EFFECTS OF DISCUSSION CONSTRAINTS, DISCOURSE MAPS, AND
INTERACTIVE INTERCULTURAL ELABORATION IN ONLINE
DISCUSSIONS ON STUDENTS’ KNOWLEDGE CONSTRUCTION,
CRITICAL THINKING, AND INTERCULTURAL SENSITIVITY

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ABSTRACT

Research shows both benefits and challenges of online discussion as a collaborative learning activity. Online discussion is especially challenging for novice college students who have limited metacognitive skills as well as limited knowledge of the subject domain. With limited metacognitive skills, it can be challenging for novice students to engage in high-order cognitive activities and as a result, participate meaningfully in online discussions. In addition, in an online discussion with participants from different cultural backgrounds, the text-based nature of an online discussion medium and the cultural differences between participants may make it even more difficult to establish common ground and shared understanding than in an online discussion with participants from the same culture, especially if the participants do not have any or only have little experience with cross-cultural interaction.

Therefore, the discussion board system in this study was designed with cognition-supported features (which combine a constraint-based discussion feature using a discourse structure with an automatically generated discourse map) and interactive intercultural elaboration features to address these issues. The study assessed the quantitative effects of these features on knowledge construction, critical thinking and intercultural sensitivity. In addition, the study also examined if prior knowledge and experience in the subject domain, prior experience in online discussions, or prior cross-cultural experience affected those results. Patterns of knowledge construction and critical thinking in four different types of online discussion boards were explored qualitatively by examining selected online discussion transcripts from eight weeks.
Participants were 103 undergraduate students enrolled in an introductory-level psychology course at an Ivy League university in the northeastern United States who engaged in eight weekly online discussions in groups of eight students, each on a course-related topic. Students’ knowledge construction in online discussions was examined using Gunawardena, Lowe, and Anderson (1997)’s Interaction Analysis Model that includes five phases of knowledge construction; students’ critical thinking in online discussions was examined using Newman, Webb, and Cochrane (1995)’s critical thinking coding scheme with ten categories of critical thinking indicators.

The results revealed that the cognition-supported features significantly helped learners in their knowledge construction and critical thinking in online discussion, although the effect was of greater magnitude for knowledge construction than for critical thinking. However, prior knowledge and experience in psychology and prior experience in online discussion did not influence the effectiveness of the cognition-supported features. Study results also indicated that the interactive intercultural elaboration features did not improve learners’ intercultural sensitivity. Possible reasons for failing to show an effect of interactive intercultural elaboration features on students’ intercultural sensitivity may have been the students’ relatively high level of initial intercultural sensitivity and prior cross-cultural experience or students’ imprecise use of the features.

Results from descriptive analysis of four discussions in Phase 3 of the study to compare argumentation and problem solving discussion frameworks used as discourse structures revealed that in terms of knowledge construction, argumentation-based discussions had more evidence of low-level knowledge construction Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance), while problem solving-based discussions had more
high-level knowledge construction Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) evidence. This might have been due to the more structured nature of the argumentation framework. For both discussion frameworks, the group who used the cognition-supported features first tended to have more occurrences of higher phases than the group who only used these features towards the end of the semester.

Study findings also revealed the possible influence of a discussion topic’s characteristics on students’ knowledge construction and critical thinking when comparing different discussion board types. In terms of knowledge construction, a discussion with a focus on finding and solving problems and with cognition-supported features had most occurrences of high-level phases and had fewest occurrences of low-level Phase I (Sharing and Comparing) during the knowledge construction process, followed by a discussion with a lot of details given initially but without any special features. On the contrary, a discussion with both sets of features but with a focus on sharing personal experience and from the group with less experience with cognition-supported features had the fewest occurrences of high-level phases but most occurrences of low-level Phase I. In addition, descriptive analysis of different discussion board types in terms of critical thinking showed that the discussions from the group more experienced with cognition-supported features had more higher level critical thinking indicators in the following categories: critical assessment, justification, and linking.

The positive study results enable one to conclude that the constraint-based discussion and discourse map features should be used in online discussion activities in college classrooms and extended use of these cognition-supported features may be beneficial for students. In addition, the level of structure in a discussion framework and the design of discussion topics should be considered in relation to the intended learning outcomes when
designing online discussion activities using constraints. Lastly, the study may stimulate future research in facilitating cross-cultural interaction and intercultural learning in online discussion through the interactive intercultural elaboration process.
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CHAPTER 1

INTRODUCTION

Background

Collaborative Learning and Online Discussion

Collaborative learning has been shown to be an effective learning strategy, supported strongly by Vygotsky’s sociocultural learning theory (Vygotsky, 1978). Research also shows that collaborative learning clearly provides positive educational value (Berge & Collins, 1995). Vygotsky’s sociocultural perspective indicates that development occurs first at the social level and then at the individual level. This means that social interaction can “lead to student cognitive development and higher mental functioning” (Kim & Bonk, 2002, p.2). People can learn through interacting with others. This is done through advancing one’s own zone of proximal development (ZPD) by interacting with experts and more capable peers (Bonk & Cunningham, 1998). In collaborative learning, students interact with peers to learn together or work together on the same tasks.

Online discussion is a type of collaborative learning where the collaboration is supported by online discussion systems which support asynchronous communication. Therefore, online discussion is classified as a form of asynchronous computer-mediated communication (CMC). Other types of asynchronous CMC include email, weblogs, bulletin boards, and listservs, etc. Nearly 90% of the post-secondary institutions in the US employed asynchronous CMC tools during the 2000-2001 academic year (Najafi, Ellis, Cox, & Calvert, 2007). In online learning, asynchronous discussion is currently the dominant form of
Online discussion has many advantages. It can support group knowledge construction and learning and help develop students’ critical thinking skills. On a discussion board, students can discuss different topics that are related to course content. In one study, Vonderwell (2003) found that most students could learn from each other through online course-related discussions in small groups. Interactions in asynchronous discussions are also possibly richer than in synchronous discussions like chat and face-to-face conversation (Romiszowski & Mason, 2004). Romiszowski and Mason explained this through the nature of asynchronous text communication, where students have more time to reflect and think and compose messages for posting. This distinguishes asynchronous communication from synchronous discourse where students need to respond instantly. Reflection is a critical component for meaningful learning (Schon, 1983). Reading messages can possibly involve “active engagement, thought, and even reflection on what has been read” (Romiszowski & Mason, p. 399). Through the process of interacting with others in asynchronous discussions (including reading and responding to others’ messages), individual surface learning is pushed into a deeper level of learning where critical thinking skills and analytic skills are developed (Chapman, Raymond, & Smiley, 2005; Harvard, Du, & Olinzock, 2005).

Chambers (2000) also agreed that online discussion tools can be used for effective teaching and learning, especially in distance education and for adult students. Students are free from time and place constraints in their communication. Higher education becomes more accessible for “previously marginal groups, such as disabled people, working adults, those who live in geographically remote places or work asocial hours” (para. 6). According
to Chambers, asynchronous CMC tools allow students to exchange ideas and views with others in an uninterrupted way. These tools can support central processes in humanities education which include reading with understanding as well as writing. Through technologies like online discussion boards, people from different cultures increasingly participate in collaborative learning projects. With all the potential learning benefits that online discussion has, it is important to understand how to support the collaboration process in online discussions, including online discussions in a multicultural environment.

*Cross-Cultural Collaborative Learning and Online Discussion*

As new and advanced collaborative learning technology tools emerge, students from different cultures now have opportunities to collaborate with each other during the course of their learning, for example participating in the same discussion while being geographically dispersed. This leads to an increase in the cultural diversity of learners, especially in online learning. Means such as email, discussion boards, weblogs, audio/video conferencing and instant messengers open various possibilities for cross-cultural communication.

When people in a collaborative learning group come from different cultures and backgrounds, there will be diverse perspectives. According to Kim and Bonk (2002), culture plays a significant role in learners’ cognitive development through social interaction and discourse. The cross-cultural dimension brings certain advantages to collaborative work. Some examples are enhancing students’ perspective taking abilities (Bonk, Appelman, & Hay, 1996), enhancing students’ performance since students have more desire to perform well in front of their foreign peers (Bonk & Cunningham, 1998).
Benefits of a culturally diverse learner population are further supported by Piaget’s Socio-Cognitive theory where cognitive conflicts or socio-cognitive conflicts play a central role in cognitive development (Piaget, 1950). In the context of this theory, conflicts become essential since they may lead to developmental change. Buchs, Butera, Mugny, and Darnon (2004) present advice in promoting constructive socio-cognitive conflicts, including “arranging tasks in such a way that different points of views are possible and can be confronted” (p. 24). According to Buchs et al., various research showed learners’ cognitive progress when confronted with different points of views even when they were at the same cognitive level. Compared to an online discussion where the learner population is culturally homogenous, an online discussion environment where the learner population is culturally diverse may generate more different points of views. As a result, a cross-cultural online discussion may have more opportunities for socio-cognitive conflicts as learners encounter various viewpoints different from their own. In the context of Piaget’s approach, culturally diverse discussion participants can have the potential to promote learning. At the same time, encounters with viewpoints from people coming from other cultures may also increase learners’ intercultural sensitivity and understanding as learners learn more about other cultures.

Problem Statement

Even though discussion board tools have the potential to support meaningful social interactions and learning, it does not mean that this potential can be easily realized. There are inherent issues in many of the current discussion board systems. We can often find online discussions that have low quality and do not lead to meaningful learning. Vonderwell
(2003) found that messages need to be constructed thoughtfully to ensure effective communication and learning. However, for novice students who are new to a domain, it can be a challenge to think critically about the domain content and construct thoughtful messages (Choi, 2002).

In addition, since learners in a multi-cultural online discussion environment come from different backgrounds, they may have different viewpoints. As a result, the discussions are more prone to misunderstandings due to the difficulty of establishing a common ground in communication. An extensive examination of discussion boards used in education also shows that most current discussion boards in education are neutral to a learner’s cultural background. Specifically, they do not explicitly facilitate cross-cultural communication or explicitly encourage diverse expressions. As a result, students may miss valuable learning opportunities. Further elaboration of these cognitive and cultural issues is provided below. Suggestions for solving these issues through providing scaffoldings are also offered.

**Discussion Boards and Cognitive Issues**

With many discussion board tools used in higher education today, it can be difficult for students to follow all the ideas in a discussion as the discussion develops and gets longer (Chambers, 2000; Vonderwell & Zachariah, 2005). It is a challenge for students to mentally organize the information in a meaningful way so that they can read and respond more thoughtfully. Students can feel confused and overwhelmed with the amount of information posted. According to Chambers, it can be time-consuming and overwhelming for students to read and comprehend discussion board messages, especially when students do not log in frequently, when there are a lot of messages and when there are many discussants writing on
different aspects of one topic or even different topics. As a result, students may be less likely
to post meaningful responses that contribute to knowledge construction. The discussion can
become fragmented and it is easy for the “frame of meaning” to slip (Chambers, para. 10).
Due to the loose structure of online discussions, students can also feel anxious, especially for
those who do not have much experience with online learning (Pena-Shaff, Altman, &
Stepheson, 2005).

In many online discussions, there is some level of discussion or communication, but
one must question how deep and collaborative it is. Kaye (1992) distinguished
“collaborative learning” from mere “communication”, and defined “collaborative learning”
as “individual learning occurring as a result of group processes” involving “some agreement
on common goals and values, and the pooling of individual competencies for the benefit of
the group of community as a whole” (p. 2). Schrage (1990) pointed out that an important
characteristic in successful collaboration is that new meanings about the world are
constructed through interaction with others. However, it is not often like that in course
discussion boards. Students have limited time. In addition, with limited metacognitive
skills, their messages do not always contribute to the construction of new meanings about the
world or the topics of the discussion (Choi, 2002).

To help students process better the information produced in an online discussion as
well as write meaningful postings and responses to others, tools that support information
processing and organization are needed. Even though the discussion board environment has
the potential to improve students’ critical thinking skills (e.g. argumentation, reasoning,
judging), without metacognitive scaffolding, the development of these skills is left mostly to
students’ existing metacognitive abilities. Novice learners, who are new to a domain, often
have limited metacognitive skills (e.g. reflection, monitoring, evaluation) to ask good questions or generate good feedback (Choi, 2002). It is also a challenge for them to read messages critically. Therefore, providing metacognitive and cognitive scaffolding may enhance students’ critical thinking skills and learning. These scaffoldings can help students be more aware of how much they learn from a discussion and help students see that participating in an online discussion can be useful for their learning, thereby making students more likely to participate.

One way to help scaffold learners’ metacognition is through the use of a constraint-based discussion board. Jonassen and Remidez (2005) described a “constraint-based discussion board” where learners are required to “classify the nature of the comments and replies to others’ comments” (p.1). Their system supports “a variety of discourses, including argumentation, problem solution, literary analysis, and any other kind of activity” (p. 1).

In order to for the system to support a variety of discourses, the authors employ discourse structures. For each type of discourse (e.g. argumentation, problem solution, literary analysis), there is a structure that supports the dialogue in a discussion. This structured discourse requires students to classify their messages by labeling them based on the type of discourse it is. For example, if a discussion is of the problem solution discourse type, structured labels include hypotheses, positions, arguments, evidence, conclusions, solutions, and event conditions. Students then need to classify their posting as one of these components. This system scaffolds critical thinking skills, especially reasoning skills. From a cognitive and information processing perspective, providing constraints helps learners structure the discussion board information in a meaningful way as these constraints make explicit the logical flow of the discussion, thereby providing a reasoning model for novice
learners to follow. Constraints in this case serve as a scaffold to compensate for learners’ lack of adequate metacognitive skills.

Based on Vygotsky (1978)’s concept of the Zone of Proximal Development, scaffolding is necessary when learners cannot perform a task or acquire understanding of new things on their own. Senge (1990) pointed out the importance of making informal reasoning explicit to support social negotiation. Since research findings in direct instruction of reasoning skills show mixed results (Jonassen & Remidez, 2002), the integration of a discourse structure such as an argumentation discourse or a problem solution discourse into a constraint-based discussion board can possibly better facilitate learners’ development of their reasoning skills by putting learners in a situation that calls for making reasoning explicit through classifying and labeling. Cho and Jonassen (2002) found that such a system helped learners generate more coherent arguments and increased the number of problem-solving actions in their discussions. Jeong (2003) found higher frequency of elaborated messages in a constraint-based discussion board compared to a standard discussion board. Findings in Brooks and Jeong (2006) implied that pre-structured discussions can increase the frequency of constructive conflict and therefore potentially lead to more critical discourse.

Many of the constraint-based discussion systems provide graphical interfaces to represent a discussion and relationships between messages in the discussion (Suthers, 1998). Visualizing argumentation allows students and instructors to see the structure of the whole discussion as well as the flow and the important ideas of the discussion, which should lead to more meaningful knowledge construction and help students post more meaningful messages in response to previous messages (Suthers & Jones, 1997). Most learners should learn better when there is a visual advanced organizer to help them structure overwhelming unstructured
postings. An example of such visual advanced organizer is a discourse map that shows the structure of a discussion and presents the relationships between messages in the discussion.

In summary, in order to help novice students with limited metacognitive skills have meaningful online discussions, cognition-supported features including a constraint-based discussion and a discourse map is predicted to prompt students to engage in critical thinking processes by making the logical flow of a discussion and the reasoning processes explicit to students and to assist students with organizing, processing online discussion information and building knowledge.

**Discussion Boards and Cultural Issues**

In a multi-cultural discussion board, there are also culture-related issues. Culture can be an ambiguous concept. It can extend beyond the simple boundaries of nationalities since “there are differences within nationalities and cultural groupings also” (BlackroadConnections, 2000, p.2). Dutch anthropologist Geert Hofstede defines culture as “patterns of ‘thinking, feeling, and potential acting’ that every person carries within him or herself, and which he terms ‘mental programs’” (cited in Marinetti & Dunn, n.d., para. 5). The sources of one’s cultural patterns are the social environments in which one grew up and experienced different things. Culture affects who we are, the way we think, behave and respond to our environment and above all, the way we learn (Marinetti & Dunn).

In a longitudinal study, Chase, Macfadyen, Reeder, and Roche (2002) revealed different communication patterns and miscommunication in multi-cultural online discussions. Between cultures, there are differences in terms of attitudes towards communication using new technologies, characteristics of electronic genres, communication
styles and routines, and viewing/listening practices. These differences along with cultural gaps can be manifested through incidents of miscommunication beyond ones expected in face-to-face situations because online environments lack certain features of face-to-face interaction.

Discussion boards can be impersonal compared to face-to-face interaction (Moallem, 2003). Therefore, it can be difficult for learners to establish common ground, which is important for good communication. In an online environment, the cultural identities and backgrounds of the discussants are often hidden. Even when learners are aware of others’ cultural identities and backgrounds, it is still not easy to recognize the cultural nuances in written messages. Since a person’s behaviors and interpretations of events are influenced by their cultural and contextual experiences (Taylor, 1998), these cultural characteristics quietly influence the discourse; and cultural messages are embedded in discussion although often unrecognized. This can become a challenge for cross-cultural interactions. However, currently many discussion board tools used in education do not support establishing common ground in a multi-cultural environment.

In addition to the lack of support for establishing common ground between learners, most discussion boards also do not explicitly encourage diverse expressions despite their cognitive benefits. Instead they are quite neutral where cultural nuances are often not recognized by participants. As a result, many valuable learning opportunities may be missed. McLoughlin (1999) strongly emphasized the need for taking into account the cultural dimensions when designing education technology.

In a qualitative study, Goodfellow, Lee, Gonzalez, and Mason (2001) suggested that cross-cultural understanding can be promoted in a learning environment in which diversity is
inclusive or contexts outside the “dominant culture of the course” are acknowledged. Based on student comments in the study, in such a learning environment, students can have conscious experiences of diversity including the experiences of being among “friends all over the world” and “fellow students from completely different cultural backgrounds,” “extending consciousness of cultural diversity,” “understanding problems from different perspectives,” “feeling part of a global network” (Perceptions of Globality section, para. 6). These perceptions are beneficial to students. However, when the cultural aspects are silent, students do not benefit as much as they otherwise could from the existing multiple perspectives.

In order to solve the challenges in cross-cultural interactions, focus on metacognitive and cognitive scaffolding alone may not be enough. Cultural scaffolding to support cultural awareness and understanding of multiple perspectives may be necessary. This scaffolding should help learners be more aware of the existing cultural differences in the learning environment. This should support the process of taking multiple perspectives, enhance the quality of learning through taking advantage of the diversity of learners, and facilitate understanding between students. Hart (1998) suggests the following:

One could imagine, perhaps, an e-mail exchange between people of different cultures in which certain words in the email texts could be hyperlinked to background information on the unique meaning these words have in the different cultures. For example, a U.S. American (of European descent) may see in their e-mail from a person from China that the word family is hyperlinked. If the reader chooses, they could click on the hyperlinked word family and then they would be taken to a document that explains the concept of family in China (e.g., importance of the extended family, background on Confucian beliefs about family structure, etc.). Such
a reference may help the reader better understand the overall e-mail message. (For Further Discussion section, para. 7).

Similarly, we can also provide such access to the culturally hidden meanings of words written in a message board. In addition, instead of giving students out-of-the-book meanings, these culturally hidden meanings can be provided by students themselves. Through the explanation process of culturally loaded words, students externalize their understanding of such words to others. Explanation is also a powerful learning strategy for deepening learners’ understanding. This may help facilitate intercultural communication and interpretation as well as knowledge construction as students explain their own perspectives and view others’ perspectives on the same word. In this study, the whole process of explaining culturally loaded words and viewing others’ explanations while having the chance to revise one’s own existing entries is called interactive intercultural elaboration process.

In summary, in order to help facilitate shared understanding in online discussion between students from different cultures and intercultural learning, interactive intercultural elaboration features is predicted to help students to learn from multiple perspectives and become aware of cultural differences, and thus improve their intercultural sensitivity.

Culture and Cognition

According to Holvikivi (2007), traditional perspectives view culture and cognition as separate entities and have no connection where “human intellectual activity is understood as an abstract mental process somewhere within the human mind, separate from bodily or human functions” (p.74). From the 1950s until the 1970s, human intelligence was explained in terms of computer information processing (Hakkarainen, Palonen, Paavola, & Lehtinen,
2004) while ignoring culture, history, context, and emotion (Hutchins, 1995). More recent approaches explain human cognition while not neglecting the cultural aspects. There is an acknowledgment that different cultures can construct knowledge in different ways (Holvikivi). Hutchins looks at culture as a human cognitive process that happens both inside and outside people’s minds. The concept of cultural schemas also emerged with two types: schemas shared by a culture and schemas internalized in individuals (Strauss & Quinn, 1997).

The connection between culture and cognition calls for instructional design principles that embrace both culture and cognition and address how the complex connection between the two is taken into account in designing collaborative learning technologies. Therefore, in order to design effective online discussions, it should be powerful to have both cognition-supported features and interactive intercultural elaboration features so that students’ thinking processes as well as intercultural interactions may be enhanced.

**Purpose of the Study**

The purpose of this research was to study the effects of cognition-supported features and interactive intercultural elaboration features integrated into a multicultural discussion board environment on knowledge construction and critical thinking in online discussions and on intercultural sensitivity (see Table 1.1). Specifically, the study tested the effects of cognition-supported features that combined a constraint-based discussion feature using a discourse structure with an automatically generated discourse map on students’ knowledge construction and critical thinking in online discussions. In addition, the influence of students’ prior knowledge and experience with the subject domain and students’ level of prior
experience with online discussion inside and outside of classroom context on these effects was also examined. Second, the study tested the effects of interactive intercultural elaboration features on students' intercultural sensitivity. The influence of students’ prior cross cultural experience on these effects was also examined. Next, the study also sought to describe the levels of student knowledge construction when given discussion scenarios using different discourse structures and different content, and lastly, to compare knowledge construction and critical thinking in the four different types of discussion boards: a standard threaded discussion board, with cognition-supported features, with interactive intercultural elaboration features, and with combined cognition and intercultural features.

Table 1.1. Discussion Board Features and Tools and Dependent Variables

<table>
<thead>
<tr>
<th>Features</th>
<th>Discussion Board Tools</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognition-Supported Features</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constraint-Based Discussion Feature</td>
<td>The system allows students to select a label for their posting based on the integrated discussion structure set for that discussion.</td>
<td>Knowledge Construction &amp; Critical Thinking</td>
</tr>
<tr>
<td>Discourse Map</td>
<td>The system automatically generates a map of the discussion and students can navigate through the discussion by using the map.</td>
<td></td>
</tr>
<tr>
<td><em>Interactive Intercultural Elaboration Features</em></td>
<td>Students can click on a cultural word highlighted by the discussion board system to provide their own understanding of that cultural word. Students can navigate through other group members’ explanations of cultural words to read the explanations. Students can edit their previous explanations of cultural words. Students can enter a new cultural word into the system.</td>
<td>Intercultural Sensitivity</td>
</tr>
</tbody>
</table>
Research Questions

Question 1: Effects of Constraint and Discourse Map on Knowledge Construction

1.1. Does the use of the cognition-supported features integrated into the online discussion board system affect students’ level of knowledge construction in online discussions?
1.2. Does students’ level of prior knowledge and experience in subject domain influence the effect of the cognition-supported features on knowledge construction?
1.3. Does students’ level of prior experience with online discussion influence the effect of the cognition-supported features on knowledge construction?

Question 2: Effects of Constraint and Discourse Map on Critical Thinking

2.1. Does the use of the cognition-supported features integrated into the online discussion board system affect students’ level of critical thinking in online discussions?
2.2. Does students’ level of prior knowledge and experience in subject domain influence the effect of the cognition-supported features on critical thinking?
2.3. Does students’ level of prior experience with online discussion influence the effect of the cognition-supported features on critical thinking?

Question 3: Effects of Interactive Intercultural Elaboration on Intercultural Sensitivity

3.1. Does the use of interactive intercultural elaboration features integrated into the online discussion board system affect students’ level of intercultural sensitivity?
3.2. Does students’ level of prior cross cultural experience influence the effect of interactive intercultural elaboration features on students’ intercultural sensitivity?
Question 4: Examining Patterns of Knowledge Construction in Two Different Discourse Structures

In the case of a constraint-based discussion board, how different are the patterns of knowledge construction in discussions for Argumentation and Problem Solving discourse structures?

Question 5: Examining Patterns of Knowledge Construction and Critical Thinking in Four Types of Discussion Boards

How different are the patterns of knowledge construction and critical thinking between four types of discussion boards: without any special features, with cognition-supported features, with interactive intercultural elaboration features, and with both sets of features?

Research Hypotheses

Question 1.1
Students will demonstrate a significantly higher level of knowledge construction in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.

Question 2.1
Students will demonstrate a significantly higher level of critical thinking in discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.
Question 3.1

Students will have a significantly higher level of intercultural sensitivity in a discussion board with interactive intercultural elaboration features than in a discussion board without interactive intercultural elaboration features.

**Significance of the Study**

The results of this study have implications for instructional designers, instructors, and researchers in designing discussion boards improving students’ level of knowledge construction and critical thinking using discussion boards as collaborative learning tools. The study also adds more empirical evidence to the literature of a constraint-based discussion and a discourse map in online discussion, and offer implications for further research in the area of constraint-based online discussions and for designing online discussion activities using constraints and a discourse map. In addition, the study may stimulate future research in facilitating cross-cultural interaction and intercultural learning in online discussion through the interactive intercultural elaboration process and supporting multicultural learning environments.

**Definitions of Terms**

Cognition-Supported Features:

Cognition-supported features include two integrated features called constraint-based discussion and an automatically-generated discourse map (see Table 1.1).
**Constraint-Based Discussion Board:**

Jonassen and Remidez (2005): Constraint-based discussion boards are defined as “prestructured forms of conversation systems that impose different conversational ontologies onto the discussion” (p. 116). In this type of discussion board, learners need to label their messages based on a discourse framework imposed on the system.

