment before the deadline (24 Mar 2017, 12 noon)

1. The instructional case in the following pages will be used as Group Assignment for IS4234.
2. Please read the following materials in detail, before attempting to complete Assignments 1-5.
3. <u>You are required to</u> :
    a. Read the case scenario
    b. Identify the main points and start online discussions
    c. Add as much relevant **comments**, **discussions, debates** and external **links** to parts of the materials given with the relevant guidelines from COSO and COBIT frameworks.
    d. Edit the tables and the report documents for submission of Assignments 1-5.
    e. Review group members' work for brevity and accuracy
    f. Complete the final version by the above deadline.

4. <u>Please do all you work using this Google Doc</u>.

Learning Objectives:

Students have the opportunity to use this case material to (1) familiarize themselves with internal control frameworks recommended by the SEC for compliance with SOX, (2) provide themselves with an opportunity to review and evaluate internal control weaknesses using recommend frameworks, and formulate recommendations that can help thwart such weaknesses through examination of problems encountered in a real-world case, (3) demonstrate how two widely used internal control frameworks, COSO and COBIT, are inextricably linked, as financial reporting processes are driven by information technology systems, and/or (4) demonstrate how internal control frameworks can contribute to compliance with other regulatory requirements beyond SOX, such as information security laws. The case requires students to think about the many challenges that face accounting professionals and management as they attempt to assess overall risk as it relates to internal controls, information technology, and financial reporting. These learning objectives respond to the need by the profession for auditing students to have specific competencies and skills in areas such as decision modeling, risk analysis, communication via reporting, research, and technology.

@ Note: Use the following notations at the start of every input (See instruction 3 above):

Symbols	Description of symbol
+	Identifies a message posted by a learner assigned to the team supporting the given claim/statement.
-	Identifies a message posted by a learner assigned to the team opposing the given claim/statement.
ARG#	Identifies a message that presents one and only one argument or reason. Number each posted argument by counting the number of arguments already presented by the team.
EXP	Identifies a message that provides additional support, explanation, clarification, elaboration of another message.
CHA	Identifies a message that questions or challenges the merits, relevancy, validity, accuracy or plausibility of a presented argument (ARG) or challenge (CHA).
EVI	Identifies a message that provides proof or evidence to establish the validity of an argument or challenge.
CLA	Identifies a message by a learner assigned to the team initiating a claim/statement.
NEW	Identifies a message by a learner assigned to the team that presenting new concepts and/or ideas.

Appendix C Email Questionnaire

The email questionnaire, for the students to provide feedback on the experience in case-based collaborative learning at the end of the second cycle.

Dear Students,

I would appreciate if you can spend some time to provide feedback on the recent IS4234 module:

1. Collaborative learning through edits and comments on shared Google Docs helps in:
   1.1 Being conscious of your own understanding in the topics. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.2 Discovering and learning new knowledge from your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.3 Knowing how the topics were understood by your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.4 Motivating you to contribute new knowledge to your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.5 Raising awareness of errors highlighted among your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.6 Discussing and verifying misconceptions with your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
   1.7 Improving cooperation through exchanges among your group members. (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

1.8 Enhancing communication with group members using asynchronous technology.

(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

2. If your answers in Question 1.x are *Strongly Disagree*, *Disagree* or *Neutral*, kindly elaborate on what can be done to improve on the underlined purpose.
3. If your answers in Question 1.x are *Agree* and *Strongly Agree*, kindly elaborate on what was done well to support the underlined purpose.
4. If you have other inputs, positive or negative, kindly give details.

Kindly reply within the week. Thank you.

Kindest regards,

The Benedict

Lecturer

Department of Information Systems and Analytics

School of Computing

National University of Singapore

Appendix D Online Questionnaire

The online Questionnaire with a mixture of 5-point Likert scale and open-ended questions, for the students to provide feedback on the experience in case-based collaborative learning at the end of the fourth cycle.

Case-based Collaborative Learning Feedback

Please submit feedback regarding case-based collaborative learning, a learning approach which you have experienced in the module IS4234 Control and Audit of Information Systems.

Your valuable feedback will help to improved student engagement in similar approach to learning.

* Required

Name *

____

Student Number *

____

The name of my 1st group member is ... *

____

How well did I know the above group member before this module? *

	1	2	3	4	5	
Never met before	○	○	○	○	○	The best of before friends

The name of my 2nd group member is ...

____

How well did I know the above group member before this module?

	1	2	3	4	5	
Never met before	○	○	○	○	○	The best of before friends

Adding comments in case-based collaborative learning on Google Docs ... *

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
helps me to recall prerequisite learning	○	○	○	○	○
guides me in my train of thoughts	○	○	○	○	○
leads me to realise my own misconceptions	○	○	○	○	○
motivates me to think deeper into topics	○	○	○	○	○
encourages me to research for new knowledge	○	○	○	○	○

Sharing comments in case-based collaborative learning on Google Docs ... *

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
improves my communication of new ideas to others	○	○	○	○	○
helps me to synchronise and plan schedules with others	○	○	○	○	○
enhances discussion of misconceptions and queries with others	○	○	○	○	○
helps in my conceptual understanding through explanation by others	○	○	○	○	○
motivates others to	○	○	○	○	○

participate in providing feedback to me

Receiving comments from group members about my inputs ... *

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
makes me doubt my inputs if comments are opposing	○	○	○	○	○
makes me doubt my group members if comments are opposing	○	○	○	○	○
motivates me to think deeper if comments are opposing	○	○	○	○	○
makes me trust my inputs if comments are supportive	○	○	○	○	○
makes me trust my group members if comments are supportive	○	○	○	○	○
concludes inputs with no further reflections if comments are supportive	○	○	○	○	○

How do the instructions provided for inputting comments affect me in adding, sharing and receiving comments? *

____

____

____

____

My learning engagement in collaborative case-based collaborative learning is improved with ... *

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
the high accessibility of an online collaborative learning environment	◯	◯	◯	◯	◯
asynchronous feature of collaboration through inputs among group members	◯	◯	◯	◯	◯
synchronised feature of colour-allocated highlighting of text by group members	◯	◯	◯	◯	◯
the use of a wide range of annotation tags	◯	◯	◯	◯	◯
the use of a compact range of annotation tags	◯	◯	◯	◯	◯
explanation in class on the use of annotation tags	◯	◯	◯	◯	◯
printed instructions to share comments in annotation tags	◯	◯	◯	◯	◯
increasing teacher's feedback on comments	◯	◯	◯	◯	◯
increasing group members' feedback on comments	◯	◯	◯	◯	◯
allocated time for online discussions and comments	◯	◯	◯	◯	◯

Case-based collaborative learning was most effective in engaging my group members and me as learners for ... *

◯ Assignment 1 (Completing audit reports of real case)
◯ Assignment 2 (Reviewing case scenarios by other groups)
◯ Assignment 3 (Authoring & reviewing case scenarios among group members)

What aspects of this approach to learning were most effective, and why? *

Case-based collaborative learning was least effective in engaging my group members and me as learners for ... *

- ○ Assignment 1 (Completing audit reports of real case)
- ○ Assignment 2 (Reviewing case scenarios by other groups)
- ○ Assignment 3 (Authoring & reviewing case scenarios among group members)

What aspects of this approach to learning were least effective, and why? *

What are the other ways to improve student engagement as learners in this approach to learning? *

SUBMIT