**Critical Thinking:**

Critical thinking is defined as higher-order thinking skills or high quality thinking such as information processing, reasoning, inquiry, creative thinking and evaluation (Wegerif, 2005). In this study, critical thinking is viewed as a sequential problem solving process with five stages: problem identification, problem definition, problem exploration, problem applicability, and problem integration (Garrison, 1992). According to Garrison, each of these five critical thinking stages corresponds with each of the five critical reasoning skills identified in Henri (1991) accordingly: elementary clarification, in-depth clarification, inference, judgment, and strategies. Based on these five critical thinking stages, Newman, Webb, and Cochrane (1995) developed ten categories of critical thinking indicators to examine critical thinking in collaboration:

**Cross-cultural Collaborative Learning:**

Cross-cultural collaborative learning means learners from different cultures interacting and learning together to perform a task, to acquire a skill and to achieve a new understanding.
Culture:
Culture in this study is based on nationality origin. In a narrower categorization, culture may also be examined terms of ethnicity. Triandis (cited in Morse, 2003) defined ethnicity “people who have culture, language, history and traditions in common” (p. 41).

Discourse Map:
A discourse map shows a visual structure of the discussion. It is a node-link graph that represents the relationship between different discussion messages (see Figure 1-1).

Figure 1-1. A discourse map example
**Interactive Intercultural Elaboration:**

Interactive Intercultural Elaboration (see Table 1.1) refers to a strategy in which learners explain what certain terms may mean in their culture. These explanations can be viewed by other learners in a multi-cultural group. Students can revise their explanation any time. These revisions can be prompted by looking at others’ explanations or by reflecting more on their own explanations.

**Knowledge Construction:**

In this study, knowledge construction is defined as a core process in collaboration, a certain way that a group uses to develop a new level of understanding together about a topic under investigation (Stahl, 2006). It is about constructing new meanings (Scardamalia & Bereiter, 1996). This definition is also consistent with the five-phase-knowledge construction process discussed in Gunawardena, Lowe, and Anderson (1997). In this knowledge construction model, there are five phases of negotiation and co-construction: sharing/comparing of information, discovery and exploration of dissonance or inconsistency of ideas, negotiation/co-construction of knowledge, testing/modification of proposed co-constructed synthesis, and co-construction of knowledge/application of newly constructed meaning.

**Intercultural Sensitivity:**

Intercultural sensitivity is defined as an individual’s “active desire to motivate themselves to understand, appreciate, and accept differences among cultures” (Chen & Starosta, 1998, p. 231).
Standard Threaded Discussion Board:

A standard threaded discussion board is a threaded discussion board without both cognition-supported features and interactive intercultural elaboration features.
In this review, theoretical foundations of collaborative learning and the benefits and challenges of collaborative learning in general and online discussion in particular will be discussed. Especially, these benefits and challenges are examined in relation with knowledge construction and critical thinking. In addition, the added benefits of a diverse student population to the learning environments as well as issues that may come up in such a learning environment are examined. The cognitive challenges that students might have when participating in online discussion and the communication issues that emerged from cultural differences lead to the need for scaffolding novice students with limited metacognitive skills and limited experience with cross-cultural interaction in the collaboration process in multicultural online discussions. To address the cognitive challenges students may encounter in online discussion, the review examines the cognitive benefits of constraints and a discourse map in discussion boards as potential solutions for assisting students in their thinking process. To address issues in online cross-cultural interaction, interactive intercultural elaboration is suggested to be used as an explanation strategy for facilitating online intercultural communication and interpretation and developing intercultural sensitivity.
Collaborative Learning, Online Discussion, Knowledge Construction and Critical Thinking

Collaborative Learning

Collaborative learning has been used widely in education with important positive education values. Learning collaboratively is supported by major learning theories, specifically, Vygotsky (1978)’s socio-cultural learning theory and Piaget (1950)’s socio-cognitive development theory. Vygotsky’s socio-cultural learning theory suggests that cognitive change depends on the social interactions in which individuals are involved. Piaget’s socio-cognitive development theory also acknowledges the role of social interactions on an individual’s cognitive development. However, while Vygotsky’s approach focuses on the social interactions between people with different cognitive development levels, Piaget’s socio-cognitive theory focuses more on interaction between learners with similar intellectual or development levels but with different viewpoints.

Empirical literature has also shown the positive effects of collaborative learning compared to individual learning (Slavin, 1983; Webb, 1991). For example, collaborative learning can improve monitoring and regulation skills (Brown & Palinscar, 1989; Blaye & Chambres, 1991). Monitoring and regulation skills have been considered “important preconditions for high level learning” by thousands of studies (Lehtinen, 2003, p.44). There are also empirical studies that show positive effects of Computer Supported Collaborative Learning (CSCL) on student learning (Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999).
Collaborative learning can provide opportunities for challenging cognitive activities such as explanation, argumentation, inquiry, etc. which can be the catalysts for collaborative learning mechanisms such as knowledge articulation, cognitive load sharing, and cognitive load distribution (Dillenbourg, 1999). However, it can be challenging for novice learners with limited metacognitive skills and limited knowledge in the subject domain to engage in these cognitive activities effectively. Therefore, scaffolding should be provided to assist novice learners in the collaborative learning process. Based on this need, this study examines how students can be assisted during the collaboration process, specifically during the collaboration process in online discussion.

**Knowledge Construction and Collaborative Learning Processes**

Recently, the notion of knowledge construction has often been discussed in the community of collaborative learning researchers, especially in the area of Computer Supported Collaborative Learning (CSCL). This notion shares a common theme of constructing new meaning with the concept of knowledge building from Scardamalia and Bereiter (1996), where the authors developed the notion of community learning in computer-supported classrooms. From this perspective, collaborative learning is a collaborative process of constructing shared meanings or a shared conception of a problem (Stahl, 2006). In Stahl’s words, collaborative learning “can be viewed as the gradual construction and accumulation of in increasingly refined and complex cognitive and linguistic artifacts” (p. 314). In addition to the two learning metaphors for learning indicated by Sfard (1998) (acquisition metaphor and participation metaphor), Hakkarainen et al. (2004) proposed a third metaphor for learning called knowledge creation which refers to the creating of new
knowledge and skills in cultural practices. Within the past ten years, the terms *knowledge construction*, *knowledge building*, *knowledge creation* have often been explored and written about in the literature in collaborative learning.

Besides analogies, interrelated theories have also emerged that revolve around these concepts, such as Nonaka and Takeuchi (1995)’s theory of knowledge creations, theory of knowledge building from Scardamalia and Bereiter (1996) and Bereiter (2002), and Stahl (2006)’s theory of knowledge construction. Theories in knowledge construction are built around processes in collaborative learning.

Important processes in collaborative learning include meaning making, conflict resolution, negotiation and argumentation (Dillenbourg, 1996; Bossche, Gijselaers, Segers, & Kirschner, 2006; Stahl, 2006). According to Stahl, these processes are necessary in knowledge construction. Meaning making encompasses meaning creation, meaning sharing and interpretation. In Bossche et al.’s terms, meaning making means construction and co-construction of meaning. According to Stahl (2000), construction starts when a learner articulates his or her personal meaning. After that, this learner will give his or her personal meaning to others in the group. The others in the group will then try to understand the given meaning and apply this meaning into the current situation they are in. Co-construction of meaning means collaborative construction of meaning. In this process, meaning is collaboratively refined, built on, or modified in some way compared to the original meaning (Baker, 1994). From this process of construction and co-construction, new meanings as the result of collaborative work emerge.

Another important process is referred to as conflict resolution. It means learners moving toward agreement during a constructive conflict. Constructive conflict is defined as
“negotiation of the differences in interpretation among team members by arguments and
clarifications” (Bossche et al., 2006, p.497). In learning, conflict is only meaningful when it
leads the team members to further elaboration on the topic (Bossche et al.). Conflict and the
coordination of points of view are also central in Piaget’s socio-cognitive theory of cognitive
development (Dillenbourg, Baker, Blaye, & O’Malley, 1996). With a focus on an
individual’s cognitive development in the context of social interaction, Piaget (1950)’s socio-
cognitive development theory also specifies that in order for cognitive conflict to enhance the
collaborative process, the conflict must trigger the restructure of individual cognition.

Nastasi and Clements (1992) distinguished between social conflict and cognitive
conflict. Social conflict is not related to the problem itself and includes events such as name
calling and criticism. Cognitive conflict is related to the problem in terms of task
conceptualization or solution. The authors found that only cognitive conflict had a positive
correlation with individual improvement. Besides meaning making and conflict resolving,
negotiation and argumentation are also important processes in collaboration. Negotiation and
argumentation are two kinds of common interaction in collaborative learning research
(Dillenbourg et al., 1996). According to Dillenbourg et al., negotiation is looked at as an
indicator for joint involvement in Vygotsky’s approach, with the purpose of attaining shared
understanding of meanings of utterances in collaboration. As conceptualized in Piaget’s
approach, argumentation is looked at as a possible means for resolving socio-cognitive
conflict.

Since theories of knowledge construction are built upon processes in collaboration, in
order to support knowledge construction in collaborative learning, it is important to support
processes in collaborative learning. Therefore, the online discussion board system under examination in this study was designed to support these collaborative processes.

**Online Discussion, Knowledge Construction and Critical Thinking**

Online discussion is a type of computer mediated communication (CMC) and a type of collaborative learning where the collaboration is supported by online discussion systems which support asynchronous communication. Literature shows both positive and negative implications of CMC use in education (Morse, 2003).

Morse (2003) stated that an asynchronous CMC learning environment provides a lot of benefits compared to face-to-face instruction or synchronous CMC learning environments. Benefits of asynchronous CMC include “flexibility, participation quality and quantity, communication openness/access and post-participation review/access for reference purposes” (Morse, p. 38). For students who are less likely to speak up in class, they may feel more comfortable to write on a discussion board. In addition, in face-to-face class discussions, students do not have enough time to reflect on and consider thoughtfully what others say in class, which can lead to misinterpretation and easy acceptance of authoritative views (Pea & Gomez, 1992). As a result, students may not personally internalize the knowledge and construct their own understanding of the knowledge, which is important for meaningful learning. The asynchronous nature of online discussion gives students more time to reflect on their messages as well as on others’ messages and more flexibility as to when to contribute their ideas (Brooks & Jeong, 2006). Students can have more time to think through what they want to write, and as a result, that may allow them to write more thoughtful messages. Online discussion also provides students with opportunities to express
their thoughts in writing. Students can always review the discussion later for further thinking. It has also been known that CMC and online threaded discussion boards can facilitate critical thinking through collaborative argumentation (Collins & Collins, 1996; Pilkington & Walker, 2003).

Although online discussion provides students with many opportunities, it is not free of issues that can cause challenges during the important processes of collaboration like meaning making, conflict resolution, negotiation and argumentation. Roschelle and Pea (1999) specified several difficulties: dependence of web communication on text, the different nature of asynchronous communication compared to face-to-face communication and the lack of clear Web-specific support features for collaborative processes. Even though the asynchronous nature of online discussion brings a lot of benefits to learning as specified in a section above, it is this very nature that causes issues for student learning as well. It is a challenge to create mutual understanding and shared values and goals online. Studies showed that it is difficult to get common understanding even in face-to-face classroom situations (Winne & Marx, 1982). It is even more so in an online learning environment. Online interactions lack nonverbal cues that exist in face-to-face interaction (e.g. tone of voices, facial expression, etc.). The lack of nonverbal cues can make it more difficult for learners to understand each other and therefore it is difficult to establish common ground in social interactions.

Collaborative learning is beneficial. However, Law (2005) stated that it is not valid to assume that as long as putting people in a group and ask them to discuss in online discussions, collaborative learning happens. There is need to understand the conditions and criteria for true collaborative learning to happen in CMC contexts (Law). According to de
Laat (2002), even when learners perceive their collaborative experience in a positive way, they may still only be within the phase of sharing information and not yet at a high order thinking level. Especially for learners who are novice in a subject and with limited metacognitive skills, it is not easy to post meaningful messages or engage in deep learning through discussions. Studies found that in online threaded discussion, students often repeat points already made and rarely respond to each other’s points (Koschmann, 2003). Discussions often lack coherence and depth (Herring, 1999). Brooks and Jeong (2006) pointed to lack of turn-taking as a reason for these issues. Turn-taking allows students to express their ideas with undivided attention from group members, keep the discussions on topic, and help the discussions follow a logical flow and therefore assist the group in achieving its goals in the discussion. The authors suggested that without turn-taking procedures, students can experience cognitive overload as the discussion gradually grows off track and lacks a coherent line of inquiry. Hewitt (2003) also pointed out that students tend to reply to messages without considering the message’s relevance to the main discussion topic. These problems can be due to learners’ lack of cognitive skills like analysis, reasoning or argumentation (Jonassen & Remidez, 2005).

Therefore, the cognition-supported features integrated into online discussion board system examined in this study was designed to assist novice students with limited metacognitive skills as well as limited knowledge in the subject domain, especially in helping students to form a logical flow of a discussion, reduce cognitive overload in a complex discussion, organize and process a discussion, and write meaningful messages to contribute to a discussion. The features were aimed to support students’ knowledge construction and critical thinking in online discussion.
**Online Discussion and Knowledge Construction**

Gunawardena et al. (1997) developed the Interaction Analysis Model for CMC to examine the social construction of knowledge in CMC context, where participants interact “to produce new knowledge or to arrive at new understandings of meaning” (p. 410). In this model, the knowledge construction process is viewed in an image of a patchwork quilt block, “built up by the application, one after another, of small pieces of cloth, which when assembled form a bright and colorful pattern. The pieces, according to this analogy, are the contributions of individual participants. Each participant contributes to the whole his or her own texture and color of thought, just as every scrap of fabric forms a distinctive element in the overall pattern. The pattern may not be complete during a single conference, but individual responses can contribute toward the formation of a pattern” (p. 411).

The Interaction Analysis Model had five phases: Phase I: Sharing/comparing of Information; Phase II: The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements; Phase III: Negotiation of meaning/co-construction of knowledge; Phase IV: Testing and modification of proposed synthesis or co-construction; and Phase IV: Agreement statement(s)/applications of newly-constructed meaning. Under each phase, there were different knowledge construction operations that represent the different sociocognitive processes that may happen in each phase.

In this study, students’ knowledge construction is examined under the lens of the Interaction Analysis Model.
Online Discussion and Critical Thinking/High Order Thinking

According to Resnick (1987), high-order thinking is complex, requires mental efforts to result in meaningful outcome. The affordances of online discussion provide opportunities for learners to engage in high order thinking processes (Morse, 2003). CMC can support critical thinking, collaboration, and knowledge building (Harasim, 1989). Through engagement in high order thinking, students can acquire thinking skills that are necessary for mastering processes of thinking and learning that can be used in different situations in life (Wegerif, 2005). Thinking skills mostly refer to higher-order thinking skills or high quality thinking such as information processing, reasoning, inquiry, creative thinking and evaluation. Some would consider these skills separately and others consider them as various aspects of high-order thinking (Wegerif). To promote critical thinking collaborative argumentation has been used in online learning environments (Derry, Levin, Osana, Jones, & Peterson, 2000). Through the reasoning process in argumentation, learners can formulate their ideas and beliefs (Cho & Jonassen, 2002).

Online discussion then should be used as a method to develop students’ critical thinking skill. However for novice students, it can be difficult to engage in meaningful online discussions without support. Therefore, an aim of the features designed for the online discussion board system in this study was to assist students in their critical thinking process.

To examine critical thinking in online discussion, Newman et al. (1995) and Newman, Johnson, Webb, and Cochrane (1997) developed a set of critical thinking indicators based on Garrison (1992)’s five-stage problem solving process that includes problem identification, problem definition, problem exploration, problem evaluation/applicability, and problem integration. There are ten categories of indicators:
Relevance, Importance, Novelty, Bringing outside knowledge/experience to bear on problem, Ambiguities: clarified or confused, Linking ideas and interpretations, Justification, Critical assessment, Practical utility (grounding), and Width of understanding (complete picture). This set of critical thinking indicators is used in this study to examine students’ critical thinking in online discussion.

Cross-cultural Collaborative Learning in Online Discussion

Cross-Cultural Collaborative Learning

The benefits of cross-cultural collaborative learning are theoretically supported by Piaget’s socio-cognitive development theory where individual cognition is developed through resolving constructive conflicts. A multicultural learning environment may provide more opportunities for encountering such conflicts than a heterogeneous learning environment. Research has also shown that multiple perspectives are beneficial to complex problem solving (Lomi, Larsen, & Ginsberg, 1997). According to Stahl (2006), openness to and examination of multiple perspectives lead to creativity and novel results in group work.

Daniels, Berglund, and Petre (1999) described two cross-cultural collaborative projects. In one project, there was collaboration between Finish graduate students in a course called “Computer Aided Learning Environments” and French third-year students in “Network Learning”. Finish students were designing a Java course to teach to French students. In the other project, there were project groups with team members from America and Sweden; each team had six to eight students and the projects lasted from five to ten weeks, these students were all third or fourth year Computer Science students. The authors
concluded that the international experience was motivating to the students, however students’
level of efficacy in participating in such collaboration was more likely to be influenced by
their social and communication skills than by their technical skills. The authors suggested
providing “well-judged guidance” to students from the beginning.

Kim and Bonk (2002)’s study explored the cross-cultural differences in online
collaborative behaviors among undergraduate preservice teachers from different cultures. In
the first semester of the study, students and instructors from Finland and the US participated
in discussions in case situations or problems in school observations. Each country had their
own conference where they posted their cases and problems and others could participate in as
well. In the next semester of the study, Korean students were added to the collaborations. The
results indicated that US students tend to participate more in postings to others of different
cultures in the Finish conference than Finish students did in the US conference. The authors
used qualitative content analysis to analyze the discussion transcripts. The results showed
that there were differences in online collaborative behaviors between different cultures. For
example, Korean students were more socially and contextually driven while American
students were more action-oriented and pragmatic, while Finish students are more reflective,
group-focused and quite theoretically oriented. American students and Finish students also
spent a lot of time sharing knowledge and provide cross-cultural feedback. Students
expressed positive reaction toward their involvement with cross-cultural collaboration.

These studies showed differences in how students in different cultures may
collaborate with people from other cultures and the potential influence of factors like social
and communications skills and communication styles on cross-cultural collaboration. These
differences may be manifested in words and concepts students use to communicate with
Culture and Collaborative Learning

There are many definitions of culture in the literature. Kroeber and Kluckhohn (1952) reviewed a list of more than 200 definitions of culture and categorized them into six groups: descriptive, historical, normative, psychological, structural and genetic. Damen (1987) stated that “culture is learned and shared human patterns or models for living; day-to-day living patterns. These patterns and models pervade all aspects of human social interaction. Culture is mankind’s primary adaptive mechanism” (p. 367). In many definitions, the concept of culture is an active notion, not a passive notion (Vatrapu & Suthers, 2007). From Hofstede (1997)’s perspective of culture, culture is learned, not something people inherited. As people spend more time in other cultures, their cultural characteristics are changed as well (Morse, 2003). This is similar to what Vatrapu and Suthers (2007) suggested: an individual’s cultural biography “includes the interactive effects of the geography of that individual’s upbringing (ecology) and the formative experiences of his/her life (history)” (p. 262).

Influential work from Hofstede (1980) suggested different societies differ on four continuums of four social behavioral dimensions: Low Power Distance vs. High Power Distance, Individualism vs. Collectivism, Femininity vs. Masculinity, and High Uncertainty Avoidance vs. Low Uncertainty Avoidance. However, there since have been different cultural frameworks. For example, Ronen and Shenkar (1985) characterize different societies
by a set of attitudinal characteristics. Trompenaars (1993) also suggests different sets of attitudinal dimensions to characterize different societies.

In an analysis of how different cultural dimensions affect intercultural online collaborative learning, Vatrapu and Suthers (2007) discuss culture’s influence on behavior, communication, and cognition. First, the authors explained the relationship between culture and behavior based on Hofstede’s framework of four dimensions of culture: Low Power Distance vs. High Power Distance, Individualism vs. Collectivism, Femininity vs. Masculinity, and High Uncertainty Avoidance vs. Low Uncertainty Avoidance.

Power distance is the extent to which less powerful individuals expect and accept the unequal distribution of power (Hofstede, 1997). In low power distance societies, the learning environment is more often student-centered, teachers expect students to initiate communication, students may speak up spontaneously in class and are allowed to contradict or criticize teacher, effectiveness of learning is related to amount of two-way communication in class, and teachers are treated as equals outside class. On the contrary, in high power distance societies, the learning environment is often teacher-centered, students expect the teacher to initiate communication, students speak up in class only when invited by the teacher, students do not contradict or criticize teachers publicly, learning effectiveness depends a lot on teachers’ abilities and teachers are shown respect outside class as well.

The Individualism vs. Collectivism dimension is defined as the level at which a culture influences an individual’s dependence on self or the group. This dimension has implications for group interactions in collaborative learning. For example, Vatrapu and Suthers (2007) pointed out that even though according to socio-cognitive conflict theory, students should identify and discuss conflicts for effective collaboration, this works better in
an individualistic culture than in a collectivist culture where “consensual forms of intersubjective meaning making processes may be more prevalent” (p. 264).

The femininity vs. masculinity dimension refers to division of labor based on gender in a culture. This may affect interactions in groups as well. High uncertainty avoidance vs. low uncertainty avoidance dimension refers to how comfortable an individual feels towards uncertainty. This dimension may affect students’ perception of the online learning environment.

In addition, Hall (1976) suggested the Low Context vs. High Context Communication as a dimension to characterize differences in communication between different cultures. Later low context vs. high context also became an additional dimension in Hofstede’s framework. In low context cultures, information needs to be explicit in order to sufficiently convey meaning. In high context cultures, there is a high level of mutually shared information that implicitly provides background information to people in the conversation, which requires longer time to interpret to sufficiently convey meaning.

According to Hall and Hall (1990), in low context communication, the listener needs to know everything; in high context communication, the listener already knows a lot of background information. This dimension is very relevant in intercultural communication. Especially in a CMC environment, when communication between people depends on words rather than on environmental contexts for establishing shared meaning and interpretation, the influence of the low context/high context dimension in different cultures on communication can be even stronger (Cifuentes & Yu-chih, 2001).

In an exploratory study by Morse (2003) in a graduate level course, the author identified several cross-cultural differences between students in low context cultures and
students in high context cultures in this asynchronous learning environment (i.e. computer-mediated classroom) in terms of their perception of online discussion’s advantages and disadvantages, learning styles, and perception of learning effectiveness of a computer mediated course. When the data was analyzed, the study used cultural context as a separator and separated 24 students into two groups: a high context group and a low context group. There were three discussion groups in this study; each discussion group had eight students. The discussion groups participated in three discussions throughout the seminar course; each discussion lasted three weeks. The author found some difference between the high context group and the low context group regarding what they perceived to be advantages and disadvantages of participating in online discussions. The low context sub group liked the flexibility of the CMC environment which was independent of time and place while the low context sub group liked that they had time to think through their messages before posting. At the time, the low context sub group liked that they could reflect on others’ contributions more. Low context participants found that the medium introduced new ways of conveying their opinion, encouraged ability to feel at ease at an early stage of graduate development, and allowed individual opinions to not be interrupted by others. High context participants found that the medium helped them break language barriers, required contributions from them every day, and forced them to read relevant literature. In addition, the high context sub group focused more on their individual skills and efforts in the discussion while the low context sub group focused more on the participation environment. However, regardless of culture, both sub groups seemed to acknowledge the advantage of the asynchronous learning network and perceived higher quality and quantity of learning through online discussions.
In many cultural research studies, the culture concept is based on national/state culture; however, a broad range of research has indicated that national/state is artificial (Morse, 2003). According to Morse, ethnicity rather than nationality indicates cultural background and plays the key role in a person’s cultural and educational behaviors. Triandis (cited in Morse) defined ethnicity as “people who have culture, language, history and traditions in common” (p. 41). Parhizgar (1998) indicated that there are cultural differences in learning styles between different ethnic groups since learning styles are influenced by the standard behaviors and values in the society they live in.

Mainstream researchers in psychology held a belief in a “fundamental dissociation between cognition and culture” (Vatrapu & Suthers, 2007, p. 266). However, there are exceptions to this belief. In addition, there is empirical evidence that shows differences in cognitive processes between Westerners and East Asians in their cognitive processes like attention, perception, casual inference, knowledge organization and reasoning (Nisbett & Norenzayan, 2002; Nisbett, 2003). This difference prompts cultural-sensitive design of learning environment that can support cognitive processes of learners from different cultures.

The above review shows that cultural differences influence behaviors, communication, and cognition. However, there is little known about the implication of asynchronous learning networks to the cultural differences of the learners (Morse, 2003). These differences may influence the ways learners interact in online discussions. In addition, in a text-based environment like online discussions, students may not be aware of the cultural differences expressed in others’ online behaviors, communication, and thinking. As a result, important meanings conveyed and learning opportunities maybe lost. It is then important to enable online discussion participants to be aware of cultural differences expressed in online
discussion interaction. Therefore, in this study, the interactive intercultural elaboration features were designed to enable learners to be aware of these subtle cultural differences.

**Cross-Cultural Collaborative Learning and Intercultural Sensitivity**

Intercultural sensitivity is a part of intercultural communication competence (Chen & Starosta, 2000). There are three closely related but separate concepts: intercultural sensitivity, intercultural awareness, and intercultural communication competence (Chen & Starosta, 1996; Chen & Starosta, 1998). According to Chen and Starosta (2000), intercultural communication competence includes cognitive, affective and behavioral ability of an individual in the intercultural communication process. The cognitive aspect of intercultural communication competence is represented by the concept of intercultural awareness that refers to “the understanding of cultural conventions that affect how we think and behave” (cited in Chen & Starosta, 2000, p.3). The affective aspect of intercultural communication competence is represented by the concept of intercultural sensitivity that refers to the subjects’ “active desire to motivate themselves to understand, appreciate, and accept differences among cultures” (Chen & Starosta, 1998, p. 231). And the behavioral aspect of intercultural communication competence is represented by the concept of intercultural adroitness that refers to the “ability to get the job done and attain communication goals in intercultural interactions” (Chen & Starosta, 1996, p. 367).

Intercultural sensitivity, the affective component of intercultural communication competency, represents a person’s attitude. According to Chen and Starosta (1997), in order to be interculturally sensitive, individuals must possess the following characteristics: self-
Esteem, self-monitoring, open-mindedness, empathy, interaction involvement, and suspending judgment.

Encountering different cultures in a direct way may help to enhance intercultural sensitivity. This can be explained through Mezirow and Associates (2000)’s Transformative Learning Theory. One of the central points in this theory is the transformation of individual perspective and attitude when encountering different viewpoints. Through the interactive intercultural elaboration features examined in this study, the learners can have access to viewpoints from people from different cultures and therefore might be transformed and become more sensitive to cultural differences.

**Instructional Support and Scaffolding for CSCL**

Vygotsky (1978)’s concept of the Zone of Proximal Development (ZPD) has been used prominently in education to support the concept of scaffolding. Scaffolding learners means to provide learners with certain help to support learners who cannot achieve a task or understand something by themselves. A scaffold is supposed to help learners to achieve as task or understand something beyond their current level. Vygotsky’s approach emphasizes learners need for interactions with more advanced individuals in order to advance their cognitive development. When learners have similar cognitive developmental levels, it is important that learners are provided with scaffolding during their collaboration process in order to do an advanced task or to understand something new. According to Hogan and Pressley (1997), instructional scaffolding means to assist learners with minimal support and
fade this assistance gradually and increase learners’ responsibility and independence in doing an advanced task or understanding a new concept.

Understanding the processes in collaborative learning will help scaffold the collaboration by providing support for these processes (Jaervelae, Haekkinen, Arvaja, & Leinonen, 2003). For example, Scardamalia and Bereiter (1996) considered the cognitive mechanisms of social and individual aspects of knowledge building in order to provide cognitive scaffolding in CSCL. As discussed in one of the above sections, important processes in collaboration include meaning making (meaning creating, sharing, and interpretation or construction and co-construction of meaning), conflict resolving, negotiation and argumentation. Instructional scaffolding in collaborative learning should support these processes. For example, providing students with an argumentation framework may facilitate their argumentation process or asking learners to elaborate more on what they mean may facilitate the meaning making and negotiations processes.

From a dialoguing perspective, meaning making or construction and co-construction of meaning can be looked at as a circular movement of thought that involves internalization, meditation, and externalization (Wegerif, 2005). Internalization means the things that we have access to come inside our head and become implicit in our thought and actions. Externalization means to express what we know explicitly in a dialogue or a collaboration situation. In another way, the internalization process and the externalization process are mediated through technology. For example, in Vygotsky’s approach, language is an important technology through which meanings are internalized and externalized. “Vygotsky’s idea of how teachers work through a ‘zone of proximal development’ to help learners acquire new skills refers to the moment of internalization by individuals of pre-
existing cultural tools mediated by the scaffolding work of tutors” (Wegerif, 2005, p. 6). Hence, most approaches to teaching thinking have focused on the process of internalization. However, Wegerif suggests that “in any dialogue, moments of internalization and externalization are united in a flow movement of meaning” (p. 5). Therefore, he also suggests that it is also important to support the process of externalization in a collaborative situation. Scaffolding for externalization will help learners to express their ideas and construct their ideas in a collaborative context in a more meaningful ways. Internalization and externalization processes are always mediated by tools used in these processes. Educational technology can be designed to mediate the collaboration and enhance the quality of collaboration by supporting learners’ thinking (Wegerif).

In this study, two sets of online discussion features were designed to support students’ thinking and intercultural learning in the collaboration process: cognition supported features including a constraint-based discussion and an automatic-generated discourse map and interactive intercultural elaboration features.

**Supporting Cognition:**

**Making Thinking Visible via Constraints and Discourse Map**

In a previous section, issues of online threaded discussion were discussed. To summarize, issues include the lack of depth and coherence in online discussion and the lack of nonverbal cues in online discussion. The issue related to discussion quality (i.e. lack of depth and coherence or evidence for high order thinking) can be attributed to the available affordances of a standard discussion board and the limited metacognitive skills of novice
students. Issues related to a standard threaded discussion board’s affordances include the lack of clear relational structure for messages (except for a neutral hierarchical structure that indicate the replies to a certain message). This also means lack of support for students’ metacognition, as novice students have not developed an adequate schema to comprehend a complex discussion and sufficiently process the various bits of information presented to them in the discussion and as a result, they cannot contribute meaningfully.

**Constraints and Making Thinking Visible**

To respond to the above issues, constraint-based discussion board systems have been developed to facilitate critical and meaningful discourse. In these systems, students need to label the types of messages and responses based on the imposed constraints. Students are then presented with more information to add to the discussion schema and therefore may be able to contribute more meaningful messages. Labeling the messages should help students understand each message’s function and therefore be able to logically connect the messages together. In addition to messages labeling, Jonassen and Remidez (2002) also added the constraints of the message types that can follow a certain type of message. Using constraints is supported by cognitive research results which show that knowledge structures can assist information processing (Bossche et al., 2006). Cohen (1994) provides evidence that knowledge construction can be enhanced in a learning environment where learners are encouraged to articulate and structured ideas.

The idea of making thinking visible has been explored in literature. “From a cognitive point of view, it is particularly important to transform internal and hidden processes into a public form in which they can be examined and imitated” (Lehtinen, 2003). The
process of making internal thinking visible is the basis for the cognitive value of externalization in social interaction (Collins, Brown, & Holum, 1991; Lehtinen & Rui, 1996).

Computer-supported learning environments can be used to support the externalization process and making thinking visible. For example, the concept of constraint has been used in making thinking visible in different computer-supported learning environments: Hewitt (2002) and Scardamalia and Bereiter (1994) make the steps and contributions in the inquiry process visible; Lehtinen and Rui (1996) make the steps of decision making paths visible; Suthers, Erdoesne Toth, and Weiner (1997) make argumentation structure visible; Hakkarainen, Lipponen, and Jaervelae (2002) created a progressive inquiry model of computer supported learning to make the steps or elements of a research like process visible; Beers, Kirschner, Boshuizen, and Gijselaers (2005) make communication rules and negotiation framework to support grounding processes visible; Edelson and O’Neil (1994) make the steps of collaborative scientific inquiry visible in the CoVis Collaboratory Notebook, a shared and hypermedia database; Bell (1997)’s SenseMaker (part of KIE) makes expert thinking visible to provide a process to support individual reflection, promotes the collaborative exchange and discrimination of ideas (see Table 2.1).

Table 2.1. Making Thinking Visible in CSCL Environments

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Processes made visible</th>
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</thead>
<tbody>
<tr>
<td>Lehtinen &amp; Rui (1996)</td>
<td>Decision Path</td>
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<tr>
<td>Suthers et al. (1997)</td>
<td>Argumentation Structure</td>
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<tr>
<td>Hakkarainen et al. (2002)</td>
<td>Research Process</td>
</tr>
<tr>
<td>Beers et al. (2005)</td>
<td>Communication Rules and Negotiation Framework</td>
</tr>
<tr>
<td>Bell (1997)</td>
<td>Expert Thinking</td>
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</table>
Beers et al. (2005) used an online communication tool (NTool) with embedded support of grounding processes. This tool uses specific communication rules and constraints to achieve the purpose. It also makes users make their private understanding of others’ contributions visible. The article describes two studies: study 1 is a laboratory experiment with university students in their senior year; study 2 took place in a practical educational setting with second year students of secondary vocational education. Students in study 1 had more constraints in writing their messages than students in study 2. The results show that in study 1, high constraints support high common ground. However, this result reversed in study 2 where groups with low constraints achieved the most common ground. Analyses also show that the groups with lower constraints in both studies made significantly more contributions than the other groups. This implies a trade-off between the range of topics in the collaboration and the common ground achieved.

Barron (2003)’s study shows that teams where members critically explored each other’s thinking and explicitly accepted, agreed, and subsequently documented contributions to the discussion, ultimately generated better problem solutions. Scardamalia and Bereiter (1984) used sentence openers as procedural supports for children’s writing like skilled writers observed to do. This can also be seen as some types of constraints. The results showed that children gained planfullness and reflectivity.

Empirical studies have shown some evidence for positive effects of constraint usage on the level or high-order or critical thinking in the online discussion context. Cho and Jonassen (2002) found that using constraint-based discussion boards led to an increase in the generation of coherent arguments and the number of problem-solving actions. Comparing constraint-based discussion threads without using sequencing of message type constraints
and with the use of sequencing of message type constraints, Jeong (2003) found significant increases in the frequency of elaboration in replies to challenges when students used constraints in sequencing of message types but no significant increase in the number of challenges in response to an argument.

In Schaffer and Price (2005)’s study, there were six groups of students from two universities in the United States and the U.K. Among them 16 students were graduate students from a university the United States, enrolled in a Computer Assisted Learning course. They came from different majors and this was their first instructional design-related course. There were 29 students from the U.K., in a final-year course in the Interactive Multimedia major. Students in the two classes worked in different projects but six groups of students discussed the issues in their projects, with different levels of structure/support ranging from high structure/high involvement to low structure/low involvement from the faculty. Pre and post collaboration questionnaires and transcripts of group collaboration were analyzed to assess the development of cross disciplinary thinking and level of critical thinking. Using Fruchter and Emery (1999)’s four-dimension framework to assess the effectiveness of multi-disciplinary teams (the four dimensions include island of knowledge, awareness, appreciation and understanding), the author found that only students from structured groups report appreciation for other disciplines while none of the students from unstructured groups reach the level of awareness for other disciplines. Students with high prior knowledge and experience tended to participate more actively in the discussion and provide feedback to others while people with low prior knowledge and experience often just wrote one or two line messages. The level of group structure and instructor support did not matter here to students with high prior knowledge and experience. In addition, and Wu and
Hiltz (2004) suggested that those “who have taken prior online courses should be more familiar with the process of online discussions and thus should feel less anxiety and uncertainty, resulting in higher motivation and higher enjoyment” (p.142). Therefore, students with higher prior experience on online discussion might also potentially demonstrate better participation in online discussion in terms of both quantity and quality than students with low prior experience in online discussion.

Moore and Marra (2005)’s study involved 37 graduate students in two course sections. The students were required to contribute to the online discussion of an instructional design case study. The two sections used different discussion protocols. In one section, students used a constructive argumentation (constraint-based) approach while in the other section, students used a less structured approach. The authors analyzed the discussions using content analysis and used the Interaction Analysis Model (IAM) as the analysis protocol. The results revealed that in both sections, the discussions demonstrated co-construction of knowledge; however, the less structured section “reached the highest phase of knowledge building” (p.). The researchers also found the task-oriented nature of the discussion and the more structured approach (constructive argumentation) influenced the interactions and co-construction of knowledge.

Although most of these studies showed evidence for positive effect of constraints in online discussions, Moore and Marra (2005) showed that students in less structured online discussions reached higher phases of knowledge building than students in a more structured section. This leads to the need for more empirical evidence to support the use of constraints in learning and the conditions and criteria in which it works. In addition, there is also a need for further investigation in whether or not prior knowledge and experience and prior
experience in online discussion has an influence on the effects of constraint-based discussion on students’ performance in online discussion.

**Constraint-Based Discussion Boards**

In the past ten years, there have been various discussion board tools that employ one form of constraint or another (see Table 2.2). According to Bell (1997), there are two types of tools that support argumentation construction: discussion-based tools supporting a group’s dialogical argumentation (e.g. CSILE, SpeakEasy) and knowledge representation tools supporting individuals’ construction of rhetorical arguments (e.g. Euclid, Belvedere). Jonassen and Remidez (2005) presented the findings from discussion board activities based on a problem solving discourse structure with twelve types of messages categorized into four levels: problem, proposal, warrant, and evidence. In their study, participants included 21 adult learners in a graduate class called “Computers as Mind Tools”. Participants used the constraint-based discussion board to solve a problem in a week. The study did not compare the constraint-based discussion board and the standard threaded discussion board but rather answered two questions: “Could students use this type of discussion board effectively?” and “Could students label the messages accurately?” The results show a cautious yes to the first question and an overall yes answer to the second question.

Multimedia Forum Kiosk (MFK) is a discussion tool that promotes scientific discourse. Its unique feature is to provide “two unique, structured representations about a specific topic in science” and allow students “to explore multimedia evidence for their views” (Hsi & Hoadley, 1997, p. 25). There are two graphical representations of discourse in MFK: an Opinion Area and a Discussion Area. The Discussion Area features argument
maps that display questions, disagreements, and lines of reasoning. The labels of the nodes in the argument map include “and”, “or”, and “but”. These labels are loosely based on discourse theory from Bales (1970), designed to force students “to compare their own ideas to those of others and to reflect more carefully on arguments made before extending the discussion”. In Hsi and Hoadley’s study using the MFK, middle school students from a public school participated in an experimental physical science curriculum. There were six class periods with a total of 165 students used MFK during an 18-week curriculum (heat, light, sound and energy). The online discussions were characterized by a high level of scientific conceptual content, elaboration, and question asking. These characteristics of the online discussion were demonstrated through the student-generated models of the phenomena under investigation, the causal explanations and the content-focused questions asked by the students in the discussion. The results show that there were equal learning opportunities for both genders through generating explanations, revising others’ ideas, and asking questions: more students participated in online discussion compared to only 15.3% students who participated in class discussion. In online discussion, females participated more than males did while males participated more than females in class discussions. Girls felt less stifled when anonymity is an option in online discussions.

Covis Collaboratory Notebook is a shared, hypermedia database (Edelson & O’Neil, 1994). This notebook supports the collaborative scientific inquiry (e.g. investigating weather and climate related phenomena) in high school science learning. In this system, students can create three types of notebooks: private journals, project notebooks, and discussion notebooks which can be viewed by everyone. The constraint system used in this is a system of page types for a notebook. Types of pages include information, commentary, question,
conjecture, evidence for, evidence against, plan, step in plan. Page types provide both content description and relationship to other pages. This constraint system follows a process model of inquiry and thereby creates a supporting structure for collaborative inquiry. Students can develop the inquiry through the Notebook’s interface through the framework of collaborative inquiry embedded in the notebook. Through this system, the collaborative inquiry process is made explicit. In a study using this Notebook, 118 students in six high school classes created 59 notebooks containing a total of 352 pages. The results are descriptive and show positive evidence of knowledge construction.

CSILE (Computer Supported Intentional Learning Environment) was developed by Scardamalia and Bereiter (1991)’s group. Various studies have been done using this learning environment. This collaborative learning environment has been used mostly in elementary and middle schools. In this environment, learners can create their notes (texts and graphics) and others can comment on their notes. The author of a note is notified when that note is commented on. Students will gain experience of reflecting and refining their thoughts as they read and respond to others’ comments. One critical feature of this system is that students need to label their note with one of the following labels before they can save and retrieve the note: Problem, My Theory, I Need to Understand, New Information. This environment is much more than a discussion board (it is conceptualized as a database where students can create, search, organize and comment on notes) but the idea of labeling note in CSILE is essentially the same as the idea applied in constraint-based discussion boards where students need to label their messages. CSILE supports generating good questions to encourage knowledge building through providing external support to higher cognitive processes and making metacognitive activity visible by labeling notes with thinking types.
Novice learners often have problems formulating good questions that lead to productive knowledge construction (Scardamalia & Bereiter, 1991). In Scardamalia and Bereiter’s study, participants are students in grade 5-6 in an inner elementary school serving an ethnically and socioeconomically heterogeneous population. The authors used a four-level knowledge advance rating scale to rate the quality of questions generated in CSILE. Students seemed to engage more readily in the divergent processes of knowledge building such as generating questions, hypotheses, and relevant information, but needed help in convergent processes like pruning information, synthesizing information, deep explanation. Scardamalia and Bereiter (1993) presented some findings regarding the use of CSILE among grades 1-6 students. Compared to controlled-group students, CSILE enhanced learning of students who used this environment in terms of standardized achievement tests of reading and language, portfolio selections and learning commentaries in the area of writing, mathematics, and science, comprehension of difficult text and transfer of learning to novel problems, graphical literacy, depth of explanations in students’ written reports, beliefs about learning consistent with a progressive view of knowledge advancement.

In Bell (1997)’s study of the use of the argumentation tool SenseMaker (a component of KIE, Knowledge Integration), participants included approximately 800 middle school students who used the SenseMaker software in their classroom projects. SenseMaker used the following structure for scientific arguments: evidence, claims and explanations. Results show that students seemed to be able to construct conceptual knowledge and scientific arguments through the use of SenseMaker. Results also show that SenseMaker facilitated meaningful collaboration by making thinking visible between individual participants (by categorizing evidence into frames and rating the quality of evidence items). SenseMaker
hence promotes both collaborative learning and individual learning. However, in this study, there was no comparison group.

Table 2.2. Systems with a Constraint-Based Discussion Component

<table>
<thead>
<tr>
<th>System</th>
<th>Characteristics</th>
<th>Learners</th>
<th>Effects</th>
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<tbody>
<tr>
<td>Constraint-Based Discussion Board from Jonassen &amp; Remidez (2005)</td>
<td>Use a problem solving discourse structure with twelve types of messages categorized in four levels</td>
<td>21 graduate students, in a graduate class called “Computers as Mind Tools”</td>
<td>No comparison between the constraint-based discussion board and the standard threaded discussion board</td>
</tr>
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</table>
| Multimedia Forum Kiosk from Hsi & Hoadley (1997) | - Have two graphical representations of discourse: an Opinion Area and a Discussion Area  
- The Discussion Area features argument maps that display questions, disagreements, and lines of reasoning  
- Nodes of the argument map labeled “and”, “or”, “but” | 165 middle school students used MFK during an 18-week curriculum of heat, light, sound, and energy | No comparison between this system and a standard system  
Online discussions had a high level of scientific conceptual content, elaboration, and question asking |
| Covis Collaboratory Notebook from Edelson & O’Neil (1994) | - Shared, hypermedia database  
- Support collaborative scientific inquiry  
- 3 types of notebooks  
- Students can label a notebook’s pages with page types: information, commentary, question, conjecture, evidence for, evidence against, plan, step in plan | 118 high school students in six high school classes | No comparison between this system and a standard system  
Descriptive results showed positive evidence of knowledge construction |
<table>
<thead>
<tr>
<th>System</th>
<th>Characteristics</th>
<th>Learners</th>
<th>Effects</th>
</tr>
</thead>
</table>
| CSILE (Computer Supported Intentional Learning Environment) from Scardamalia & Bereiter’s group | - Students can create their notes (texts and graphics) and others can comment on their notes  
- Students need to label their notes with one of the following labels: Problem, My Theory, I Need to Understand, New Information  
- Also conceptualized as a database | Elementary and middle school students                                         | Compared to students who did not use the system, CSILE enhanced students’ learning in many aspects |
| Sense Maker from Bell (1997)  | - An argumentation tool  
- Use the following structure for scientific arguments: evidence, claims, and explanations | 800 middle school students          | There was no comparison group  
Students seemed to be able to construct conceptual knowledge and scientific argument through the use of Sense Maker |
| Structured discussion board from Aviv, Erlich, Ravid, & Geva (2003) | - Used a moral decision making model to structure the discussion | University students                  | - Compared to the non-structured group, the structured group reached a higher level of cognitive activity.  
- The difference was statistically significant |
<table>
<thead>
<tr>
<th>System</th>
<th>Characteristics</th>
<th>Learners</th>
<th>Effects</th>
</tr>
</thead>
</table>
| Structured discussion board from Brooks and Jeong (2006) | - Used a collaborative argumentation model  
- Students needed to label their messages as arguments, challenges, supporting evidence, and explanations on a threaded discussion board | 30 graduate students | - There were a control group where students were not required to label their messages  
- There were 64% challenges generated per argument in the pre-structured group than in the control group  
- There were no significant differences found in the mean number of counter-challenges, supporting evidence, and explanations posted in replies to challenges |

In Aviv, Erlich, Ravid, and Geva (2003), the participants include students in two three-month long ALN academic university courses in Israel: a formal, structured, closed forum and an informal, nonstructured, open forum. The courses’ subject is Business Ethics. The results show that in the structure ALN, the knowledge construction process reached a very high phase of critical thinking while in the non-structured ALN, there was a low level of cognitive activity. The differences are statistically significant. The structured ALN used Geva (2000)’s moral decision making model to structure the discussion. Messages were analyzed using the Interaction Analysis Model that includes the following phases: sharing/comparing information, discovery of disagreement/inconsistency, synthesis via
negotiation of meaning, testing against prescribed principles, and summary/application of
knowledge (Scott, 2001).

In Brooks and Jeong (2006)’s study, 30 graduate students participated in online
discussions (in this case collaborative argumentation) with 16 students in the pre-structured
discussion group and 14 students in the control group. In the pre-structured group, students
needed to label their messages as arguments, challenges, supporting evidence, and
explanations on a threaded discussion board. In the pre-structured group, students were
required to post supporting and opposing arguments. In the control group, students were not
required to do so. The result shows that there were 64% more challenges generated per
argument in the pre-structured group than in the control group. This implies that pre-
structured discussions can increase the frequency of constructive conflict and therefore
potentially lead to more critical discourse. However, there were no significant differences
found in the mean number of counter-challenges, supporting evidence, and explanations
posted in replies to challenges.

Even though there are quite a few applications of constraint-based collaborative
systems as reviewed above, there are few experimental studies to study the effects of
constraint-based discussion boards and the standard threaded discussion board. In the 1990s,
most studies had participants from a middle school or high school context. After 2000, there
have been studies of constraint-based discussion boards with college students and graduate
students as participants but only a few studies have comparison groups. There are only a few
studies that focus on the level of critical thinking and the level of knowledge construction in
the context of constraint-based discussion boards. More empirical evidence is needed to
understand the benefits of constraint-based discussion board on student learning and the
conditions in which it works. In addition, from an instructional design perspective, it would be meaningful to know which types of discourse lead to a high level of knowledge construction in an online discussion context. The results will have implications for the designing of discussion board activities to promote critical thinking of subject content. Currently, there seems to be no study that looks at this issue.

Therefore, this study examines empirically the effects of constraint-based discussion board combined with a discourse map in order to further understand the effect of constraint-based discussion on students’ knowledge construction and critical thinking. In addition, to understand better which types of discourse lead to a high level of knowledge construction in an online discussion context, two types of discussion frameworks are examined in terms of knowledge construction in constraint-based discussions that use these two frameworks.

*Cognitive Benefits of Visuals in Learning*

Visuals have been known to assist learners in comprehending complex information since it allows the learners to see the relationships between different things in a graphical format. This is supported by Information Processing Theory. Using visuals to represent structure of the discussion (e.g., using a discourse map) can help learners visualize the entire discussion along with the relationships between messages in a clear picture, therefore prompting subsequent meaningful contributions (Buckingham Shum, MacLean, Bellotti, & Hammond, 1997). It also helps learners identify important ideas and have a logical flow of the discussion in their head (Suthers & Jones, 1997).

Limited literature on the effects of discourse maps in an online discussion context prompts for more empirical studies in this area. Specifically, the proposed study will look at
the combined effects of a constraint-based discussion board with discourse map on students’ level of critical thinking and group knowledge construction. These scaffoldings may support different processes in collaboration by providing students with organizers of the complex discussion information as well as making higher order thinking processes visible to students throughout the discussion.

Interactive Intercultural Elaboration as an Explanation Strategy for Facilitating Intercultural Communication and Interpretation

In discourse, there is tacit information in the background which is not made explicit and the co-construction of knowledge also involves the negotiation of these tacit meanings (Stahl, 2006). As discussed in an above section, it is a challenge for learners to establish common ground in an online environment. It is even more of a challenge when the online discussion participants come from different cultural backgrounds (Jaervelae et al., 2003). According to socio-linguistics researchers, to enhance the process of creating mutual understanding, it is important for the speakers to be aware of the addressees’ knowledge base (i.e. what the addressees know and what they do not know) (Graumann, 1995). This assumption should also be applied in asynchronous online communication when constructing messages (Jaervelae et al.). This part will discuss the interactive intercultural elaboration as an explanation strategy for facilitating intercultural communication and interpretation and thereby supporting learners in a multicultural learning environment to establish common ground in their discussions.
When there are multiple perspectives, it is important for team members to achieve a common ground in order to take advantages of the multiple perspectives (Beers et al., 2005).

Therefore, in an online discussion with participants coming from different cultures and who may not be used to cross-cultural interactions, it may be beneficial to design online discussion features that help students in achieve common ground and at the same time be aware of the cultural nuances of these multiple perspectives.

**Explanation and Elaboration**

Explanation can advance individual cognition, learning and conceptual understanding (Lehtinen, 2003; Hatano & Inagaki, 1992; Webb, 1991). When explanation is done in a group context, the process becomes interactive as the explanation is constructed jointly by the group (Baker, 1991). As the learner explains their ideas to others, they need to first form a better mental model of their ideas in their heads (i.e. to organize and reorganize the existing knowledge) (Lehtinen; Hatano & Inagaki). In other words, they need to externalize their ideas and understanding into verbal means (whether oral or written or non-verbal gestures); through this process, the cognition model of the ideas and knowledge will be enhanced. In a collaborative situation, these externalized ideas and understanding will be further elaborated by their teammates. This has been demonstrated through different instructional models, for example, the Reciprocal Teaching model of Palinscar and Brown (1984), where externalization of students’ mental processes is important in the development of metacognitive skills. This model has been shown successful through many empirical studies (Jaervelae, 1996). In reciprocal teaching, a learner needs to learn to understand given materials and then explain and teach the materials back to his or her partner.
Although there is not really any study on the effects of explanation in online discussion boards, the benefits of explanation have been shown in other contexts. Webb (1991) performed a meta-analysis of the research that focused on the level of elaboration in the explanation provided by one learner to another. Results from this meta-analysis show that elaborated explanations are positively correlated with the explainer’s performance. Self-explanation has a positive effect on an individual’s learning (Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

Since explanation and elaboration are beneficial strategies for learning, in this study, explanation and elaboration are integrated into set of features called interactive intercultural elaboration features that students use to explain their understanding of certain words to others.

**Interactive Intercultural Elaboration**

Interactive Intercultural Elaboration refers to a strategy in which learners explain what certain things may mean in their culture. These explanations can be viewed by other learners in a multi-cultural group. Students can revise their explanation any time they want. These revisions can be prompted by looking at others’ explanations or by reflecting more on their own explanations. Interactive Intercultural Elaboration may lead to deeper learning as the learners understand more of the cultural nuances embedded in posted messages. This strategy makes explicit the cultural-based meanings that are often hidden in a neutral, culture-free online discussion environment. This potentially facilitates the meaning making process in cross-cultural collaboration. As learners have encounters with multiple perspectives, this can also lead to creativity in group discussion (Stahl, 2006). At the same
time, access to perspectives of people from different cultures may increase learners’
intercultural sensitivity, the affective component of intercultural communication competence.
Intercultural sensitivity is defined as a person’s “active desire to motivate themselves to
understand, appreciate, and accept differences among cultures” (Chen & Starosta, 1998, p.
231).

Based on positive findings of the effects of explanation in learning and the known
benefits of multiple perspectives, with the use of interactive intercultural elaboration features,
students may engage in many intercultural learning opportunities and as a result, their
intercultural sensitivity may be enhanced. Therefore, this study also focuses on the effects of
interactive intercultural elaboration on students’ intercultural sensitivity.

**Summary**

Based on literature review, Figure 2-1 represents the theoretical framework of this
study. Research shows both benefits and challenges of online discussion as a collaborative
learning activity. Online discussion is especially challenging for novice college students who
have limited metacognitive skills as well as limited knowledge of the subject domain. With
limited metacognitive skills, it would be challenging for novice students to engage in high-
order cognitive activities and as a results, participate meaningfully in online discussions. In
addition, in an online discussion with participants from different cultural backgrounds, the
text-based nature of online discussion medium and the cultural differences between
participants may make it even more difficult to establish common ground and shared
understanding than in an online discussion with participants from the same culture, especially
if the participants do not have or have little experience with cross-cultural interaction. Therefore, the discussion board system in this study was designed to address these issues.

![Theoretical framework](image)

**Figure 2-1. Theoretical framework**

Since the literature has shown theoretical and some empirical evidence for the positive effect of the use of constraints and visuals in online discussion to assist students in their thinking process by making thinking visible, cognition-supported features including a constraint-based discussion and an automatically generated discourse map were designed. Since the literature has also shown benefits of explanation and elaboration in student learning, the interactive intercultural elaboration features were designed in an effort to assist
students in establishing shared understanding and intercultural learning, as a result, hopefully enhance their intercultural sensitivity, which is much needed in this world. Based on the literature review in this section, it can be observed that there is need for more empirical studies examining the use of constraint and discourse map representing an online discussion in college classrooms and for more understanding of designing effective online discussion activities for students coming from different cultures. Therefore, this study focuses on examining the effects of cognition supported features including a constraint-based discussion combined with a discourse map on students’ knowledge construction and critical thinking and the effects of intercultural elaboration features on students’ intercultural sensitivity. In addition, the researcher also questions whether or not students’ prior knowledge and experience in the subject domain and prior experience in online discussion influence the effect of cognition-supported features on students’ knowledge construction and critical thinking and whether or not students’ prior cross cultural experience influences the effect of interactive intercultural elaboration features on students’ intercultural sensitivity. Two different discourse structures are compared to examine how different types of discourse structure may influence students’ knowledge construction in a constraint-based discussion.
CHAPTER 3
RESEARCH METHODOLOGIES

The purpose of this research was to study the effects of cognition-supported features and interactive intercultural elaboration features integrated into a multicultural discussion board environment. Specifically, the study tested the effects of cognition-supported features that combined a constraint-based discussion via a discourse structure with an automatic generated discourse map on students’ knowledge construction and critical thinking in online discussions. In addition, the influence of students’ prior knowledge and experience with the subject domain and students’ level of prior experience with online discussion inside and outside of classroom context was also examined. Second, the study tested the effects of interactive intercultural elaboration features on students' intercultural sensitivity. The influence of students’ prior cross cultural experience was also examined. Next, the study also sought to describe the levels of student knowledge construction when given discussion scenarios using different discourse structures, and lastly, to compare knowledge construction and critical thinking in the four different types of discussion boards: no special features, cognition-supported features, interactive intercultural elaboration features, and combined cognition and intercultural features.

Pilot Study

The purpose of the pilot was to refine the research procedures. The pilot study was conducted in a large introductory course in Business Communications at a large public
university of about 22000 students in Australia. The course was selected for the study since its content was conducive for online discussion and the student population in the course was culturally diverse. This course introduced students to the theory and practice of communication in business and in the workplace.

There were 209 students in this Business Communications course. Students were asked to participate in online discussions in groups of nine to ten students making up 23 discussion groups. These groups were formed by randomly assigning students to different discussion groups while assuring similar level of cultural diversity in the different discussion groups. The 23 discussion groups were then divided into four treatment groups, each using one type of discussion board: 1/standard threaded discussion board; 2/discussion board with the cognition-supported features; 3/discussion board with the interactive intercultural elaboration features; and 4/discussion board using both cognition and cultural features. Five discussions groups used the standard threaded discussion board, and six discussion groups used each the other three types of discussion board. Students participated in six discussions, each lasting a week. Each discussion was course-related and about business communication-related issues.

The discussion board activity was a voluntary activity and not graded. Therefore, students’ participation was none to very limited. Due to the low participation from students, there was insufficient data for studying the effects of the different features in the discussion board and how students use the features. The main lesson from this pilot study was that the discussion activity needs to be required and given appropriate credit or emphasis students to motivate students to participate. Undergraduate students normally have low motivation in writing as well as class activities that are not required or given any course credit.
Main Study

Participants

Participants in this study were college students at an Ivy League university in the northeastern United States who were enrolled in an introductory class on social psychology during the Fall 2008 semester. At the beginning of the semester, there were 112 students in this course. However, five students dropped by the end of the semester. Of the remaining 107 students, 103 students consented to participate in the study.

Since the online discussion activity was a required class assignment, the beginning of the class, all students (including both research participants and non research participants) were divided into 14 small online discussion groups of eight students. A stratified random assignment approach was employed to ensure approximately similar levels of cultural diversity in each small discussion group. The 14 small discussion groups were randomly divided into two big groups called Group 1 and Group 2, differentiated by the type of supporting features each group used during the experimental period of the study. Therefore, in each of these big groups, there were seven small discussion groups.

Students in this course had different cultural backgrounds. Therefore, the student sample was suitable for the study’s context of a multicultural learning environment. As shown in Figure 3-1, among these 103 students, 90 students or 87% of the students had United States as the primary country of upbringing and 13 students or 13% of the students had other countries as the primary country of upbringing, with 8% of the students brought up in Asian countries and 5% of the students brought up in Canada, Mexico and Australia. In
addition, nine students had more than one primary country of upbringings (in the United States, Asia, Europe, and the Caribbean Sea).

Figure 3-1. Students’ countries of upbringing

Although the majority of students in this course were brought up in the United States, their ethnic origins were very diverse. As shown in Figure 3-2, among these 103 students, 49 students had United States as their primary country of ethnic origin while 54 students had other countries as their primary country of ethnic origin. More specifically, 47% of the students had United States origins, 21% of the students had Asian origins, 12% of the students had Western European origins, 8% of the students had Eastern European origins, and the remaining 12% had ethnic origins from the Caribbean Sea, South America, Mexico, Canada, Iran, and Australia. In addition, 15 students had more than one primary country of ethnic origin with the second ethnic of origin in areas like Mexico, Africa, Asia, Europe, the Caribbean Sea, and Native American.
The 103 research participants ranged across various levels of classification in their undergraduate studies. As seen in Figure 3-3, the highest percentage of the students (40% or 41 students) were second year students. 27% and 24% of the students were fourth year students and third year students respectively. The lowest percentage of the students (9%) were first year students. The research participants included 66 females (64%) and 37 males (36%) (see Figure 3-4).
In summary, the study sample was diverse in terms of cultural background, undergraduate classification, and gender.

**Context for the Study**

**Course Selection Criteria**

An Introductory Social Psychology course was selected for running this study because it had a diverse population of students. The course was also suitable for online discussion activities due to its content and objectives. In addition, this was a large course which was advantageous for running an experimental study. Due to the large number of students in the course, it was not feasible for all students to communicate and share their opinions on the course topics during class time. Therefore, an online discussion activity could be beneficial for students because it could provide a shared online space that they could use to discuss class topics outside of class time in order to review and strengthen what they learned in class.
**Course Description**

This social psychology course provided students with an overview of theories and research on social behavior on both individual and group levels along with social psychology’s real world applicability. Examples of course topics included the influence of situational contexts, obedience and conformity, aggression, persuasion, attitudes and behavior, judgment and decision making, and prejudices.

The online discussion activity was a required class assignment for all students in the course. Students’ participation in the online discussion board contributed to 5% of the final grade. Other assessment activities included three exams (one of them was the final exam), each worth 25% of the final grade, and one paper that was worth 20% of the final grade.

**Online Discussion Activities**

Students in the course participated in eight one-week discussions for eight weeks, starting from Week 4 of the semester to Week 13 of the semester. There was no discussion during Week 6 due to the university’s fall break and students had both Week 12 and Week 13 for the last discussion due to Thanksgivings break. Each week, after the lecture, a new discussion topic was posted to the discussion board. Each student was required to post at least three messages throughout the week for each discussion. The students were given specific guidelines for online discussion postings in terms of procedures and general expectation of how the postings should be written. Appendix A includes these online discussion guidelines.
Treatment Materials

Discussion Topics

The discussion topics were created by the course instructor and were relevant to the course content. Each topic was related to what had been recently taught during in class lectures. Table 3.1 includes all the eight discussion topics given to students throughout the semester and discourse structures used in those topics when cognition-supported features were available. Before participating in the first discussion, students needed to introduce themselves in a warm-up discussion to get to know each other.

Table 3.1. Discussion Topics

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Topic Description</th>
<th>Discourse Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Conformity and the Power of Situations</strong></td>
<td>No discourse structure was used</td>
</tr>
<tr>
<td></td>
<td>Research on conformity, such as Milgram's obedience studies and Zimbardo's prison simulation, indicates that under certain conditions people who are otherwise moral and decent are capable of engaging in acts of considerable cruelty toward others. First, discuss what issues do these findings raise regarding the problem of holding individuals responsible for their actions? Second, given our understanding of the power of situations in influencing behavior, can you think of ways of using this knowledge to reduce the likelihood of conformity-based acts of cruelty in prisons, such as Abu Ghraib?</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Topic Description</td>
<td>Discourse Structure</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>2</td>
<td><strong>Becoming a Peaceful Adult</strong>&lt;br&gt;You are the parent of a young child whom you would like to see become a peaceful, affectionate, and cooperative adult. To achieve this goal, to what extent would you consider taking the following steps?&lt;br&gt;a) preventing your child from watching violent television shows;&lt;br&gt;b) preventing your child from playing with &quot;violent&quot; toys such as guns, swords, etc.;&lt;br&gt;c) preventing your child from playing with aggressive children;&lt;br&gt;d) preventing your child from fighting back, if another child kept bullying him or her.&lt;br&gt;Apart from these strategies, is there anything else that you would do to increase the odds that your child becomes a peaceful, affectionate and cooperative adult? Finally, would you want to eliminate all aggressive behavior in your child? Why or why not? Discuss your decisions and the reasoning behind them.</td>
<td>No discourse structure was used</td>
</tr>
<tr>
<td>3</td>
<td><strong>Discussion 3: A Society free of prejudice?</strong>&lt;br&gt;Is everyone prejudiced to one degree or another? That is, is it possible to be entirely free of prejudice in our society? Why do you think that this is or is not the case? How could people become more aware of the subtle ways in which they hold or express prejudiced beliefs and behavior? Describe any experiences you might have had in which you suddenly realized you were acting or feeling prejudiced towards another person or group. What were your feelings upon discovering this about yourself?</td>
<td>Argumentation discourse structure</td>
</tr>
<tr>
<td>Discussion</td>
<td>Topic Description</td>
<td>Discourse Structure</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>4</td>
<td><strong>Discussion 4: Self esteem and life satisfaction of women</strong></td>
<td>Argumentation discourse structure</td>
</tr>
<tr>
<td></td>
<td>Consider the self-esteem of women. Given that some women experience a significant amount of overt prejudice and prejudice-related negative outcomes in their daily life, how do you think the responses of women compare to the responses of men when asked how satisfied/happy they are with their lives? Answer this question according to each of the following perspectives or tendencies (i.e., what would the following concepts lead you to predict?):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) &quot;looking-glass self&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) downward social comparisons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) self-serving attributional biases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some empirical evidence suggests that the self-esteem and life satisfaction of women are not significantly different from those of men. Given that fact, which of the 3 concepts that you considered seem to be most influential in the self-concept formation of women?</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Discussion 5: Weaknesses of human decision making</strong></td>
<td>Argumentation discourse structure</td>
</tr>
<tr>
<td></td>
<td>Imagine that you were writing a proposal for a book about what is wrong with human decision making and how to fix it. What are the main weaknesses of human decision making that you would emphasize? How would you suggest that people could go about improving their decision-making?</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Topic Description</td>
<td>Discourse Structure</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Discussion 6: Rewarding System and Cognitive Dissonance</td>
<td>Elementary-school teachers often use a reward system (such as offering children small prizes) in order to motivate their students to do well on their schoolwork and to maintain discipline in the classroom. Based on your knowledge of cognitive dissonance theory, what are the possible drawbacks of relying on such a system? Do you think such systems should be avoided all together? What steps could teachers take to avoid or counteract these potential negative effects?</td>
<td>Argumentation discourse structure</td>
</tr>
<tr>
<td>Discussion 7: Persuasion</td>
<td>To the best of your knowledge, how easily are you influenced by attempts to change your attitudes or behavior? Under what conditions are you more or less likely to be persuaded? Do you think your knowledge about strategies of persuasion can help you resist unwelcome attempts at persuasion? Since we live in an age of mass communication - in which we are subject to a daily onslaught of influence attempts - should children receive some kind of formal training or education about persuasion? Why or why not?</td>
<td>Argumentation discourse structure</td>
</tr>
<tr>
<td>Discussion 8: Contemporary Problems and Culture</td>
<td>What contemporary problems can you identify where an understanding of cultures may improve our capacity to improve the situation? Provide explanations for your opinions.</td>
<td>Problem Solving discourse structure</td>
</tr>
</tbody>
</table>

**Online Discussion Board**

The online discussion board system was designed, developed and programmed by the researcher for this study to provide discussion support for crafting messages and understanding peers from different ethnic orientations. These two types of discussion
supports are called “Cognition-Supported” features and “Interactive Intercultural Elaboration” features.

**Cognition-Supported Features**

Two types of cognition-supported features programmed into the discussion environment included a Constraint-Based Discussion and a Discourse Map. The constraint-based discussion feature provided in this discussion board asked students to label their message according to the message types necessary for coherent discussion in a specific type of discourse (message types are based on a specific discourse structure) and then the discourse map allows them to visualize their group’s discussion structure.

**Constraint-Based Discussion Feature**

Planning

- Each discussion topic was classified by type of discourse structure by the instructor and researcher. Two discourse structures were identified for use in this study: Argumentation framework based on Toulmin (1969)’s Argumentation model and Problem Solving framework adapted from Polya (1957)’s problem solving framework. These two discourse structures and their components are described in Table 3.2.

- The discussion board was then adapted according to the selected discourse structure (the discussion’s constraints were based on the selected discourse structure).
### Table 3.2. Discourse Structure

<table>
<thead>
<tr>
<th>Discourse Structure</th>
<th>Types of Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Argumentation</strong></td>
<td><strong>Claim/Reason</strong></td>
</tr>
<tr>
<td></td>
<td>In this combined message type, you state the position on the issue or the claims being argued for and identify the reasons for your claims or other students’ claims.</td>
</tr>
<tr>
<td></td>
<td><strong>Grounds</strong></td>
</tr>
<tr>
<td></td>
<td>In this type of message, you identify the reasons or supporting evidence for your claim or other students’ claim. Reasons and supporting evidence can include facts and statistics, personal opinion and belief, personal experience and observation, theory and law, others’ experience, and common knowledge.</td>
</tr>
<tr>
<td></td>
<td><strong>Warrant</strong></td>
</tr>
<tr>
<td></td>
<td>In this type of message, you identify why certain reasons or grounds support a claim. It is the underlined belief, value or principle that you have to hold for the connection between a claim and a reason or an evidence to make sense.</td>
</tr>
<tr>
<td></td>
<td><strong>Backing</strong></td>
</tr>
<tr>
<td></td>
<td>In this type of message, you identify justifications and reasons to back up a warrant. A message of Backing type should only follow a message of Warrant type.</td>
</tr>
<tr>
<td></td>
<td><strong>Rebuttal</strong></td>
</tr>
<tr>
<td></td>
<td>In this type of message, you identify exceptions to your claims/reasons/grounds/warrant or objections and counterarguments to other students’ claims/reasons/grounds/warrant. You can give a description of counter-examples and counter-arguments or give a rebuttal of counter-examples and counter-arguments.</td>
</tr>
<tr>
<td></td>
<td><strong>Reasons/Ground</strong></td>
</tr>
<tr>
<td></td>
<td>In this combined message type, you include both Reasons and Grounds for your claims (click on Grounds to view the description of Grounds message type).</td>
</tr>
<tr>
<td></td>
<td><strong>Warrant/Backing</strong></td>
</tr>
<tr>
<td></td>
<td>In this combined message type, you include both Warrant and Backing to support the connection between Claims and Reasons/Grounds (click on Warrant or Backing to view their descriptions separately).</td>
</tr>
<tr>
<td></td>
<td><strong>Qualification</strong></td>
</tr>
<tr>
<td></td>
<td>In this type of message, you specify the limitations of claim, warrant and backing (i.e. the strength of an argument).</td>
</tr>
<tr>
<td>Discourse Structure</td>
<td>Types of Messages</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>Plan</td>
</tr>
<tr>
<td></td>
<td>In this message type, you analyze the discussion question by explaining different concepts included in the discussion question. This is to help you to understand better the question. For example, for this topic, you should explain what &quot;universal health insurance coverage&quot; means, what &quot;a single-payer system of health coverage&quot; means, and what medical insurance means.</td>
</tr>
<tr>
<td></td>
<td>Answer</td>
</tr>
<tr>
<td></td>
<td>In this message type, you propose answers to the question(s) and provide supporting information/evidence.</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td></td>
<td>In this message type, you analyze, compare, and comment (including but not limited to giving rebuttal) on others’ opinions, answers, or collected information.</td>
</tr>
<tr>
<td></td>
<td>Conclude</td>
</tr>
<tr>
<td></td>
<td>In this message type, you organize proposed answers or comments and form conclusions for answers.</td>
</tr>
</tbody>
</table>

**Student Use**

- When posting a message, students needed to choose the type of message (a step in the discourse structure) (see Figure 3-5). For example, if the Argumentation framework was selected as the discourse structure to be used in the discussion, when students posted a message, they would need to choose the type of the message from the following: Claim/Reasons, Reasons/Grounds, Grounds, Warrant, Backing, Rebuttal, and Warrant/Backing.
Once the student created a message it was inserted automatically into the second type of cognition support, the Discourse Map. The Discourse Map is a map of the discussion such as the example in Figure 3-6 that was generated to represent all of the messages from the entire group. The map was composed of interconnected nodes. Each node represented a message and was labeled by the type of message. Hovering the mouse over any node showed the type of the message, name and username of the student who posted the message, message title, and first 100 words of the message. Nodes on the same row and connected by horizontal arrows were replies to the same
message; a message posted later would be represented by a node to the right of a prior message. Message nodes on the same thread (from top to bottom) were replies to each other.

Figure 3-6. Partial map of a discussion of argumentation type

Figure 3-7 shows how the discourse map is positioned in the discussion board, on the right side of the current message.
Interactive Intercultural Elaboration Features

Interactive Intercultural Elaboration Features provided in this discussion board were created to support students’ intercultural interaction and intercultural awareness. These features were based on a cultural database that included words where meanings could vary depending on cultures. By default, this cultural database contained a number of culturally loaded words or phrases (e.g. “family”, “community”, “success”). However, during the course of the discussion, more culturally loaded words were be added by the users. In the discussion activity in this course, by the end of the semester, 214 words were in the cultural database. Among them, four words were added by students. The meanings/interpretations of
these words in different cultures were contributed by the users as well. This was done through the following procedures:

- If a message included a word in the cultural database, that word was automatically highlighted or underlined (see Figure 3-8).

Figure 3-8. Notification to a user after a message is submitted

- A highlighted word indicated that the user had not provided an explanation for this word previously. However, highlighted words may have been explained by other
students. The user could mouse over a highlighted word to add their explanation for this word as well as to view existing explanations for this word, if there were any (see Figure 3-9).

Figure 3-9. Mouse over a highlighted word in an un-posted reply

- An underlined word indicated that the user provided an explanation for this word previously. Other users may have explained this word as well. The user could mouse over an underlined word to view existing explanations for this word (see Figure 3-10). For each explanation of a word, the cultural background of the explanation’s author, identified by his or her countries of upbringing and ethnicities, was visible.
Your reply message has not been posted yet.

You need to provide an explanation for each highlighted word and then resubmit before your message can be posted (mouse over highlighted words...). This explanation will help your fellow students understand your message better. You do not need to search for what it formally means (i.e. dictionary meaning). You just need to state *your* understanding of what it may mean and its key characteristics in your culture in a couple of sentences. For example, if you are prompted to enter an explanation for the word/concept "family", you just need to enter what "family" means to *you* and some key characteristics of a family in the context of your culture. To some, "family" may mean a very close-knit and big group of people (including all relatives) living in the same neighborhood or even in the same house. To others, it may mean a nuclear unit of a family to live very far apart and visit from time to time. The user needed to explain what he/she meant or what that word meant in his/her culture: e.g., people from different cultures may have different perspectives on the concept of family.

When viewing the messages in a discussion topic, all culturally loaded words were underlined and a user could mouse over an underlined word to read further.
explanations (see Figure 3-11) or add or modify their explanation for that word from their perspective (see Figure 3-12).

Figure 3-11. Mouse over an underlined word in a posted message
When viewing the messages in a discussion topic, the user could also add an explanation and interpretation for any word. This word and its interpretation then went into the cultural database.

**Database of Cultural Words**

To prepare for the discussions with interactive intercultural elaboration features, the researcher created a cultural database with culturally-sensitive words that may appear in a
discussion before the discussion started. Cultural words were added each week before a new
discussion started. By the end of the study, there were 214 cultural words in the database (see
Appendix B) and explanations were provided for 149 words.

_Tutorials and Online Discussion Board Guidelines_

At the beginning of the semester, before the first discussion, students were given a
posting guideline to tell participants about the benefits of the discussion activity, and provide
logistics, general discussion timelines, posting requirements in terms of quantity and quality,
and a recommended posting timeline (see Appendix A1).

For each discussion, right after each discussion prompt, students were reminded of
their posting timeline and requirement as well as of the special features available in their
discussion board if there were any (see Appendix A2). The direction for the warm-up
discussion is also included in Appendix A2.

Two online tutorials were created to introduce students to the special features and
how to use them. However, there was no checking on whether or not students actually went
through the online tutorials. Both tutorials were in Flash format and developed using Adobe
Captivate. Each tutorial had a number of screens that students could manually go through or
put in automatic play mode. The tutorials included three main components: What, Why, and
How. The What component briefly described the features’ main ideas. The Why component
explained why students should use these features. The How component explained how they
could use the features for different online discussion tasks. Different relevant screenshots of
the discussion board were used to demonstrate the different features in the How component.
The first tutorial was called Introduction to Cognitive Features, introducing students to the cognition-supported features of the discussion board. This tutorial had seven screens, introducing the two types of features included in the cognition-supported features. For each type of features, the What, Why and How were included. The first screen was an advanced organizer of the tutorial. The next three screens introduced students to posting messages following a discussion framework, including an introduction to the Toulmin Model of Argumentation. In the introduction to the argumentation model, students could explore the model by clicking on the different rectangles, each representing one component of the model. They were then presented with a description and an example of the corresponding component. The last three screens introduced students to the discussion map.

The second tutorial was called Interactive Cultural Explanation, introducing students to the interactive intercultural elaboration features of the discussion board. This tutorial had six screens. The first screen was an advanced organizer for the tutorial. The second screen was about the What and Why components. The last four screens showed students how they could use these cultural features when writing messages and reading messages as well as how they could revise their explanations and add their own cultural words.

**Treatments**

Throughout different time periods of the study, four types of discussion boards were used by the researcher in different combinations to make up the treatment conditions needed to answer the various research questions. These include:

1. a standard threaded discussion board with no additional features/treatments
2. a discussion board with cognition-supported features
3. a discussion board with interactive intercultural elaboration features, and
4. a discussion board with both cognition-supported features and interactive intercultural elaboration features.

Research Questions

Question 1: Effects of Constraint and Discourse Map on Knowledge Construction

1.1. Does the use of the cognition-supported features integrated into an online discussion board affect students’ level of knowledge construction in online discussions?
1.2. Does students’ level of prior knowledge and experience in the subject domain influence the effect of the cognition-supported features on knowledge construction?
1.3. Does students’ level of prior experience with online discussions influence the effect of the cognition-supported features on knowledge construction?

Question 2: Effects of Constraint and Discourse Map on Critical Thinking

2.1. Does the use of the cognition-supported features integrated into an online discussion board affect students’ level of critical thinking in online discussions?
2.2. Does students’ level of prior knowledge and experience in the subject domain influence the effect of the cognition-supported features on critical thinking?
2.3. Does students’ level of prior experience with online discussions influence the effect of the cognition-supported features on critical thinking?

Question 3: Effects of Interactive Intercultural Elaboration on Intercultural Sensitivity

3.1. Does the use of the interactive intercultural elaboration features integrated into an online discussion board affect students’ level of intercultural sensitivity?
3.2. Does students’ level of prior cross cultural experience influence the effect of interactive intercultural elaboration features on students’ intercultural sensitivity?

**Question 4:**

*Examining Patterns of Knowledge Construction in Two Different Discourse Structures*

In the case of a constraint-based discussion board, how different are the patterns of knowledge construction in discussions for Argumentation and Problem Solving discourse structures?

**Question 5:**

*Examining Patterns of Knowledge Construction and Critical Thinking in Four Types of Discussion Boards*

How different are the patterns of knowledge construction and critical thinking between four types of discussion boards: without any special features, with cognition-supported features, with interactive intercultural elaboration features, and with both sets of features?

**Research Design**

*Rationale for a Mixed Method Study*

To answer the research questions of this study, a mixed research method was employed, which required both quantitative and qualitative data. This was a field study since the study was carried out in a real classroom environment.
**Overall Research Design**

The study was conducted over three phases (see Table 3.3).

- **Phase 1:** (first 2 weeks of the study, from Week 4 and Week 5 of the semester): All students used the standard threaded discussion board. Topics 1 and 2 (see Table 3.1) were discussed in this phase. Group discussions based on Topic 2 were coded to obtain students’ knowledge construction and critical thinking pretest scores for Research Questions 1 and 2 as well as for examining knowledge construction and critical thinking in a standard threaded discussion board for Research Question 5.

- **Phase 2:** (second 3 weeks of the study, from Week 7 to Week 9 of the semester): Group 1 used the discussion board with cognition-supported features; Group 2 used the discussion board with interactive intercultural elaboration features. Topics 3, 4, and 5 were discussed in this phase (see Table 3.1). Group discussions based on Topic 5 were coded to obtain students’ knowledge construction and critical thinking posttest scores for Research Questions 1 and 2 as well as for examining knowledge construction and critical thinking in a discussion board with cognition-supported features and in a discussion board with interactive intercultural elaboration features for Research Question 5.

- **Phase 3:** (the last four weeks of the study from Week 10 to Week 13 of the semester): Both groups used the discussion board with cognition-supported features and interactive intercultural supported features. Topics 6, 7, and 8 (see Table 3.1) were discussed. Selected group discussions based on Topics 7 and 8 were examined for answering Research Questions 4 and 5.
Table 3.3. Study Timeline

<table>
<thead>
<tr>
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<td>Purpose</td>
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<td>Hypothesis Testing for Research Questions 1, 2, 3; Descriptive Research Question 5</td>
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<td>Research Questions 4, 5</td>
</tr>
<tr>
<td>Group 1</td>
<td>Standard Discussion Board</td>
<td>Pre KC, CT, &amp; IS</td>
<td>Discussion Board with Cognition-Supported Features</td>
<td>Post KC, CT, &amp; IS</td>
<td>Discussion Board with both Cognition-Supported Features and Interactive Intercultural Elaboration Features</td>
</tr>
<tr>
<td>Group 2</td>
<td>Standard Discussion Board</td>
<td>Pre KC, CT, &amp; IS</td>
<td>Discussion Board with Interactive Intercultural Elaboration Features</td>
<td>Post KC, CT, &amp; IS</td>
<td>Discussion Board with both Cognition-Supported Features and Interactive Intercultural Elaboration Features</td>
</tr>
</tbody>
</table>

Note. KC: Knowledge Construction. CT: Critical Thinking. IS: Intercultural Sensitivity.

Data on students’ demographic information, classification, prior knowledge and experience with psychology, prior online discussion experience, prior cross-cultural experience, and intercultural sensitivity was collected before Phase I. Pretest for intercultural sensitivity was administered between Phase 1 and Phase 2, and posttest for intercultural sensitivity was administered between Phase 2 and Phase 3.

**Research Questions 1, 2, 3: Field Experimental Control Group Design**

Research Questions 1, 2 and 3 focused on the effects of cognition-supported features, a constraint-based discussion and a discourse map, on knowledge construction and critical thinking and the effects of interactive intercultural elaboration on intercultural sensitivity. In addition, the influence of the prior knowledge and experience in psychology and prior experience in online discussion on these effects was also examined. In order to answer
research questions 1, 2, and 3, a field experimental control group designed was used (as shown in Phase 2 in Table 3.3).

The cognition-supported features and the interactive intercultural elaboration are of a different nature with different underlying mechanisms. In addition, based on the characteristics of these features, it could be assumed that the interactive intercultural elaboration features would not have negative effects on students’ knowledge construction and critical thinking in the online discussion and the cognition-supported features would not have negative effects on students’ intercultural sensitivity. Thus, they were considered to be independent features. Therefore, Group 2 was used as the control group for Group 1 to examine the effects of discourse structure and map on students’ knowledge construction and critical thinking and vice versa, Group 1 was used as the control group for Group 2 to examine the effects of interactive intercultural elaboration on students’ intercultural sensitivity.

Research Question 4

In the case of a constraint-based discussion board, how different are the patterns of knowledge construction in discussions for Argumentation and Problem Solving discourse structures?

To answer this research question, the research design was descriptive. Two discussion topics, Topics 7 and 8 (see Table 3.1), each representing the use of one of the two types of discourse structures, were selected for the analysis in this question. Topic 8 was the only topic that used the Problem Solving Framework. Since Topic 8 was in Phase 3 of the study, for a more balanced comparison of the two discourse structures, the topic chosen for examining the Argumentation Model needed also to be in Phase 3. This means that either
Topic 6 or Topic 7 would be selected. Topic 7 was selected because in Topic 6, students in Group 2 had only used the cognition-supported features for the first time.

For each topic, two small discussion groups, one in Group 1 and one in Group 2, were selected for the analysis in this question. Selection from both treatment groups was to give different perspectives to the descriptive analysis. In order to have sufficient data for descriptive analysis, the main selection criterion of these two groups was high participation from most members in the groups or that most students in the groups wrote three messages for the discussion under assessment. Quantitative Content Analysis method was used to analyze the discussion board messages following the rubric for assessing the patterns of knowledge construction.

**Research Question 5**

How different are the patterns of knowledge construction and critical thinking between four types of discussion boards: without any special features, with cognition-supported features, with interactive intercultural elaboration features, and with both sets of features?

To answer question 5, the research design was descriptive. Topics 2, 5, and 7 were selected for the analysis in this question (see Table 3.1). For each topic, the same two small discussion groups selected for research question 4 were also selected for this analysis due to the group members’ general high level of participation compared to other groups in these topics. One of these groups was in Group 1 and the other was in Group 2. Topic 2 was the last topic in Phase 1. The two small groups’ Topic 2-discussions represented the standard threaded discussion board. Topic 5 was the last topic in Phase 2. The Topic 5-discussion from the small group in Group 1 represented the discussion board with cognition-supported
features and the Topic 5-discussion from the small group in Group 2 represented the discussion board with interactive intercultural elaboration features. Topic 7, the last argumentation-based discussion in Phase 3, represented the discussion board with both cognition-supported features and interactive intercultural elaboration features.

Measurement Instruments

**Questionnaire for Student Demographics Information**

This questionnaire (see Appendix C) was modified from a questionnaire developed by Sherry Thatcher and Theo Song in the University of Arizona to gather student demographic information with a focus on collecting information on students’ cultural backgrounds including their countries of upbringing and their countries of ethnic origins as well as gender and classification information.

**Questionnaire for Prior Knowledge and Experience in Psychology**

This questionnaire (see Appendix D) was developed by the researcher to gather information regarding students’ perception of their prior knowledge and experience in psychology. This questionnaire was part of a larger survey students filled out prior to the discussion board activity. This questionnaire has three items: the first item asks for students’ perceptions about their knowledge in psychology, the second item asks for students’ perceptions about their level of experience in psychology, and the third item asks for students’ perceptions about the likelihood that they encounter different situations where
knowledge of psychology is useful. The questionnaire uses a 5-point Likert scale. The final score for each individual is the average item score (ranging from 1-5) on a five-point Likert scale. A higher score indicates higher perceived prior knowledge in the domain. This instrument has a Cronbach’s alpha of 0.597 (N = 103).

**Questionnaire for Prior Experience in Online Discussion**

This questionnaire (see Appendix E) was developed by the researcher. This questionnaire has two items. The first item asks students about their experience with online discussion in an academic context prior to this course. The second item asks students about their experience with online discussion outside the academic context. The final score for each individual is the average item score (ranging from 1-4) since both items are on a four-point Likert type scale. A higher score indicates higher prior experience in online discussion. This instrument has a Cronbach’s alpha of 0.668 (N = 103).

**Questionnaire for Prior Cross-Cultural Experience**

This questionnaire (see Appendix F) was developed by the researcher. It includes eight questions that ask students about their language skills, their experience abroad, their experience in working in groups with students from other cultures and their interactions with people from other cultures. There were three open-ended questions, two questions that were a Yes/No question followed by an open-ended question and three Yes/No questions. A detailed scoring rubric for this questionnaire is provided at the end of the questionnaire in Appendix F. The score for prior cross cultural experience can be from 0 to about 20.
realistically (although theoretically it could be from 0 to infinite). A higher score indicates higher prior cross-cultural experience. The highest score that the participants reached in this study was 20.

**Intercultural Sensitivity Scale (ISS)**

This instrument (see details in Appendix G) was developed by Chen and Starosta (2000), to measure an individual’s intercultural sensitivity or an individual’s “active desire to motivate themselves to understand, appreciate, and accept differences among cultures” (cited in Chen & Starosta, 2000, p. 3). The instrument uses a five-point Likert scale. The final version of this instrument currently has 24 items. Its reliability and validity have been determined in several contexts. When first developed, the instrument had 44 items. To perform factor analysis, Chen and Starosta used a sample of 414 students who took the instrument and the instrument was reduced to 24 items. Five factors emerged from the factor analysis: Interaction Engagement (feeling of participation in intercultural communication), Respect for Cultural Differences (how participants orient to or tolerate their counterparts’ culture and opinion), Interaction Confidence (how confident participants are in the intercultural setting), Interaction Enjoyment (participants’ positive or negative reactions towards communicating with people from different cultures), and Interaction Attentiveness (participants’ effort in understanding what is going on in intercultural interaction). In this study, the Cronbach’s alpha reliability coefficient for the scale was 0.86. A concurrent validity test was done with 162 college students, which showed that this instrument was significantly correlated with several other related scales including interaction attentiveness, impression rewarding, self-esteem, self-monitoring, and perspective taking. Predicted
validity test was done with 174 students, which showed that individuals who scored high on 
the ISS also scored high on the intercultural effectiveness and intercultural communication 
attitude scales. The final score for each individual is the average item score (ranging from 1-5) since all items are on a five-point Likert scale. A higher score indicates higher 
intercultural sensitivity. In this current study, the Cronbach’s alpha reliability coefficient was 
found to be 0.90 (N = 84).

**Rubric for Assessing the Level of Critical Thinking in Discussion Messages**

This study used Newman et al. (1995)’s framework (see Appendix H1) for assessing 
individual students’ level of critical thinking demonstrated in their discussion messages. The 
unit of analysis used under this instrument was a message (defined as a message posted by a 
student at a certain time for a specific online discussion).

**Justifications for the Critical Thinking Rubric**

This rubric has a well defined theoretical foundation. It is based on Garrison (1992)’s 
theory of critical thinking and Henri (1991)’s rubric for assessing critical thinking skills. 
Garrison’s theory of critical thinking identified critical thinking as a sequential five-stage 
problem solving process: problem identification, problem definition, problem exploration, 
problem applicability, and problem integration. Henri identified the critical reasoning skills 
that correspond with these five stages: elementary clarification, in-depth clarification, 
inference, judgment, and strategies. However, Henri’s rubric gears more toward the learning 
outcomes of individuals. This assessment excludes the group interactions which are
important in assessing individual learning outcomes in the collaborative learning context since an individual message very much depends on others’ messages. Based on Garrison’s theory and Henri’s set of paired indicators and experience, Newman et al. (1995) identified indicators for critical thinking in all stages in Garrison’s framework. Their framework took into account group interactions in analyzing individual messages and developed more than 20 pairs of opposites as indicators for the various stages of critical thinking. These indicators were divided into 10 categories: relevance, importance, novelty, outside knowledge/experience, treatment of ambiguities, linking ideas, justification, critical assessment, practical utility and width of understanding. An example of paired indicators in the Justification category is justifying solutions (JS+) or judgment and offering judgments or solutions without explanations or justifications (JS-).

**Coding Process**

For the reliability study, two raters (the researcher and another graduate student) went through two online discussion transcripts and marked each message with different codes (as specified) in the rubric. Only one rater (the researcher) rated all messages in the 32 discussion transcripts used in the main data analysis of the study. More than one code can be used to mark a message but each code is only used one time in a message.

Since Newman, Johnson, Cochrane, & Webb (1996) matched each stage of Garrison’s critical thinking model with several critical thinking indicators, in order to increase the reliability of the coding process, first, the critical thinking stage(s) of a message were determined. That would leave a rater with fewer options for critical thinking indicators to choose from and therefore could potentially increase level of agreement between the raters.
as well as reduce the ambiguity during the coding process. Then, appropriate critical thinking indicators (codes) were selected for each stage. Again, each code was only used one time in a message. Appendix H2 show several examples of how messages were coded. These messages were taken from a discussion transcript for the Decision Making topic.

**Scoring Approach**

If a statement was coded using the positive indicator of a pair, that statement would get +1 point, otherwise, no point was given. The number of positive indicators in each message was the message score. In order to calculate the level of critical thinking score for an individual in an online discussion, two approaches were used. In the first approach, the two scores from the two messages with the highest two scores were summed up for each individual to get a critical thinking score for every student. In the second approach, a student’s critical thinking score was the sum of the critical scores of all three messages written by that student for a discussion. Therefore, the first critical thinking score, the two-message critical thinking score, was assigned to participants who wrote at least two messages (n = 89). In the second scoring approach, the level of critical thinking for each student was the sum of their three message scores. Therefore, the second critical thinking score, the three-message critical thinking score, was assigned to a subset of all participants who wrote three messages (n = 81).
Reliability and Validity

This rubric has evidence for construct validity since it was built upon Garrison (1992)’s theory of critical thinking. Each pair of indicators for critical thinking in this rubric can be matched to a stage in Garrison’s theory of critical thinking (Newman et al., 1996).

Limited reliability information for this rubric was found in the literature. The reliability of the scores obtained with this rubric was obtained using the principles of the Generalizability theory (G Theory) (Cronbach, Gleser, Nanda, & Rajaratnam, 1972). G Theory allowed this researcher to take into account multiple sources of variance simultaneously (Di Nocera, Ferlazzo, & Borghi, 2001). “In G Theory, sources of variation are defined as facets, while groupings within a facet are defined as conditions (factors and levels represent their analogs in factorial ANOVA)” (Di Nocera et al., p. 797).

Although the rubric’s original unit of analysis was a statement, in this study, a message was used as the unit of analysis instead because it provides a clearer boundary for the unit of analysis and therefore can enhance the reliability of the rubric. Since the end result was to assess individual learners, with a statement as the unit of analysis, “the social milieu and its significance in relation to the learning outcome” may not be considered (Law, 2005, p. 374). The inadequate inclusions of group dynamics can be a source of error and can lower the reliability of this rubric.

Since the end result is to assess individual learners, students (S) are objects of measurement. Facets included in the G Theory model for this rubric include raters (R) as a random facet and messages (M) as a random facet.

The design of the G-study used in this study was a nested two-facet design
(M : S) x R: (messages nested in students) cross raters. Two discussions from the fifth week of the discussion activities (i.e. Decision Making topic), each from one small discussion group, were included in the reliability study. Two raters rated all messages of these two discussions. All students who wrote three messages in these discussions were included in the G-study. One discussion group had seven students and the other discussion group had eight students. Since each student wrote three messages, a total of 45 messages were coded for the reliability study. Scores of these messages were obtained from the two raters. Then, an SPSS procedure developed by Musquash and O’Connor (2006) was used to calculate the G-reliability coefficient for the rubric (i.e. the reliability of a student’s critical thinking score) based on the coding results from the two raters. The G-coefficient (with three as the number of messages per student and two as the number of raters) was 0.625, which is an acceptable reliability (Norman & Streiner, 2000). Since the study results were based on the coding results of only one rater, the reliability of a student’s critical thinking score used in this study was further evaluated by observing the D study results based on the two-rater based G-coefficient. D study results showed that the G-coefficient based on one rater and three messages per student is 0.57, which can be considered acceptable since G-coefficient is more conservative than other reliability coefficients.

**Rubric for Assessing Students’ Knowledge Construction in Online Discussion**

Assessment in the CSCL context can be at two levels: individual level and group level. “Recent studies on the characteristics of productive online discourse have identified features at the group/community level that cannot be sufficiently described at the individual level“(Law, 2005, p. 373). Regardless, assessing outcomes at the individual level has certain
advantages. It is a challenging matter to conduct experimental studies in collaborative learning context with assessment at the group level since the sample size is often not large enough. By assessing learning outcomes at the individual level, researchers have a larger sample size which is very important in experimental studies. At the same time, in order to look at group knowledge construction, rubrics that take into account the group processes such as negotiation and knowledge co-construction should be used.

The rubric (see Appendix I1) for assessing students’ knowledge construction is Gunawardena et al. (1997)’s phase of knowledge co-construction model, the Interaction Analysis Model. In this model, there are five phases of negotiation and co-construction: sharing/comparing of information, discovery and exploration of dissonance or inconsistency of ideas, negotiation/co-construction of knowledge, testing/modification of proposed co-constructed synthesis, and co-construction of knowledge/application of newly constructed meaning. The unit of analysis used in this rubric is a message. For the purpose of this study, the end result was to infer individuals’ level of knowledge construction (under the understanding that higher phases are more advanced in terms of knowledge construction than lower phases).

**Justifications for Using the Knowledge Construction Rubric and Scoring Process**

This rubric is supported by a well defined theoretical framework, a constructivist model of CMC interaction (Gunawardena et al., 1997), where contributions from all individuals in the group in a certain phase of knowledge construction are taken into account. This is consistent with the way knowledge construction is defined in this study, a certain way that a group uses to develop a new level of understanding together about a topic under
investigation or to construct new meanings (Stahl, 2006; Scardamalia & Bereiter, 1996). In order to assess knowledge construction, the authors of this rubric assess the processes that learners go through to construct knowledge as well as the nature and content of interactions between learners. In addition, this rubric is chosen also because it is suitable for this study in terms of the underlying processes that the scaffolds in this study seek to support and the benefits that diversity can bring to these processes (e.g. discovery and exploration of dissonance or inconsistency among ideas, concepts or statements or negotiation of meaning).

Another very powerful feature of this rubric is the inclusion of group interactions. Knowledge construction is then assessed in a group context as generated by the group, not by an individual. For this reason, this rubric is suitable for assessing an online discussion as a whole as well as for assessing an individual’s knowledge construction level within his or her group context.

Coding Process

Each message was coded according to the phases and operations detailed in Appendix I1. It was crucial to analyze a message in relation with other messages in the discussion. To take into account group interactions, during the coding process, the raters maintained a focus on a discussion as a whole, not on only individual messages. An important question during the analysis process was “Did the discussion as a whole move through the phases?”.

First, a rater would read a message in relation with other messages in the discussion and determine the knowledge construction phases that a message expressed. After that knowledge construction operations under each phase were determined. Appendix I2 show
several examples of how messages were coded. These messages were taken from a discussion transcript for the Decision Making topic.

**Scoring Approach**

A message’s score was the value of the highest phase achieved in that message (e.g. if a Phase 5 operation is found in the message, the message score will be 5). Two scores for an individual student’s knowledge construction were created to answer research question 1. Even though students were required to write three messages for each discussion, not all students did. If only students who wrote three messages were included in the data analysis, a number of data points would be left out. The two scoring approaches allowed different ways of scoring knowledge construction and therefore provided more complete results based on the data set. In the first scoring approach, the level of knowledge construction for each student was the sum of their two highest messages scores. Therefore, the first knowledge construction score, the two-message knowledge construction score, was assigned to participants who wrote at least two messages (n = 89). In the second scoring approach, the level of knowledge construction for each student was the sum of their three message scores. Therefore, the second knowledge construction score, the three-message knowledge construction score, was assigned to a subset of all participants who wrote three messages (n = 81).
Reliability and Validity

This rubric has evidence for construct validity. As pointed out in the Justifications section, this rubric is theoretically founded and includes processes in knowledge construction, therefore, it has construct validity. The theoretical foundation of this rubric is also consistent with the way knowledge construction is defined in this study.

Reliability for this instrument was calculated using G Theory. Similar to the G-study to determine the reliability of the rubric for assessing the level of critical thinking from Newman et al. (1995), a nested two-facet design is also used the G-study to calculate the reliability of this rubric. In this case, individual students are objects of measurement. Facets included in the G Theory model for this rubric include raters (R) as a random facet and messages as another random facet. The design is then (M : S) x R: (Messages nested in Students) crossed Raters.

Two same discussion transcripts of the fifth week of the discussion activities used in the G-study for the Critical Thinking rubric were included in this reliability study. Two raters rated all messages in the reliability study using the Knowledge Construction rubric. Knowledge construction scores for all messages in these two discussion transcripts were obtained from the two raters. Using the SPSS procedure from Musquash and O’Connor (2006), G-coefficient (with three as the number of messages per student and two as the number of raters) was found to be 0.647. Since the study results were based on the coding results of only one rater, the reliability of a student’s knowledge construction score used in this study was further evaluated by observing the D study results based on the two-rater based G-coefficient. D study results showed that the G-coefficient based on one rater and
three messages per student is 0.60, which is an acceptable reliability (Norman & Streiner, 2000).

Research Procedures

Research procedures included the following:

Ethics Approval

- Ethics approval was obtained from Penn State Institutional Review Board before the data was collected.
- Using a signed informed consent form, students were asked for permission to access their online discussion data and any related information they provide when using the discussion board tool as well as survey data (see Appendix K).

Administer Initial Questionnaire and Intercultural Sensitivity Pretest

- Before the online discussion activity started, students filled out an online survey that included the following:
  - Part of the Questionnaire for Student Demographics Information (the questions on gender and classification)
  - Questionnaire for Prior Knowledge and Experience in Psychology
  - Questionnaire for Prior Experience in Online Discussion
  - Questionnaire for Prior Cross-Cultural Experience
  - Intercultural sensitive scale (served as pretest for students’ intercultural sensitivity)
• The cultural background questions in the Questionnaire for Student Demographics Information were given when students registered on the discussion board so that similar levels of cultural diversity could be assured in different small discussion groups.

**Form Discussion Groups and Treatment Groups**

• Students were divided into groups of eight students for online discussion. These groups of eight were then assigned into two different treatment groups: Group 1 and Group 2.

• The collected information on cultural backgrounds was used to assure there was approximately similar level of diversity in all small discussion groups. For this purpose, students who had a country of upbringing or a country of ethnic origin different than the United States were called culturally different students (compared to the students who have been only brought up in the United States as well as have their ethnic origin from solely the United States). These students were then further divided into four levels of cultural difference as followings with the lowest number indicating the highest level of cultural difference: Level 1 students were composed of students who had both main country of upbringing and main country of ethnicity origin different from the United States; Level 2 students were composed of students who are composed students who were brought up mainly in the United States but also brought up in another country and had their main country of ethnic origin different from the United States; Level 3 students were composed of students who were brought up in the United States and had their main country of ethnic origin different from the United States; Level 4 students were composed of students who were brought up in
the United States as well as had United States as their main country of ethnic origin but also had one or more other countries of ethnic origin (see Table 3.4)

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Main country of upbringing</th>
<th>Other countries of upbringing</th>
<th>Main country of ethnic origin</th>
<th>Other countries of ethnic origins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>12</td>
<td>Not the United States</td>
<td>Not the United States</td>
<td>Not the United States</td>
<td>Not the United States</td>
</tr>
<tr>
<td>Level 2</td>
<td>7</td>
<td>United States</td>
<td>Not the United States</td>
<td>Not the United States</td>
<td>Not the United States</td>
</tr>
<tr>
<td>Level 3</td>
<td>23</td>
<td>United States</td>
<td></td>
<td>Not the United States</td>
<td>Not the United States</td>
</tr>
<tr>
<td>Level 4</td>
<td>11</td>
<td>United States</td>
<td>United States</td>
<td>Not the United States</td>
<td>Not the United States</td>
</tr>
</tbody>
</table>

- Students of different levels of cultural deviation from the United States culture were assigned randomly into the 14 online discussion groups in a way that assured approximately similar levels of cultural diversity across the 14 groups by taken into account the different levels of cultural deviation from the main culture in the class (the United States culture). Approximately, there were three to four students of these culturally different students in each discussion group. Not all groups had a Level 1 student (Level 1 is the highest level of cultural deviation from the United States culture) but all groups with only three culturally different students (instead of four) had one Level 1 student in them to compensate for their smaller number of culturally different students. After the randomization, final adjustments to assure the culturally different students in each discussion group had their ethnic origins not only from different countries but also from at least two different areas of the world. This would increase the chance for a maximal level of cultural diversity in each group. Based on
the ethnicity backgrounds of these students, the following distinct areas were used for this purpose: Australia, Africa, Caribbean Sea, East Asia, West Asia, Eastern Europe, Western Europe and Canada, Mexico, the Middle East, and South America. All students from the United States culture were then also assigned randomly into different discussion groups, taken into account the number of culturally different students in each group and the size of each discussion group (eight students).

**Organize Discussion Activities**

- Students were given weekly discussion topics to discuss online.
- As described in the Overall Research Design section, there were three phases of the study. In Phase 1 that lasted three weeks, both discussion groups in both Group 1 and Group 2 used the standard threaded discussion board. In Phase 2 that lasted three weeks, Group 1 used Treatment 1 (cognition-supported features) and Group 2 used Treatment 2 (interactive intercultural elaboration features). In Phase 3 that lasted 2 weeks, both Group 1 and Group 2 used both Treatment 1 and Treatment 2.
- Before the cognition-supported features and the interactive intercultural elaboration features were integrated into students’ discussions, students were asked to follow an online tutorial about how to use these features.
- To prepare for the discussion board with cognition-supported features, a discourse structure was selected whenever a discussion topic was posted.
- To prepare for the discussions in the discussion board with interactive intercultural elaboration features, the researcher created an initial cultural database with culturally-sensitive words that may appear in the discussion before the discussion started.
Administer Intercultural Sensitivity Posttests and Final Survey

- After Phase 1 and Phase 2, students retook the intercultural sensitivity survey again as posttests.
- After Phase 3, students took a final survey that asked them about their experience with the online discussion activity in the course.

Data Analysis

Quantitative Content Analysis and Coding of Online Discussions

In this study, discussion board messages were analyzed using quantitative content analysis. According to Berelson (1952), quantitative content analysis is “a research technique for the objective, systematic, quantitative description of the manifest content of communication” (p. 519). The three criteria of quantitative content analysis include objectivity, reliability, and systematic consistency (Rourke, Anderson, Garrison, & Archer, 2001).

To test the objectivity and reliability of the analysis based on the knowledge construction coding scheme Gunawardena et al. (1997) and the critical thinking coding scheme Newman et al. (1995), two raters were used to code and rate a selected sample of discussion messages. This selected sample of discussion messages comes from two discussions. The selection criterion for these two discussions was high level of participation in the discussion (i.e. most students wrote three messages). The first rater was the researcher and the second rater was another graduate student in a different field. The second rater was trained through the following procedure: 1/discussion topic content was introduced; 2/the coding categories were explained to and coding examples were given to the second rater;
3/the second rater rated several messages not in the selected sample for the reliability analysis; 4/the second rater discussed with the first rater the results in step 3 to further understand the coding schemes. After the second coder was trained, two raters coded the selected sample of discussion messages independently for the reliability studies.

To answer research questions 1, 2, and 3, two discussion topics were selected for analysis: the second topic and the fifth topic (Discussion 2 and Discussion 5). Discussion 2 was the discussion right before Phase 2 of the study and discussion 5 was the discussion right at the end of Phase 2 of the study. Since there were 14 discussion groups, 14 discussions of the second topic and 14 discussions of the fifth topic were analyzed by the researcher using knowledge construction coding scheme and critical thinking scheme. After that knowledge construction scores and critical thinking scores were obtained for each message: pretest scores from discussion 2 and posttest scores from discussion 5. Based on message scores, students’ knowledge construction scores and critical thinking scores were calculated using two approaches as mentioned in the Scoring Process section for each rubric.

**Statistical Analysis with ANCOVA and t-tests**

To answer research questions 1, 2, and 3, ANCOVA and t-tests were used to analyze the numerical data in SPSS. All data for answering these questions, prior knowledge score, prior experience in online discussion score, prior cross-cultural experience score, intercultural sensitivity pretest and posttest, knowledge construction pretest and posttest, critical thinking pretest and posttest, were computed. Knowledge construction scores and critical thinking scores were obtained from the quantitative content analysis of the online discussions as detailed in the Quantitative Content Analysis section.
To answer Research Question 1.1 to determine whether or not cognition-supported features support students’ knowledge construction, ANCOVA with knowledge construction posttest as dependent variable, treatment group as independent variable, and knowledge construction pretest as the covariance was used. Important assumptions for running ANCOVA including Normality Assumption, Equal Variances Assumption, and Homogeneity of Regression were tested and if not satisfied, posttest-only comparison t-test was used. Also, if ANCOVA results showed that the influence of the covariate was not significant, a posttest-only comparison using t-test was performed instead so that the effect size statistic (eta-squared) would be more accurate. To answer Research Question 1.2 to determine whether or not prior knowledge and experience in the subject domain influenced the effect of cognition-supported features on knowledge construction, ANCOVA with knowledge construction posttest as dependent variable, treatment group as independent variable, and prior knowledge and experience in the subject domain as the covariance was used. To answer Research Question 1.3 to determine whether or not prior online discussion experience influences the effect of cognition-supported features on knowledge construction, ANCOVA with knowledge construction posttest as dependent variable, treatment group as independent variable, and prior knowledge and experience in the subject domain as the covariance was conducted.

This procedure for answering research questions 1.1, 1.2, 1.3 was the same for both knowledge construction scores, two-message score and three-message score.

A similar approach was used for answering research question 2.1, 2.2, and 2.3, with critical thinking as the dependent variable in all the analyses.
To answer Research Question 3.1 to determine whether or not interactive intercultural features support students’ intercultural sensitivity, ANCOVA with intercultural sensitivity posttest as the dependent variable, treatment group as independent variable, and intercultural sensitivity pretest as the covariance was used. Important assumptions for running ANCOVA including Normality Assumption, Equal Variances Assumption, and Homogeneity of Regression were tested and if they were not satisfied, posttest-only comparison t-test was used. To answer Research Question 3.2 to determine whether or not prior cross cultural experience influences the effect of interactive intercultural elaboration features on students’ intercultural sensitivity, ANCOVA with intercultural sensitivity posttest as dependent variable, treatment group as independent variable, and prior cross cultural experience as the covariance was conducted.

Descriptive Analysis

To answer research question 4 comparing knowledge construction in the Argumentation framework used in Topic 7 and the Problem Solving framework used in Topic 8, the discussion transcripts of these two topics from two discussion groups were selected. The selection criteria included each discussion group coming from a treatment group and most students having written three messages per discussion for these topics. These discussion transcripts were then coded and examined in terms of knowledge construction phases, knowledge construction operations under each phase, and the density of knowledge construction using the knowledge construction coding scheme.

To determine if there was evidence of knowledge construction at higher phases in one group versus the other or one discussion framework versus the other, two codes were analyzed: the number of times a phase appeared in all messages and the highest phase of
knowledge construction reached in each message. First, the discussions were examined for knowledge construction phases in order to see how frequently students went through each phase in each type of discussion frameworks. Analysis was done at the message level. Each message was coded with all knowledge construction phases found explicitly in the message. The frequency of each phase as the highest phase in a message as well as the frequency of each phase found in all the messages was examined. For example, if Phase I and Phase II knowledge construction levels were found in a message, it would be coded as Phase I and Phase II. In this case, the highest phase for this message would be recorded as Phase II would be the highest phase and Phase I and Phase II would be recorded to note the frequency of each phase. To determine if there was a difference between the two discussion frameworks in the existence of knowledge construction operations in each phase, the differences between the two discussion frameworks in the number of different knowledge construction operations in each phase were examined. The results may reveal the operations or cognitive processes more likely to be prompted by one discussion framework versus the other. In addition, the density of knowledge construction was assessed by the average number of knowledge construction operations made by each student in the whole discussion.

To answer research question 5, topic 2, topic 5, and topic 7 from the same two discussion groups in research questions were coded and examined descriptively based on the knowledge construction coding and critical thinking coding. Knowledge construction coding was examined in a similar approach with Research Question 4. Frequencies of critical thinking indicators were counted for each discussion board type and examined descriptively.
CHAPTER 4

RESULTS

Purpose of the Study

The purpose of this research was to study the effects of cognition-supported features and interactive intercultural elaboration features integrated into a multicultural discussion board environment. Specifically, the study tested the effects of cognition-supported features that combined a constraint-based discussion via a discourse structure with an automatic generated discourse map on students’ knowledge construction and critical thinking in online discussions. In addition, the influence of students’ prior knowledge and experience with the subject domain and students’ level of prior experience with online discussion inside and outside of classroom context was also examined. Second, the study tested the effects of interactive intercultural elaboration features on students' intercultural sensitivity. The influence of students’ prior cross cultural experience was also examined. Next, the study also sought to describe the levels of student knowledge construction when given discussion scenarios using different discourse structures, and lastly, to compare knowledge construction and critical thinking in the four different types of discussion boards: standard threaded discussion board, with cognition-supported features, with interactive intercultural elaboration features, and with combined cognition and intercultural features. In summary, five main research questions were asked.
Research Question 1:

Effects of Cognition-Supported Features on Knowledge Construction

Question 1.1.

Does the use of the cognition-supported features integrated into the online discussion board system affect students’ level of knowledge construction in online discussions?

Hypothesis 1.1.

Students will demonstrate a significantly higher level of knowledge construction in their discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.

Two scores measuring an individual student’s level of knowledge construction were calculated to answer research question 1. These were two-message knowledge construction score and three-message knowledge construction score. Results based on these two knowledge construction scores are presented below.

Test of Assumptions

Two-Message Knowledge Construction Score

Before performing ANCOVA with two-message knowledge construction posttest as the dependent variable, treatment group as the independent variable and knowledge construction pretest as the covariate, important assumptions were assessed (see Table 4.1).
Table 4.1. Assumptions for ANCOVA with 2-Message Knowledge Construction Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z score tests showed pretest and posttest distributions of the control group satisfied the normality assumption but pretest and posttest distributions of the cognition-supported features group did not so outliers were managed. After that, the absolute values of z-scores of skewness and kurtosis were less than 1.96. The resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>There were no changes in the dataset.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Five low scoring outliers were eliminated in both pretest and posttest and a high score in the posttest was truncated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed significant violation of this assumption: ( F = 9.844, p = 0.002 ).</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>This assumption was not assessed since the Homogeneity of Variance assumption was violated.</td>
</tr>
</tbody>
</table>

Since the homogeneity of variance assumption was violated, ANCOVA could not be performed and posttest-only comparison, with an independent samples t-test was used instead. Assumptions for performing t-test were assessed (see Table 4.2).

Table 4.2. Assumptions for t-test with 2-Message Knowledge Construction Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z score tests showed the posttest distribution of the control group satisfied the normality assumption but the posttest distribution of the cognition-supported features group did not so outliers were managed. After that, the absolute values of z-scores of skewness and kurtosis were less than 1.96. The resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>There were no changes in the dataset.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Three low scoring outliers were eliminated and a high score was truncated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed significant violation of this assumption: ( F = 12.384, p = 0.001 ).</td>
</tr>
</tbody>
</table>

Based on the results of the test of assumptions, t-test was run and the equal variances-not-assumed version was used.
**Three-Message Knowledge Construction Score**

Before performing ANCOVA with three-message knowledge construction posttest as the dependent variable, treatment group as the independent variable and knowledge construction pretest as the covariate, important assumptions were assessed (see Table 4.3).

Table 4.3. Assumptions for ANCOVA with 3-Message Knowledge Construction Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z score tests showed the pretest distribution of the cognition-supported features group did not satisfy the assumption and outliers existed so outliers were managed. After that, the absolute values of z-scores of skewness and kurtosis were less than 1.96. The resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>One low scoring outlier in the pretest distribution was removed and two high scores in the pretest distribution were truncated.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Three low scoring outliers in the posttest distribution were eliminated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F(1, 75) = 0.022$, $p = 0.882$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 73) = 0.069$, $p = 0.0793$</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA with three-message knowledge construction pretest as a covariate was performed on the reduced dataset. However, since ANCOVA results showed that the main effect of the covariate (knowledge construction pretest) was not statistically significant, $F(1, 74) = 1.865$, $p = 0.176$, an independent samples t test on knowledge construction posttest was performed to get a more accurate effect size statistic Eta Squared, after t-test assumptions were assessed for normality and homogeneity of variance (see Table 4.4).
Table 4.4. Assumptions for t-test with 3-Message Knowledge Construction Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption</td>
<td>Z-score tests based on skewness and kurtosis statistic for the distributions of the original dataset showed that the original posttest distributions satisfied the normality assumption. Regardless, to minimize outliers, the only low scoring outlier in the cognition-supported features group was eliminated. After outlier management, the absolute values of z-scores of skewness and kurtosis were less than 1.96, indicating the resulting distribution still met the normality assumption.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results indicated there was no significant violation of this assumption: $F = 0.811$, $p = 0.370$.</td>
</tr>
</tbody>
</table>

Based on the results of the test of assumptions, t-test was run and the equal-variances-assumed version was used.

**Descriptive Statistics**

Table 4.5 and Table 4.6 show the means and standard deviation after managing outliers for the two-message knowledge construction posttest only and the three-message knowledge construction posttest only.

Table 4.5 shows two-message knowledge construction posttest in the cognition-supported features group is higher than in control group.

Table 4.5. Two-Message Knowledge Construction Posttest

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cultural group)</td>
<td>44</td>
<td>5.91</td>
<td>1.522</td>
</tr>
<tr>
<td>Cognition-supported features group</td>
<td>43</td>
<td>7.14</td>
<td>1.037</td>
</tr>
</tbody>
</table>

*Note. Maximum score for level of two-message knowledge construction is 10*
In Table 4.6, descriptive statistics are reported for after outlier management. Descriptive results showed that the cognition-supported features group had higher three-message knowledge construction posttest score than the control group did (see Table 4.6).

Table 4.6. Three-Message Knowledge Construction Posttest

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cultural group)</td>
<td>40</td>
<td>7.73</td>
<td>2.100</td>
</tr>
<tr>
<td>Cognition-supported features group</td>
<td>45</td>
<td>9.02</td>
<td>2.039</td>
</tr>
</tbody>
</table>

Note. Maximum score for level of three-message knowledge construction is 15

As shown in Table 4.5 and Table 4.6, the cognition-supported features group where cognition-supported features were used had higher knowledge construction posttest scores than the control group did. This was true for both two-message and three-message knowledge construction scores.

Hypothesis Testing

Statistical Effects of Cognition-Supported Features on Two-Message Knowledge Construction Score

An independent samples two-tailed t-test with equal variances not assumed, comparing the two-message knowledge construction posttest mean scores between the cognition-supported features group and control group, was performed. The significant level is 0.05 level. The results showed that the level of knowledge construction in the cognition-supported features group was significantly higher than that of the control group, \( t(73.689) = 4.407, p = 0.000 \) for Discussion 5 with the use of the cognition-supported features. Therefore, the alternative hypothesis is confirmed. The effect size, as indexed by Eta Squared (\( \eta^2 \)), was
0.21, indicating a large effect (Cohen, 1988). These results show that cognition-supported features significantly increase knowledge construction.

**Statistical Effects of Cognition-Supported Features on Three-Message Knowledge Construction Score**

Posttest only data from students who wrote three messages in discussion 5 were included. Results from the independent samples two-tailed t-tests, with posttest only data, with equal variances assumed, comparing the posttest mean scores between the cognition-supported features group and control group showed that the level of knowledge construction in the cognition-supported features group was significantly higher in the cognition-supported features group than in the control group: \( t(83) = 2.887, p = 0.005 \). The significant level is 0.05. The strength of the association between type of discussion board features and knowledge construction posttest or the effect size, as indexed by Eta Squared, was 0.091, indicating a medium effect size (Cohen, 1988). These results suggest that cognitive-supported features significantly increase knowledge construction.

Results of statistical tests in both two-and three-message knowledge construction scores consistently showed that cognition-supported features integrated into the online discussion board system positively affected students’ level of knowledge construction in online discussions. The alternative hypothesis is confirmed: students have significantly higher knowledge construction in discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.
**Question 1.2.**

Does prior knowledge and experience in psychology influence the effect of cognition-supported features on students’ knowledge construction?

**Test of Assumptions**

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with knowledge construction posttest as the dependent variable, treatment group as the independent variable and prior knowledge and experience in psychology as the covariate were assessed.

**Two-Message Knowledge Construction Score**

In this analysis, two-message knowledge construction posttest scores and scores of prior knowledge and experience in psychology were included.

The homogeneity of variance assumption was not satisfied for the dependent variable knowledge construction. Therefore ANCOVA could not be conducted for the two-message knowledge construction score and thus no results were found for the two-message knowledge construction score case.

**Three-Message Knowledge Construction Score**

In this analysis, three-message knowledge construction posttest scores and scores of prior knowledge and experience in psychology were included. Table 4.7 showed the testing of assumptions for using ANCOVA.
Table 4.7. Assumptions for ANCOVA with 3-Message Knowledge Construction Score: Q1.2

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>As reported in Research Question 1.1, the normality assumption was satisfied for the three-message knowledge construction variable. Z-score tests based on skewness and kurtosis statistics for the distributions of the covariate prior knowledge and experience in psychology also indicated that the covariate met the normality assumption without any extreme outliers.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>As reported in Research Question 1.1., the homogeneity of variance assumption was also satisfied for the dependent variable knowledge construction</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 81) = 0.089, p = 0.0766$</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.

**Descriptive Statistics of Prior Knowledge and Experience in Psychology**

Table 4.8 presented the means and standard deviations of the covariate prior knowledge and experience and its items in the analysis against the three-message knowledge construction posttest for each group. The descriptive statistics showed that students in the cognition-supported features group and the control group had similar prior knowledge and experience in psychology. In addition, on average, in both groups, students tended to be undecided about whether they have high knowledge of psychology or practical experience involving psychology. However, on average, in both groups students tended to agree that they have encountered many situations where knowledge of psychology is useful.
### Table 4.8. Descriptive Statistics for Prior Knowledge & Experience in Psychology

<table>
<thead>
<tr>
<th>Item</th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>I have high knowledge of psychology</td>
<td>45</td>
<td>3.31</td>
<td>0.82</td>
</tr>
<tr>
<td>I have practical experience involving psychology</td>
<td>45</td>
<td>3.33</td>
<td>1.02</td>
</tr>
<tr>
<td>I have encountered many situations where knowledge of psychology is useful</td>
<td>45</td>
<td>3.76</td>
<td>0.74</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>3.47</td>
<td>0.69</td>
</tr>
</tbody>
</table>

*Note.*

1. All items are on a 5-point Likert scale:
   - Strongly Disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly Agree

2. Total score for prior knowledge and experience in psychology is the average score of its three items.

### Statistical Results

The prior knowledge and experience of students was analyzed against the three-message knowledge construction scores. Results of ANCOVA showed that the main effect of the covariate prior knowledge and experience in psychology was not significant, $F(1, 82) = 0.661$, $p = 0.418$. Therefore, students’ level of prior knowledge and experience did not influence the effect of the cognition-supported features on students’ knowledge construction.
Question 1.3.

Does students’ level of prior experience in online discussion influence the effect of cognition-supported features on students’ knowledge construction?

Test of Assumptions

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with knowledge construction posttest as the dependent variable, treatment group as the independent variable and prior experience in online discussion as the covariate were assessed.

Two-Message Knowledge Construction Score

In this analysis, two-message knowledge construction posttest scores and scores of prior experience in online discussion were included.

The homogeneity of variance assumption was not satisfied for the dependent variable knowledge construction. Therefore ANCOVA was not conducted for two-message knowledge construction score, and thus no results were found for the two-message knowledge construction score case.

Three-Message Knowledge Construction Score

In this analysis, three-message knowledge construction posttest scores and scores of prior experience in online discussion were included.
Table 4.9. Assumptions for ANCOVA with 3-Message Knowledge Construction Score: Q1.3

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>As reported in Research Question 1.1, the normality assumption was satisfied for the knowledge construction score. Z-score tests based on skewness and kurtosis statistics for the original distributions of the covariate prior experience in online discussion also indicated that the covariate met the normality assumption without any outliers.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>As reported in Research Question 1.1, this assumption was also satisfied for the dependent variable knowledge construction.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 81) = 0.000$, $p = 0.996$</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.

**Descriptive Statistics of Prior Experience in Online Discussion**

Table 4.10 presented the means and standard deviations of the covariate prior experience in online discussion for each group. The descriptive statistics showed that in both groups, students tended to have little experience in online discussion both in and outside classroom context. In addition, students in the cognition-supported features group and the control group had similar prior experience in online discussion.
Table 4.10. Descriptive Statistics for Prior Experience in Online Discussion

<table>
<thead>
<tr>
<th></th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>My level of experience in online discussion in classroom context prior to this course is…</td>
<td>45</td>
<td>2.04</td>
<td>0.73</td>
</tr>
<tr>
<td>My level of experience in online discussion outside of classroom context is…</td>
<td>45</td>
<td>2.00</td>
<td>0.90</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>2.02</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Note:

1. All items are on a 4-point Likert-type scale: None Little Adequate High
2. Total score for prior experience in online discussion is the average of item scores

Statistical Results

The prior experience in online discussion of students was analyzed against the three-message knowledge construction scores. The results from ANCOVA (Analysis of Covariance) showed that the main effect of the covariate prior online discussion experience was not significant, $F(1, 82) = 0.440, p = 0.509$. Therefore, students’ level of prior experience in online discussion did not influence the effect of the cognition-supported features on students’ knowledge construction.
Research Question 2:

Effects of Cognition-Supported Features on Critical Thinking

Question 2.1.

Does the use of the cognition-supported features integrated into the online discussion board system affect students’ level of critical thinking in online discussions?

Hypothesis 2.1.

Students will demonstrate a significantly higher level of critical thinking in their discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.

Two scores measuring individual student’s level of critical thinking were calculated to answer research question 2. These were a two-message critical thinking score, and a three-message knowledge construction score. Results based on these two critical thinking scores are presented below.

Test of Assumptions for the Two Critical Thinking Scores

Two-Message Critical Thinking Score

Before performing ANCOVA with two-message critical thinking posttest as the dependent variable, treatment group as the independent variable and critical thinking pretest as the covariate, important assumptions were assessed (see Table 4.11).
Table 4.11. Assumptions for ANCOVA with 2-Critical Thinking Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z-score tests based on skewness and kurtosis statistics for the original distributions showed that the original distributions satisfied the normality assumption of ANCOVA. However, outliers existed. Therefore, outliers were managed to minimize outliers for more accurate ANCOVA results. After outlier management, the absolute values of z-scores of skewness and z-scores of kurtosis were less than 1.96, indicating the resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>Two high scores of the pretest distribution were truncated; one low scoring outlier in the pretest distribution and one low scoring outlier in the posttest distribution were eliminated.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Three high scores of the critical thinking posttest distribution were truncated and one low scoring outlier in the critical thinking posttest distribution was eliminated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results indicated there was no significant violation of this assumption: F (1, 84) = 0.626, p = 0.431.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: F(1, 82) = 1.126, p = 0.292</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA with two-message critical thinking pretest as a covariate was performed on the reduced dataset. However, since ANCOVA results showed that the main effect of the covariate (critical thinking pretest) was not statistically significant, F(1, 83) = 0.126, p = 0.724, an independent samples t test on critical thinking posttest was performed to get a more accurate effect size statistic Eta Squared, after t-test assumptions were assessed for normality and homogeneity of variance (see Table 4.12).
Table 4.12. Assumptions for t-test with 2-Message Critical Thinking Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z score tests showed the posttest distribution in each group satisfied the normality assumption. However, outliers were managed for more accurate t-test results. After outlier management, the absolute values of z-scores of skewness and kurtosis were less than 1.96, indicating the resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>One low scoring outlier was eliminated.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Three high scores were truncated and one low scoring outlier was eliminated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results indicated there was no significant violation of this assumption: $F = 1.108$, $p = 0.295$.</td>
</tr>
</tbody>
</table>

Based on the results of the test of assumptions, t-test was run and the equal variances assumed version was used.

**Three-Message Critical Thinking Score**

Before performing ANCOVA with three-message critical thinking posttest as the dependent variable, treatment group as the independent variable and knowledge construction pretest as the covariate, important assumptions were assessed (see Table 4.13).

Table 4.13. Assumptions for ANCOVA with 3-Message Critical Thinking Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z score tests showed the original distributions satisfied the normality assumption. However, outliers were managed for more accurate ANCOVA results. After outlier management, the absolute values of z-scores of skewness and kurtosis were less than 1.96, indicating the resulting distributions met the normality assumption.</td>
</tr>
<tr>
<td>Control Group</td>
<td>Two high scores in the pretest distribution were truncated.</td>
</tr>
<tr>
<td>Cognition-Supported Features Group</td>
<td>Two low scoring outliers were eliminated and two high scores in the posttest distribution were truncated.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F(1, 77) = 1.561$, $p = 0.215$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 75) = 0.208$, $p = 0.650$</td>
</tr>
</tbody>
</table>


Since these important assumptions for running ANCOVA were not violated, a one-way ANCOVA with three-message critical thinking pretest as a covariate was carried out on the reduced dataset. However, since ANCOVA results showed that the main effect of the covariate (critical thinking pretest) was not statistically significant, \( F(1, 76) = 0.163, p = 0.688 \), an independent samples t test on critical thinking posttest was performed to get a more accurate effect size statistic Eta Squared, after t-test assumptions were assessed for normality and homogeneity of variance (see Table 4.14).

Table 4.14. Assumptions for t-test with 3-Message Critical Thinking Score

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption</td>
<td>Z-score tests based on skewness and kurtosis statistic for the distributions of the original dataset showed that the original posttest distributions satisfied the normality assumption. However, to minimize outliers for more accurate t-test results, in the cognition-supported features group, two low scoring outliers were eliminated and two high score outliers were truncated. After outlier management, the absolute values of z-scores of skewness and kurtosis were less than 1.96, indicating the resulting distribution still met the normality assumption.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results indicated there was no significant violation of this assumption: ( F = 0.818, p = 0.181 ).</td>
</tr>
</tbody>
</table>

Based on the results of the test of assumptions, t-test was run and the equal-variances-assumed version was used.

**Descriptive Statistics**

Table 4.15 and Table 4.16 show the means and standard deviations after managing outliers for the two-message critical thinking posttest and the three-message critical thinking posttest.
Descriptive statistics for two-message critical thinking posttest in Table 4.15 showed that students’ critical thinking in the cognition-supported features group was higher than in the control group.

Table 4.15. Two-Message Critical Thinking Posttest

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cultural group)</td>
<td>43</td>
<td>9.40</td>
<td>2.412</td>
</tr>
<tr>
<td>Cognition-supported features group</td>
<td>45</td>
<td>10.20</td>
<td>2.128</td>
</tr>
</tbody>
</table>

*Note. Maximum score for two-message critical thinking is 36*

Descriptive results for three-message critical thinking posttest in Table 4.16 showed that the cognition-supported features group had higher critical thinking than the control group.

Table 4.16. Three-Message Critical Thinking Posttest

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Cultural group)</td>
<td>40</td>
<td>12.15</td>
<td>3.332</td>
</tr>
<tr>
<td>Cognition-supported features group</td>
<td>44</td>
<td>13.73</td>
<td>2.840</td>
</tr>
</tbody>
</table>

*Note. Maximum score for three-message critical thinking is 54*

As shown in Table 4.15 and Table 4.16, the cognition-supported features group had higher critical thinking posttest than the control group did. This was true for both two-message and three-message critical thinking scores.
Hypothesis Testing

Statistical Effects of Cognition-Supported Features on Two-Message Critical Thinking Score

Results from the independent samples two-tailed t-test, with equal variances assumed, comparing two-message critical thinking posttest mean scores between the cognition-supported features group and control group showed that the difference in critical thinking level between the two groups was also not significant, $t(86) = 1.662, p = 0.100$, two-tailed. The significant level is 0.05 level.

Statistical Effects of Cognition-Supported Features on Three-Message Critical Thinking Score

Results from independent samples two-tailed t-test, with equal variances assumed, comparing three-message critical thinking posttest mean scores between the cognition-supported features group and the control group showed that the level of critical thinking in the cognition-supported features group was also significantly higher than in the control group: $t(82) = 2.341, p = 0.022$. The significant level is 0.05. The strength of the association between type of discussion board features and critical thinking posttest or the effect size, as indexed by Eta Squared, was 0.0626, indicating a medium effect size according to Cohen (1988). These results suggest that cognitive-supported features significantly increase students’ critical thinking.

Results of statistical tests of the effects of three-message critical thinking scores showed that cognition-supported features integrated into the online discussion board system positively affected students’ critical thinking in online discussions. The alternative
hypothesis is confirmed: students will have significantly higher critical thinking in discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features. However, results of statistical tests of the effects of the two-message critical thinking scores failed to confirm the alternative hypothesis. Nevertheless, the low p value (0.1) calls for further exploration of the effect of the cognition-supported features on students’ critical thinking. Based on both analyses of two-message critical thinking scores and three-message critical thinking scores, it can be said that there is strong evidence for a positive effect of cognition-supported features on students’ critical thinking in online discussion, but further research would be helpful to confirm this positive effect.

**Question 2.2.**

Does prior knowledge and experience in the subject domain influence the effect of cognition-supported features on students’ critical thinking?

**Test of Assumptions**

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with critical thinking posttest as the dependent variable, treatment group as the independent variable and prior knowledge and experience in psychology as the covariate were assessed.

**Two-Message Critical Thinking Score**

The testing of assumptions for using ANCOVA with two-message critical thinking posttest scores were shown in Table 4.17.
Table 4.17. Assumptions for ANCOVA with 2-Message Critical Thinking Score: Q2.2

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge</td>
<td>Z-score tests based on skewness and kurtosis statistics showed that the normality assumption was satisfied for both the dependent variable critical thinking and the covariate prior knowledge and experience in psychology.</td>
</tr>
<tr>
<td>Construction Score</td>
<td></td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F = 1.108$, $p = 0.295$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 84) = 0.10$, $p = 0.922$.</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.

**Three-Message Critical Thinking Score**

The testing of assumptions for using ANCOVA with three-message critical thinking posttest scores were shown in Table 4.18.

Table 4.18. Assumptions for ANCOVA with 3-Message Critical Thinking Score: Q2.3

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge</td>
<td>Z-score tests based on skewness and kurtosis statistics showed that the normality assumption was satisfied for both the dependent variable critical thinking and the covariate prior knowledge and experience in psychology.</td>
</tr>
<tr>
<td>Construction Score</td>
<td></td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F = 1.818$, $p = 0.181$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 84) = 0.04$, $p = 0.948$.</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.
Descriptive Statistics of Prior Knowledge and Experience in Psychology

Table 4.19 showed the means and standard deviations of prior knowledge and experience and its items for each group in the analysis against two-message critical thinking posttest. Table 4.20 showed the means and standard deviations of prior knowledge and experience and its items for each group in the analysis against three-message critical thinking posttest. In both cases, the cognition-supported features group and the control group had similar prior knowledge and experience in the subject domain. In addition, in both analysis against two-message critical thinking score and analysis against three-message critical thinking score, the statistics indicated that in both groups, on average, students tended to be undecided about whether they have high knowledge in psychology or practical experience involving psychology. However, on average, they tended to agree that they have encountered many situations where knowledge of psychology is useful.

Table 4.19. Descriptive Statistics for Prior Knowledge and Experience in the Analysis with Two-Message Knowledge Construction Posttest

<table>
<thead>
<tr>
<th></th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>I have high knowledge of psychology</td>
<td>45</td>
<td>3.31</td>
<td>0.82</td>
</tr>
<tr>
<td>I have practical experience involving psychology</td>
<td>45</td>
<td>3.33</td>
<td>1.02</td>
</tr>
<tr>
<td>I have encountered many situations where knowledge of psychology is useful</td>
<td>45</td>
<td>3.76</td>
<td>0.74</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>3.47</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Note.

1. All items are on a 5-point Likert scale:
   Strongly Disagree, Disagree, Undecided, Agree, Strongly Agree

2. Total score for prior knowledge and experience in psychology is the average score of its three items.
Table 4.20. Descriptive Statistics for Prior Knowledge and Experience in the Analysis with Three-Message Knowledge Construction Posttest

<table>
<thead>
<tr>
<th></th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>I have high knowledge of psychology</td>
<td>44</td>
<td>3.30</td>
<td>0.82</td>
</tr>
<tr>
<td>I have practical experience involving psychology</td>
<td>44</td>
<td>3.32</td>
<td>1.03</td>
</tr>
<tr>
<td>I have encountered many situations where knowledge of psychology is useful</td>
<td>44</td>
<td>3.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>3.45</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Note.

1. All items are on a 5-point Likert scale: Strongly Disagree, Disagree, Undecided, Agree, Strongly Agree
2. Total score for prior knowledge and experience in psychology is the average score of its three items.

Statistical Results

Two-Message Critical Thinking Score

Results of ANCOVA (Analysis of Covariance) showed that the main effect of the covariate prior knowledge and experience in psychology was not significant, F(1, 85) = 0.657, p = 0.420. Therefore, students’ level of prior knowledge and experience did not influence the effect of the cognition-supported features on students’ critical thinking.
**Three-Message Critical Thinking Score**

Results of ANCOVA (Analysis of Covariance) showed that the main effect of the covariate prior knowledge and experience in psychology was not significant, $F(1,81) = 0.665$, $p = 0.417$. Therefore, students’ level of prior knowledge and experience did not influence the effect of the cognition-supported features on students’ critical thinking.

ANCOVA results in both two-and three-message critical thinking scores consistently showed that students’ level of prior knowledge and experience did not influence the effect of the cognition-supported features on students’ critical thinking.

**Question 2.3.**

Does students’ level of prior experience in online discussion influence the effect of cognition-supported features on students’ critical thinking?

**Test of Assumptions**

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with critical thinking posttest as the dependent variable, treatment group as the independent variable and prior experience in online discussion as the covariate were assessed.

**Two-Message Critical Thinking Score**

The testing of assumptions for using ANCOVA with two-message critical thinking posttest scores were shown in Table 4.21.
Table 4.21. Assumptions for ANCOVA with 2-Message Critical Thinking Score: Q 2.3

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z-score tests based on skewness and kurtosis statistics showed that the normality assumption was satisfied for both the dependent variable critical thinking and the covariate prior experience in online discussion.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F = 1.108$, $p = 0.295$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 84) = 0.175$, $p = 0.676$.</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.

**Three-Message Critical Thinking Score**

The testing of assumptions for using ANCOVA with three-message critical thinking posttest scores were shown in Table 4.22.

Table 4.22. Assumptions for ANCOVA with 3-Message Critical Thinking Score: Q2.3

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z-score tests based on skewness and kurtosis statistics showed that the normality assumption was satisfied for both the dependent variable critical thinking and the covariate prior experience in online discussion.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F = 1.818$, $p = 0.181$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 80) = 0.596$, $p = 0.442$.</td>
</tr>
</tbody>
</table>

Since the important assumptions for running ANCOVA were satisfied, a one-way ANCOVA was performed.
Descriptive Statistics of Prior Experience in Online Discussion

Table 4.23 showed the means and standard deviations of prior experience in online discussion and its item in the analysis using two-message critical thinking posttest for each group. Table 4.24 showed the means and standard deviations of prior experience in online discussion and its items in the analysis against three-message critical thinking posttest for each group. In both cases, the cognition-supported features group and the control group had similar prior experience in online discussion. In addition, the information shows that students tended to have little experience in online discussion both inside and outside classroom context.

Table 4.23. Descriptive Statistics for Prior Experience in Online Discussion in Analysis with Two-Message Critical Thinking Posttest

<table>
<thead>
<tr>
<th></th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>My level of experience in online discussion in classroom context prior to this course is…</td>
<td>45</td>
<td>2.04</td>
<td>0.74</td>
</tr>
<tr>
<td>My level of experience in online discussion outside of classroom context is…</td>
<td>45</td>
<td>2.00</td>
<td>0.90</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>2.02</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Note:

1. All items are on a 4-point Likert-type scale: None, Little, Adequate, High
2. Total score for prior experience in online discussion is the average of item scores
Table 4.24. Descriptive Statistics for Prior Experience in Online Discussion in Analysis with Three-Message Critical Thinking Posttest

<table>
<thead>
<tr>
<th>Group</th>
<th>Cognition-Supported Features Group</th>
<th>Control Group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>My level of experience in online discussion in classroom context prior to this course is…</td>
<td>44</td>
<td>2.05</td>
<td>0.75</td>
</tr>
<tr>
<td>My level of experience in online discussion outside of classroom context is…</td>
<td>44</td>
<td>2.00</td>
<td>0.92</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>2.02</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Note:
1. All items are on a 4-point Likert-type scale: None, Little, Adequate, High
2. Total score for prior experience in online discussion is the average of item scores

Statistical Results

Two-Message Critical Thinking Score

Results of ANCOVA (Analysis of Covariance) showed that the main effect of the covariate prior experience in online discussion was not significant, F(1, 85) = 0.048, p = 0.827. Therefore, students’ level of prior experience in online discussion did not influence the effect of the cognition-supported features on students’ critical thinking.

Three-Message Critical Thinking Score

Results of ANCOVA (Analysis of Covariance) showed that the main effect of the covariate prior experience in online discussion was not significant, F(1, 81) = 1.660, p = 0.201. Therefore, students’ level of prior experience in online discussion did not influence the effect of the cognition-supported features on students’ critical thinking.
Research Question 3:

Effects of Intercultural Interactive Elaboration on Intercultural Sensitivity

Question 3.1.

Does the use of intercultural interactive elaboration features integrated into the online discussion board system affect students’ level of intercultural sensitivity?

Alternative Hypothesis:

Students in the groups with intercultural interactive elaboration features integrated into the online discussion board system will have significantly higher intercultural sensitivity than students in the groups without these features.

To answer this research question, ANCOVA with intercultural sensitivity posttest as dependent variable and intercultural sensitivity pretest as the covariate was performed.

Test of Assumptions

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with intercultural sensitivity posttest as the dependent variable, treatment group as the independent variable and intercultural sensitivity pretest as the covariate were assessed (see Table 4.25).
Table 4.25. Assumptions for ANCOVA: Q3.1

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge Construction Score</td>
<td>Z-score tests based on skewness and kurtosis statistics showed that the normality assumption was not violated for both the dependent variable intercultural sensitivity posttest and the covariate intercultural sensitivity pretest.</td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: $F = 1.554, p = 0.216$.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: $F(1, 79) = 2.129, p = 0.149$.</td>
</tr>
</tbody>
</table>

Since these assumptions for running ANCOVA were not violated, a one-way ANCOVA with intercultural sensitivity pretest as the covariate was performed.

**Descriptive Statistics**

Descriptive statistics showed high mean scores for the intercultural sensitivity scale and all of its subscales on both the pre-test and the post-test (see Table 4.26). The mean scores of pretest for the total intercultural sensitivity scale were 4.14 for the control group and 4.05 for the interactive intercultural elaboration features group. The mean scores of posttest for the total intercultural sensitivity scale were 4.16 for the control group and 4.08 for the interactive intercultural elaboration features group. The differences between the two groups were quite negligible for both pretest and posttest. Interestingly, among all the subscales, the mean scores for interaction confidence were lowest.
Table 4.26. Descriptive Statistics for Intercultural Sensitivity Scale and Its Subscales

<table>
<thead>
<tr>
<th>Subscales</th>
<th># of items</th>
<th>Group</th>
<th>N</th>
<th>Pre-test Mean (Std. Deviation)</th>
<th>N</th>
<th>Post-test Mean (Std. Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercultural Sensitivity Scale</td>
<td>24</td>
<td>Control</td>
<td>46</td>
<td>4.14(0.406)</td>
<td>43</td>
<td>4.16(0.459)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural</td>
<td>47</td>
<td>4.05(0.408)</td>
<td>49</td>
<td>4.08(0.410)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>93</td>
<td>4.10 (0.407)</td>
<td>92</td>
<td>4.11(0.433)</td>
</tr>
<tr>
<td>Intercultural Sensitivity Scale</td>
<td></td>
<td>Control</td>
<td>37</td>
<td>4.13(0.401)</td>
<td>37</td>
<td>4.14(0.475)</td>
</tr>
<tr>
<td>(valid listwise)</td>
<td></td>
<td>Cultural</td>
<td>46</td>
<td>4.06(0.410)</td>
<td>46</td>
<td>4.10(0.403)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>83</td>
<td>4.09(0.405)</td>
<td>83</td>
<td>4.11(0.434)</td>
</tr>
<tr>
<td>Subscales</td>
<td></td>
<td>Control</td>
<td>49</td>
<td>4.13(0.435)</td>
<td>46</td>
<td>4.14(0.507)</td>
</tr>
<tr>
<td>Interaction Engagement</td>
<td>7</td>
<td>Cultural</td>
<td>48</td>
<td>4.08(0.447)</td>
<td>49</td>
<td>4.14(0.450)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>97</td>
<td>4.11(0.439)</td>
<td>95</td>
<td>4.14(0.476)</td>
</tr>
<tr>
<td>Respect for Cultural Differences</td>
<td>6</td>
<td>Control</td>
<td>47</td>
<td>4.36(0.571)</td>
<td>48</td>
<td>4.32(0.643)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural</td>
<td>49</td>
<td>4.265(0.487)</td>
<td>50</td>
<td>4.27(0.511)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>96</td>
<td>4.31(0.529)</td>
<td>98</td>
<td>4.29(0.577)</td>
</tr>
<tr>
<td>Interaction Confidence</td>
<td>5</td>
<td>Control</td>
<td>50</td>
<td>3.94(0.535)</td>
<td>49</td>
<td>3.95(0.514)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural</td>
<td>48</td>
<td>3.72(0.632)</td>
<td>50</td>
<td>3.74(0.683)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>98</td>
<td>3.83(0.592)</td>
<td>99</td>
<td>3.84(0.611)</td>
</tr>
<tr>
<td>Interaction Enjoyment</td>
<td>3</td>
<td>Control</td>
<td>51</td>
<td>4.35(0.496)</td>
<td>47</td>
<td>4.36(0.589)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural</td>
<td>49</td>
<td>4.12(0.572)</td>
<td>50</td>
<td>4.12(0.572)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>100</td>
<td>4.24 (0.545)</td>
<td>97</td>
<td>4.25(0.593)</td>
</tr>
<tr>
<td>Interaction Attentiveness</td>
<td>3</td>
<td>Control</td>
<td>50</td>
<td>4.01(0.561)</td>
<td>49</td>
<td>4.075(0.554)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural</td>
<td>49</td>
<td>3.95(0.557)</td>
<td>50</td>
<td>4.01(0.483)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both</td>
<td>99</td>
<td>3.98 (0.557)</td>
<td>99</td>
<td>4.04(0.518)</td>
</tr>
</tbody>
</table>

*Note.* All items are on a 5-point Likert scale

**ANCOVA Results**

ANCOVA results showed that the main effect of the covariate (intercultural sensitivity pretest) on the intercultural sensitivity posttest was statistically significant, F(1, 80) = 185.058, p = 0.000. After the intercultural sensitivity pretest was statistically controlled, the main effect for type of discussion board features was not statistically significant, F(1, 80) = 0.136, p = 0.714. This suggests the interactive intercultural elaboration features did not significantly increase students’ intercultural sensitivity.
Question 3.2.

Does prior cross-cultural experience influence the effect of interactive intercultural elaboration features on students’ intercultural sensitivity?

In order to answer this research question, ANCOVA with intercultural sensitivity pretest and students’ prior cross cultural experience as the covariates was performed.

Missing Data Management

Data screening of prior cross cultural experience items showed that there were 7 cases that had one item with missing value. Each of these missing values was replaced with the corresponding series’ mean. Data screening of intercultural sensitivity pretest and posttest also showed missing values. For pretest, for 10 items, there were from 1 to 2 missing values among 97 cases with both pretest and posttest data (one item had 2 missing values). For posttest, for 6 items, there were from 1 to 2 missing values among 97 cases with both pretest and posttest (one item had 2 missing values). These missing values were replaced with the corresponding series’ means. Z-score tests based on skewness and kurtosis statistics showed that the resulting distributions of prior cross cultural experience were positively skewed in both groups. Therefore, the score from the high scoring outlier in the interactive intercultural elaboration features group was truncated. In addition, the scores from the high scoring outlier in the control group and the next highest scoring data point were also truncated. After this data processing procedure, the absolute values of z-scores of skewness and z-scores of kurtosis were less than 1.96, indicating the resulting distributions for prior cross cultural experience, intercultural sensitivity pretest and posttest in both groups met the normality assumption.
Descriptive Statistics

Descriptive statistics showed that after missing data management, students in the interactive intercultural elaboration features group had slightly higher prior cross cultural experience than in the control (cognition-supported features group) but slightly lower intercultural sensitivity in both pretest and posttest (see Table 4.27).

Table 4.27. Descriptive Statistics for Prior Cross Cultural Experience, Pretest Intercultural Sensitivity, Posttest Intercultural Sensitivity

<table>
<thead>
<tr>
<th></th>
<th>Control (cognitive) group</th>
<th>Interactive intercultural elaboration features group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Prior cross cultural experience</td>
<td>48</td>
<td>6.53</td>
</tr>
<tr>
<td>Pretest intercultural sensitivity</td>
<td>48</td>
<td>4.17</td>
</tr>
<tr>
<td>Posttest intercultural sensitivity</td>
<td>48</td>
<td>4.16</td>
</tr>
</tbody>
</table>

*Note. Maximum score for intercultural sensitivity is 5.*

Test of Assumptions

Normality Assumption, Homogeneity of Variances Assumption, and Homogeneity of Regression Assumption for performing ANCOVA with intercultural sensitivity posttest as the dependent variable, treatment group as the independent variable, and intercultural sensitivity pretest and prior cross cultural experience as the two covariates were assessed.
Table 4.28. Assumptions for Using ANCOVA: Q3.2

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality Assumption of Knowledge</td>
<td>Normality assumptions were satisfied for the dependent variable intercultural sensitivity posttest as well as the two covariates of intercultural sensitivity pretest and prior cross cultural experience.</td>
</tr>
<tr>
<td>Construction Score</td>
<td></td>
</tr>
<tr>
<td>Homogeneity of Variance Assumption</td>
<td>Levene test results showed this assumption was not violated: F = 0.884, p = 0.350.</td>
</tr>
<tr>
<td>Homogeneity of Regression Assumption</td>
<td>Results from a preliminary ANCOVA using SPSS GLM with a customized model that included a treatment x covariate interaction term showed that there was no significant violation of this assumption: F (1, 93) = 1.732, p = 0.191 for the interaction between treatment and intercultural sensitivity pretest, and F(1, 93) = 0.002, p = 0.963 for the interaction between treatment and prior cross cultural experience.</td>
</tr>
</tbody>
</table>

Since these assumptions for running ANCOVA were not violated, a one-way ANCOVA without these two interaction terms between treatment and the two covariates was performed.

**ANCOVA Results**

ANCOVA results showed that prior cross cultural experience did not influence the effect of interactive intercultural elaboration features on students’ intercultural sensitivity, F(1, 93) = 0.096, p = 0.757.
Research Question 4:
Patterns of Knowledge Construction in Two Different Discussion Frameworks

In the case of a constraint-based discussion board, how different are the patterns of knowledge construction in discussions following argumentation and problem solving discussion frameworks in terms of knowledge construction phases, knowledge construction operations under each phase, and the density of knowledge construction?

In order to answer this research question, discussions based on Persuasion (Topic 7) and Contemporary Problems and Culture (Topic 8) were selected. The Persuasion discussion used the argumentation framework in the cognition supported discussion board. The Problems and Culture discussion used the problem solving discussion framework. These discussions were analyzed by group: Group A participants had experience with the cognition-supported features previously, while Group B participants were using them for the first time.

Each group had 8 students. However, since one student in Group A only wrote one message for the Persuasion discussion, data from this student was eliminated for more balanced assessment and comparison between the two groups and the two discussion frameworks.

The argumentation-based and problem solving-based discussions from Group A had 21 messages each. Each student in Group A wrote three messages per discussion. The Argumentation-based discussion and problem solving-based discussions from Group B had 24 messages each. Each student in Group B wrote three messages per discussion.

For clarity and conciseness, the researcher will refer to Group A as CSF-com and Group B as IIEF-Com for the remainder of this section. CSF indicates the use of cognition-
supported features and IIEF the use of interactive intercultural elaboration features in Phase 2. Com denotes that both groups used a combination of both types of features in Phase 3 (see Table 4.29).

Table 4.29. Descriptions of Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Label</th>
<th>Number of students</th>
<th>Number of messages per student in a discussion</th>
<th>Features used in Phase 2</th>
<th>Features used Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>CSF-Com group</td>
<td>7</td>
<td>3</td>
<td>Cognition-Supported Features</td>
<td>Both types of features</td>
</tr>
<tr>
<td>Group B</td>
<td>IIEF-Com group</td>
<td>8</td>
<td>3</td>
<td>Interactive Intercultural Elaboration Features</td>
<td>Both types of features</td>
</tr>
</tbody>
</table>

Knowledge constructions in these groups’ discussions were examined descriptively in terms of knowledge construction phases, knowledge construction operations under each phase, and the density of knowledge construction.

Knowledge Construction by Phases

To determine if there was evidence of knowledge construction at higher phases in one group versus the other or one discussion framework versus the other, two codes were analyzed: the number of times a phase appeared in all messages and the highest phase of knowledge construction reached in each message. The number of times a phase appeared in all messages gives evidence of knowledge construction phases students went through in a
discussion and reveals part of what actually happened in the process. It allows the researcher to determine the level of concentration of each phase in a given discussion framework. The frequency of each phase as the highest phase in a message allows the researcher to determine which phases students reached most often in each type of discussion framework.

**Knowledge Construction Process: Frequencies of knowledge construction phases**

To examine the knowledge construction process students went through in each type of discussion framework, frequencies of knowledge construction phases were examined. Each phase coded in a message was counted once in that message. The frequency of each phase was counted for each of the groups’ discussions. After that, to obtain the average frequency of each phase, the frequencies of each phase in the whole discussion were divided by the number of students in the corresponding group. These frequencies were then descriptively compared between the two discussion frameworks as well as between the two groups (see Table 4.30).

<table>
<thead>
<tr>
<th>Framework Type</th>
<th>N</th>
<th>Phase I Sharing</th>
<th>Phase II Dissonance</th>
<th>Phase III Negotiation</th>
<th>Phase IV Testing</th>
<th>Phase V Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF-Com group</td>
<td>7</td>
<td>2.00</td>
<td>1.71</td>
<td>1.43</td>
<td>0.14</td>
<td>1.57</td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td>8</td>
<td>2.88</td>
<td>2.00</td>
<td>0.25</td>
<td>0.63</td>
<td>0.88</td>
</tr>
<tr>
<td>Both Groups</td>
<td>15</td>
<td>2.47</td>
<td>1.87</td>
<td>0.80</td>
<td>0.40</td>
<td>1.20</td>
</tr>
</tbody>
</table>

*Note.*
1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion.

2. Average Frequency for Each Phase per Student = Number of Phase Occurrences in the Discussion / Number of Students in the Group

3. Since each student wrote 3 messages, the average frequency of each phase per student is the number of phase occurrences per 3 messages from a student.

As shown in Table 4.30, there were differences between the argumentation-based discussions and the problem solving discussions in terms of the frequencies of knowledge construction phases. For both CSF-Com and IIEF-Com groups, the argumentation-based discussion elicited more Phase I (Sharing and Comparing) occurrences than the problem solving-based discussion.

For the CSF-Com group, where students were more experienced with the cognition-supported features, the argumentation-based discussion elicited more Phase II (Discovery of Dissonance) occurrences than the problem solving-based discussion. However, this was not observed in the IIEF-Com group.

For both groups, the problem solving-based discussion elicited more occurrences of Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) than the argumentation-based discussion.

Comparing CSF-Com and IIEF-Com groups, a pattern emerged: The CSF-Com group had more occurrences of higher phases like Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification); the IIEF-Com group had more occurrences of the lowest Phase I (Sharing and Comparing).

Looking at each discussion framework individually, in both discussion frameworks, there were more occurrences of Phase I (Sharing and Comparing) and Phase III (Negotiation
and Co-construction) than Phase II (Discovery of Dissonance) and Phase IV (Testing and Modification). The argumentation-based discussions had more Phase I (Sharing and Comparing) occurrences than Phase III (Negotiation and Co-construction) occurrences and more Phase II (Discovery of Dissonance) than Phase IV (Testing and Modification) occurrences. On the contrary, the problem solving-based discussions had more instances of Phase III (Negotiation and Co-construction) than Phase I (Sharing and Comparing) and more Phase IV (Testing and Modification) than Phase II (Discovery of Dissonance) occurrences.

These observations show that students in the argumentation-based discussions went through more low-level Phase I (Sharing and Comparing) and fewer Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) in the knowledge construction process. In addition, the CSF-com group went through more high-level phases than the IIEF-group in both types of discussion frameworks.

**Knowledge Construction Phase Reached**

To determine which phases students reached more often in each type of discussion framework, the frequencies of each phase as the highest phase in a message were counted for each group. Since the numbers of students in each group were not equal, the average frequency of a phase as the highest phase was obtained by dividing the frequency of that phase in a discussion by the number of students in that discussion group (see Table 4.31).
Table 4.31. Average Frequency of Knowledge Construction Phase as the Highest Phase in a Message

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Phase IV</th>
<th>Phase V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sharing</td>
<td>Dissonance</td>
<td>Negotiation</td>
<td>Testing</td>
</tr>
<tr>
<td>N</td>
<td>A</td>
<td>PS</td>
<td>A</td>
<td>PS</td>
</tr>
<tr>
<td>CSF-Com group</td>
<td>7</td>
<td>1.00</td>
<td>0.29</td>
<td>0.43</td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td>8</td>
<td>1.88</td>
<td>0.38</td>
<td>0.25</td>
</tr>
<tr>
<td>Both Groups</td>
<td>15</td>
<td>1.47</td>
<td>0.33</td>
<td>0.33</td>
</tr>
</tbody>
</table>

*Note.*

1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion.
2. Average Frequency for Each Phase and the Highest Phase per Student = Number of Phase Occurrences as the Highest Phase in the Discussion / Number of Students in the Group
3. Since each student wrote 3 messages, the average frequency of each phase as the highest phase per student is the number of phase occurrences as the highest phase per 3 messages from a student.

As shown in Table 4.31, there were differences between the argumentation-based and problem solving discussions in terms of the frequencies of knowledge construction phases as the highest phase in a message.

The argumentation-based discussion elicited more messages at the low-level Phase I (Sharing and Comparing) for both groups than the problem solving-based discussion.

For the CSF-Com group, the argumentation-based discussions had slightly more messages at Phase II (Discovery of Dissonance) than the problem solving-based discussion. However, this was not true for the IIEF-Com group.
The problem solving-based discussion elicited more messages at high-level Phase III (Negotiation and Co-construction) or Phase IV (Testing and Modification) for both groups than the argumentation-based discussion. The difference was greater for the CSF-Com group.

Comparing the CSF-Com group and the IIEF-Com group, in the argumentation-based discussions, students in the CSF-Com group seemed to reach higher phases more frequently in the knowledge construction process than students in the IIEF-Com group. The IIEF-Com group had more Phase I (Sharing and Comparing) messages but the CSF-Com group had more Phases II Discovery of Dissonance, Phase III (Negotiation and Co-construction), and Phase IV (Testing and Modification) messages. This may be evidence that these CSF-Com group students were more used to these cognition-supported features and therefore constructed knowledge at a higher level. A similar pattern was also found in the problem solving-based discussions, although to a lesser extent.

Looking at each discussion framework individually, for each group, the problem-solving discussion had more messages at Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) than at Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance). However, no pattern emerged for the argumentation-based discussions. In the argumentation-based discussions, the CSF-Com group’s messages reached Phase III (Negotiation and Co-construction) most frequently while the IIEF-Com group’s messages reached Phase I (Sharing and Comparing) most frequently.

These observations showed that the argumentation-based discussions’ messages reached Phase I (Sharing and Comparing) more often than the problem-solving based discussions’ messages while the problem solving-based discussions’ messages reached Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) more often.
In addition, the CSF-com group reached more Phase II (Discovery of Dissonance), Phase III (Negotiation and Co-construction), and Phase IV (Testing and Modification).

**Knowledge Construction by Operations**

To determine if there was a difference between the two discussion frameworks in the existence of knowledge construction operations in each phase, the differences between the two discussion frameworks in the number of different knowledge construction operations in each phase were examined. The results may reveal the operations or cognitive processes more likely to be prompted by one discussion framework versus the other.

**Phase 1: Sharing/Comparing of Information**

Average frequencies of Phase I (Sharing and Comparing) knowledge construction operation occurrences per student were obtained by dividing the numbers of Phase I (Sharing and Comparing) operations in a discussion by the number of students who participated in that discussion. As shown in Table 4.32:

- The argumentation-based discussions had more occurrences of Phase I (Sharing and Comparing) operations than the problem solving-based discussions.
- In both argumentation-based discussions and problem solving-based discussions, there were mostly Phase I/A (Share Observation) and Phase I/C (Provide Examples) occurrences, followed by Phase I/B (State Agreement).
- In both types of discussions, there were very few occurrences of Phase I/D (Clarify Details) and Phase I/E (Identify Problems).
These Phase I-related observations showed that the argumentation and problem solving discussion frameworks were quite similar in terms of which operations were found in their Phase I (Sharing and Comparing) occurrences: mostly Phase I/A (Share Observation) and Phase I/C (Provide Examples), followed by Phase I/B (State Agreement).

Table 4.32. Average Frequencies of Phase I (Sharing and Comparing) Operations

<table>
<thead>
<tr>
<th>Phase I/A Share Observation</th>
<th>Phase I/B State Agreement</th>
<th>Phase I/C Provide Examples</th>
<th>Phase I/D Clarify Details</th>
<th>Phase I/E Identify Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>A</td>
<td>PS</td>
<td>A</td>
<td>PS</td>
</tr>
<tr>
<td>CSF-Com group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.57</td>
<td>1.43</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1.75</td>
<td>1.25</td>
<td>1.25</td>
<td>0.88</td>
</tr>
<tr>
<td>Both Groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1.67</td>
<td>1.33</td>
<td>0.80</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Note:
1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion.
2. Average Frequency for Each Phase I Operation per Student = the Number of Operation Occurrences in the Discussion / Number of Students in the Group

Phase 2: Discovery and exploration of dissonance or inconsistency among ideas

As shown in Table 4.33, the argumentation-based discussions seemed to have more occurrences of Phase II (Discovery of Dissonance) operations than the problem solving-based discussions. Most of these Phase II (Discovery of Dissonance) operations were Phase II/A (Identify Agreement), followed by Phase II/C (Restate Position and Possibly Provide
Support). This pattern was consistent in both discussion frameworks. There were no occurrences of PhII/B (Clarify Disagreement) in either discussion frameworks.

Table 4.33. Average Frequencies of Phase II (Discovery of Dissonance) Knowledge Construction Operations Occurrences per Student

<table>
<thead>
<tr>
<th></th>
<th>Phase II/A Identify Disagreement</th>
<th>Phase II/B Clarify Disagreement</th>
<th>Phase II/C Restate Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>A</td>
<td>PS</td>
</tr>
<tr>
<td>CSF-Com group</td>
<td>7</td>
<td>1.43</td>
<td>0.14</td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td>8</td>
<td>0.25</td>
<td>0.63</td>
</tr>
<tr>
<td>Both groups</td>
<td>15</td>
<td>0.80</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Note.*

1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion.
2. Average Frequency for Each Phase II Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

These Phase II-related observations showed that the argumentation and problem solving discussion frameworks were similar in terms of which operations were found in their Phase II (Discovery of Dissonance) occurrences: mostly Phase II/A (Identify Agreement), then Phase II/C (Restate Position), and no occurrences of Phase II/B (Clarify Disagreement).
Phase 3: Negotiation of meaning/co-construction of knowledge

As shown in Table 4.34, the problem solving-based discussions had more Phase III (Negotiation and Co-construction) occurrences than the argumentation-based discussions. Most Phase III (Negotiation and Co-construction) operations were Phase III/D (Propose New Statements).

Table 4.34. Average Frequencies of Phase III (Negotiation and Co-construction) Knowledge Construction Operations Occurrences per Student

<table>
<thead>
<tr>
<th></th>
<th>Phase III/A Negotiate Meaning</th>
<th>Phase III/B Weigh Argument</th>
<th>Phase III/C Identify Agreement</th>
<th>Phase III/D Propose New Statements</th>
<th>Phase III/E Integrate Metaphors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N A PS</td>
<td>A PS</td>
<td>A PS</td>
<td>A PS</td>
<td>A PS</td>
</tr>
<tr>
<td>CSF-Com group</td>
<td>7 0.14 0.00 0.00 0.14 0.00 0.00</td>
<td>1.29 2.14 0.00 0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td>8 0.00 0.00 0.00 0.00 0.00 0.00</td>
<td>0.88 2.00 0.00 0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both Groups</td>
<td>15 0.07 0.00 0.00 0.07 0.00 0.00</td>
<td>1.07 2.07 0.00 0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note.
1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion.
2. Average Frequency for Each Phase III Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

Therefore, the argumentation and problem solving discussion frameworks were similar in terms of which operations found in their Phase III (Negotiation and Co-construction) occurrences: mostly Phase III/D (Propose New Statements).
Phase 4: Testing and modification of proposed synthesis or co-construction

As shown in Table 4.35, the argumentation and problem solving discussion frameworks were similar in terms of which operations were found in their Phase IV (Testing and Modification) occurrences: Phase IV/A (Test against “Received Fact”), Phase IV/B (Test against Cognitive Schema), and Phase IV/C (Test against Personal Experience). There were no occurrences of Phase IV/D (Test against Formal Data) or Phase IV/E (Test against Contradictory Testimony). In addition, the argumentation-based discussions had similar numbers of occurrences of Phase IV/A (Test against “Received Fact”), Phase IV/B (Test against Cognitive Schema), Phase IV/C (Test against Personal Experience), but the problem solving-based discussions had more occurrences of Phase IV/B (Test against Cognitive Schema) than other Phase IV operations.

Table 4.35. Average Frequencies of Phase IV (Testing and Modification) Knowledge Construction Operations Occurrences per Student

<table>
<thead>
<tr>
<th></th>
<th>Phase IV/A Test against “received fact”</th>
<th>Phase IV/B Test against cognitive schema</th>
<th>Phase IV/C Test against personal experience</th>
<th>Phase IV/D Test against formal data</th>
<th>Phase IV/E Test against contradictory testimony</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>A</td>
<td>PS</td>
<td>A</td>
<td>PS</td>
</tr>
<tr>
<td>CSF-Com group</td>
<td>7</td>
<td>0.29</td>
<td>0.57</td>
<td>0.29</td>
<td>1.14</td>
</tr>
<tr>
<td>IIEF-Com group</td>
<td>8</td>
<td>0.00</td>
<td>0.13</td>
<td>0.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Both Groups</td>
<td>15</td>
<td>0.13</td>
<td>0.33</td>
<td>0.13</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Note.

1. A: Argumentation-Based Discussion. PS: Problem Solving-Based Discussion
2. Average Frequency for Each Phase III Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group
Phase 5: Agreement statement(s)/Applications of newly-constructed meaning

There were no messages that reached Phase V in either discussion for either group.

Density of Knowledge Construction

The density of knowledge construction was assessed by the average number of knowledge construction operations made by each student in the whole discussion. Each knowledge construction operation was only counted once in a message. For example, if a message had the following codes: PhI/A, PhII/C, PhIII/D and then PhI/A again, this message’s number of knowledge construction operations would be 3 since PhI/A would be counted only once. The number of knowledge construction operations for one student is the sum of the numbers of knowledge construction operations in that student’s three messages.

As shown in Table 4.36, in the CSF-Com group, where students had used the cognition-supported features for a longer time, the knowledge construction was denser or involved more knowledge construction operations in the argumentation-based discussion than in the problem solving-based discussion, while the opposite was true for the IIEF-Com group.

Table 4.36. Average Number of Knowledge Construction Operations per Student

<table>
<thead>
<tr>
<th></th>
<th>CSF-Com group</th>
<th>IIEF-Com group</th>
<th>Both Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argumentation-Based</td>
<td>8.71</td>
<td>7.25</td>
<td>7.93</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving-Based</td>
<td>7.57</td>
<td>7.88</td>
<td>7.73</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note.

1. Each type of knowledge construction operation was counted only one time in a message
2. Average number of knowledge construction operations per student = Number of knowledge construction operations in a discussion / Number of students participating in that discussion
Summary

In summary, the following similarities and differences between the two discussion frameworks were observed:

Similarities:

• There were no Phase V (Agreement and Application) occurrences in either argumentation-based discussions or problem solving-based discussions.

• The group which have had more experience with the cognition-supported features tended to have more occurrences of higher knowledge construction phases than the group with less experience.

• At the knowledge construction operation level, Phase I (Sharing and Comparing) operations included primarily three out of five possible operations, with mostly occurrences of Sharing Observation and Providing Examples, followed by Stating Agreement. Phase II (Discovery of Dissonance) operations included primarily two out of three possible operations, with mostly occurrences of Identifying Disagreement, then Restating Position. Phase III (Negotiation and Co-construction) operations included primarily only one out of five possible operations, Proposing New Statements. Phase IV (Testing and Modification) operations included primarily three out of five possible operations, with mostly occurrences of Testing against “Received Fact”, Cognitive Schema, and Personal Experience.

Differences:

• Argumentation-based discussions had more low-level Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) while problem solving-based
discussions had more high-level Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification).

- For the CSF-Com group, the argumentation-based discussion generated more Phase II (Discovery of Dissonance) occurrences than the problem solving-based discussion.
- While the argumentation-based discussions had similar frequencies of Phase IV (Testing and Modification) operations found, the problem solving-based discussions had more Phase IV/B (Testing against Cognitive Schema) than other Phase IV operations.
- In terms of knowledge construction density, for the CSF-Com group, the argumentation-based discussion involved more knowledge construction operations than the problem solving-based discussion. The opposite was true for the IIEF group.

**Research Question 5:**

**Patterns of Knowledge Construction and Critical Thinking in Four Types of Discussion Boards**

How different are the patterns of knowledge construction based on knowledge construction phases, knowledge construction operations under each phase, and the knowledge construction density and how different is the critical thinking based on different critical thinking indicators in the four types of discussion boards: standard threaded discussion board; with cognition-supported features; with interactive intercultural elaboration features; with cognition-supported features and interactive intercultural elaboration features?

The same two groups from Research Question 4 were examined again: Group A which have had more experienced with the cognition-supported features and Group B which
have had more experience with the interactive intercultural elaboration features. For each group, three discussion transcripts from the following topics were examined: Topic 2 - Becoming a Peaceful Adult, where a standard threaded discussion board were used, Topic 5 – Weaknesses of Human Decision Making, where one set of the features was used, and Topic 7 – Persuasion, where both sets of features were used. It is important to note that these discussions were on different discussion topics. For the Peaceful Adult topic and the Decision Making topic, each group had 8 students; for the Persuasion topic, Group A had 7 students and Group B had 8 students. Each student wrote three messages per discussion.

To facilitate the reporting of the results, five different conditions were inferred (see Table 4.37):

1. Standard$_2$: the condition in which Group A and Group B discussed Becoming a Peaceful Adult (Topic 2), no special features were used, with 16 students from both Group A and Group B.

2. CSF$_5$: the condition in which eight students in Group A used the cognition-supported featured to discuss Weaknesses of Human Decision Making, Topic 5.

3. IIEF$_5$: the condition in which eight students in Group B used the interactive intercultural elaboration features to discuss Weaknesses of Human Decision Making, Topic 5.

4. CSF-Com$_7$: the condition in which seven students in Group A used both cognition-supported features and interactive intercultural elaboration features to discuss Persuasion, Topic 7. In the label CSF-Com$_7$, the CSF indicates that the group in this condition used the cognition-supported features in Phase 2 of the study.
5. IIEF-Com\textsubscript{7}: the condition in which eight students in Group B used both cognition-supported features and interactive intercultural elaboration features to discuss Persuasion, Topic 7. In the label IIEF-Com\textsubscript{7}, the IIEF indicates that the group in this condition used the interactive intercultural elaboration features in Phase 2 of the study.

Table 4.37. Relationship between Conditions, Groups, Topics, and Discussion Board Types

<table>
<thead>
<tr>
<th>Group</th>
<th>Standard\textsubscript{2}</th>
<th>CSF\textsubscript{5}</th>
<th>IIEF\textsubscript{5}</th>
<th>CSF-Com\textsubscript{7}</th>
<th>IIEF-Com\textsubscript{7}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Topics</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Discussion Board Types</td>
<td>Standard threaded discussion</td>
<td>Cognition-Supported Features</td>
<td>Interactive Intercultural Elaboration Features</td>
<td>Cognition-Supported Features and Interactive Intercultural Elaboration Features</td>
<td></td>
</tr>
</tbody>
</table>

Note. Topic 2: Becoming a Peaceful Adult, Topic 5: Weaknesses of Decision Making, Topic 7: Persuasion

Knowledge Construction

Knowledge Construction by Phases

At the knowledge construction phase level, data were analyzed to determine if there was evidence of knowledge construction at higher phases in one discussion board type versus another and how the knowledge construction phase patterns were different in the different discussion board types. Two codes were analyzed: the number of times a phase appeared in all messages and the highest phase of knowledge construction reached in each message. The number of times a phase appeared in all messages gives evidence of knowledge construction phases students went through in a discussion and reveals part of what actually happened in
the process. It allows the researcher to determine which phases students went through more often by discussion board type. The frequency of each phase as the highest phase in a message allows the researcher to determine which phases students reached more often in each type of discussion board. This information will provide implications for which condition might facilitate a higher level of knowledge construction.

**Knowledge Construction Process: Frequencies of knowledge construction phases**

To investigate the knowledge construction process students went through in each type of discussion framework and to determine the level of concentration of each phase in a discussion board type, frequencies of knowledge construction phases were examined. Table 4.38 shows the average frequencies of knowledge construction phase occurrences per student in different conditions.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Standard</th>
<th>CSF5</th>
<th>IIEF5</th>
<th>CSF-Com7</th>
<th>IIEF-Com7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I Sharing</td>
<td>1.75</td>
<td>1.38</td>
<td>2.63</td>
<td>2.00</td>
<td>2.88</td>
</tr>
<tr>
<td>Phase II Dissonance</td>
<td>1.56</td>
<td>0.75</td>
<td>1.38</td>
<td>1.43</td>
<td>0.25</td>
</tr>
<tr>
<td>Phase III Negotiation</td>
<td>2.19</td>
<td>2.50</td>
<td>1.25</td>
<td>1.57</td>
<td>0.88</td>
</tr>
<tr>
<td>Phase IV Testing</td>
<td>1.25</td>
<td>1.50</td>
<td>0.63</td>
<td>0.57</td>
<td>0.13</td>
</tr>
<tr>
<td>Phase V Agreement</td>
<td>0.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Note.*

1. Average Frequency for Each Phase per Student = Number of Phase Occurrences in the Discussion / Number of Students in the Group

2. Since each student wrote 3 messages, average frequency of each phase per student is the number of phase occurrences per 3 messages from a student.
Table 4.39 shows the ranking for the average frequencies of knowledge construction phase occurrences per student according to five different conditions and by phases, with 1 indicating the condition with highest frequencies and 5 indicating the condition with lowest frequencies. This ranking was inferred from Table 4.38.

Table 4.39. Ranking of Average Frequencies of Knowledge Construction Phases per Student by Phases

<table>
<thead>
<tr>
<th>Rank</th>
<th>Phase I Sharing</th>
<th>Phase II Dissonance</th>
<th>Phase III Negotiation</th>
<th>Phase IV Testing</th>
<th>Phase V Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IIEF-Com7</td>
<td>Standard2</td>
<td>CSF5</td>
<td>CSF5</td>
<td>CSF5</td>
</tr>
<tr>
<td>2</td>
<td>IIEF5</td>
<td>CSF-Com7</td>
<td>IIEF5</td>
<td>IIEF-Com7</td>
<td>CSF5</td>
</tr>
<tr>
<td>3</td>
<td>CSF-Com7</td>
<td>CSF5</td>
<td>IIEF5</td>
<td>IIEF-Com7</td>
<td>CSF5</td>
</tr>
<tr>
<td>4</td>
<td>Standard2</td>
<td>CSF-Com7</td>
<td>IIEF5</td>
<td>IIEF-Com7</td>
<td>CSF5</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Standard2</td>
<td>CSF-Com7</td>
<td>IIEF5</td>
<td></td>
</tr>
</tbody>
</table>

Note.  
1. Rank ranges from 1 to 5, with 1 means highest frequency and 5 means lowest frequency  
2. N/A: no occurrences  

First the low-level Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) were examined. Comparisons of the five conditions show:

- The standard threaded discussions (Standard2) on Becoming a Peaceful Adult had the most occurrences of Phase II (Discovery of Dissonance)
- The cognition-supported features discussion (CSF5) on Weaknesses in Decision Making had the lowest frequency of Phase I (Sharing and Comparing) occurrences.
• The interactive intercultural elaboration features discussion (IIEF5) on Weaknesses in Decision Making only had fewer Phase I (Sharing and Comparing) occurrences than the combined features discussion from the group that was less experienced with cognition-supported features.

• The combined features discussion on Persuasion with the group more experienced with cognition-supported features (CSF-Com7) only had fewer Phase II (Discovery of Dissonance) occurrences than the standard threaded discussions.

• The combined features discussion on Persuasion with the group less experienced with cognition-supported features (IIEF-Com7) had most Phase I (Sharing and Comparing) and fewest Phase II (Discovery of Dissonance) occurrences.

Next, the higher level phases Phase III (Negotiation and Co-construction), Phase IV (Testing and Modification) and Phase V (Agreement and Application) were examined. Comparisons of the five conditions show:

• The standard threaded discussions (Standard2) on Becoming a Peaceful Adult only had fewer occurrences of higher-level Phases III, IV, and V than the cognition-supported features discussion on Weaknesses in Decision Making.

• The cognition-supported features discussion (CSF5) on Weaknesses in Decision Making had the most occurrences of higher-level Phases III, IV, and V.

• The interactive-intercultural elaboration features discussion (IIEF5) on Weaknesses in Decision Making had only more Phase III (Negotiation and Co-construction) than the combined-features discussion from the group less experienced with cognition-
supported features and had more Phase IV (Testing and Modification) than both combined features discussions on Persuasion.

- The combined features discussion on Persuasion from the more CSF-experienced group (CSFBCom7) had more Phase III (Negotiation and Co-construction) than the interactive intercultural elaboration features discussion.

- The combined features discussion on Persuasion from the less CSF-experienced group (IIEF-Com7) had the least occurrences of Phases III and IV.

Table 4.40 shows the ranking for the average frequencies of knowledge construction phase occurrences per student according to the five knowledge construction phases and by the different conditions, with 1 indicating the phase with highest frequencies and 5 indicating the phase with lowest frequencies. This ranking was inferred from Table 4.38.

Table 4.40. Ranking of Average Frequencies of Knowledge Construction Phases per Student by Conditions

<table>
<thead>
<tr>
<th>Rank</th>
<th>Standard2</th>
<th>CSF5</th>
<th>IIEF5</th>
<th>CSF-Com7</th>
<th>IIEF-Com7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Phase III</td>
<td>Phase III</td>
<td>Phase I</td>
<td>Phase I</td>
<td>Phase I</td>
</tr>
<tr>
<td>2</td>
<td>Phase I</td>
<td>Phase IV</td>
<td>Phase II</td>
<td>Phase III</td>
<td>Phase III</td>
</tr>
<tr>
<td>3</td>
<td>Phase II</td>
<td>Phase I</td>
<td>Phase III</td>
<td>Phase II</td>
<td>Phase II</td>
</tr>
<tr>
<td>4</td>
<td>Phase IV</td>
<td>Phase II</td>
<td>Phase IV</td>
<td>Phase IV</td>
<td>Phase IV</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>Phase V</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note.

1. Rank ranges from 1 to 5, where 1 means highest frequency and 5 means lowest frequency

2. Phase I: Sharing; Phase II: Dissonance; Phase III: Negotiation; Phase IV: Testing; Phase V: Agreement

3. N/A: no occurrences
Based on the ranking in Table 4.40:

- The standard threaded discussions on Becoming a Peaceful Adult (Standard2) had as its most frequent phase Phase III (Negotiation and Co-construction), followed by Phase I (Sharing and Comparing), Phase II (Discovery of Dissonance), and Phase IV (Testing and Modification) in order of decreasing frequency.

- The cognition-supported features discussion (CSF5) on Weaknesses in Decision Making also had as its most frequent phase Phase III (Negotiation and Co-construction) occurrences, but differently from the standard threaded discussions, it had more Phase IV (Testing and Modification) occurrences than Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) occurrences.

- The interactive intercultural elaboration features discussion (IIEF5) in Decision Making had more low-level phases than high-level phases.

- For both groups, the combined features discussions on Persuasion had more Phase I (Sharing and Comparing) and Phase III (Negotiation and Co-construction) occurrences than Phase II (Discovery of Dissonance) and Phase IV (Testing and Modification) occurrences.

In summary, differences were observed in the different conditions in terms of knowledge construction phases students went through in the knowledge construction process. The discussion that saw the highest number of occurrences of high-level Phases III (Negotiation and Co-construction), IV (Testing and Modification), and V (Agreement and Application) was the cognition-supported feature discussion on Decision Making, followed by the standard threaded discussion on Becoming a Peaceful Adult. The cognition supported
features discussion and the standard threaded discussions also had the fewest low-level Phase I (Sharing and Comparing) occurrences among all the five conditions. On the contrary, the combined features discussion from the group with less experience with cognition-supported features had the fewest occurrences of high-level phases Phase II, Phase III, Phase IV but most occurrences of low-level Phase I. The interactive intercultural elaboration features discussion on Decision Making and the combined features discussion on Persuasion from the group with more experience with cognition-supported features were in the mid-range compared to other conditions in terms of frequencies of knowledge construction phases students went through.

Examining each condition individually, the cognition-supported features discussion on Decision Making had more high-level Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) than Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) occurrences, while the interactive intercultural elaboration features discussion had more instances of low-level Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) than of Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification). Standard threaded discussions on Peaceful Adult had more Phase III (Negotiation and Co-construction) than other phases, followed by Phase I (Sharing and Comparing). Both combined features discussions had more Phase I (Sharing and Comparing) than other phases, followed by Phase III (Negotiation and Co-construction).
**Knowledge Construction Phase Reached**

To determine which phases students reached more often in each type of discussion framework, the frequencies of each phase as the highest phase in a message were counted for each condition.

Table 4.41 shows the average frequencies of knowledge construction phases as the highest phase in a message per student in different conditions.

Table 4.41. Average Frequency of Knowledge Construction Phase as the Highest Phase in a Message

<table>
<thead>
<tr>
<th>Phase</th>
<th>Standard</th>
<th>CSF</th>
<th>IIEF</th>
<th>CSF-Com</th>
<th>IIEF-Com</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>Sharing</td>
<td>0.13</td>
<td>0.25</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Phase II</td>
<td>Dissonance</td>
<td>0.19</td>
<td>0.00</td>
<td>0.50</td>
<td>0.43</td>
</tr>
<tr>
<td>Phase III</td>
<td>Negotiation</td>
<td>1.44</td>
<td>1.13</td>
<td>0.88</td>
<td>1.00</td>
</tr>
<tr>
<td>Phase IV</td>
<td>Testing</td>
<td>1.25</td>
<td>1.13</td>
<td>0.63</td>
<td>0.57</td>
</tr>
<tr>
<td>Phase V</td>
<td>Agreement</td>
<td>0.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Note.**

1. Average Frequency for Each Phase and the Highest Phase per Student = Number of Phase Occurrences as the Highest Phase in the Discussion / Number of Students in the Group
2. Since each student wrote 3 messages, the average frequency of each phase as the highest phase per student is the number of phase occurrences as the highest phase per 3 messages from a student.

Table 4.42 shows the ranking for the average frequencies of the knowledge construction phase as the highest phase per student according to five different conditions and by phases, with 1 indicating the condition with highest frequencies and 5 indicating the condition with lowest frequencies. This ranking was inferred from Table 4.41.
Table 4.42. Ranking of Average Frequency of Knowledge Construction Phase as the Highest Phase in a Message by Phases

<table>
<thead>
<tr>
<th>Rank</th>
<th>Phase I Sharing</th>
<th>Phase II Dissonance</th>
<th>Phase III Negotiation</th>
<th>Phase IV Testing</th>
<th>Phase V Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IIEF-Com7</td>
<td>CSF-Com7*</td>
<td>IIEF5</td>
<td>CSF5</td>
<td>Standard2</td>
</tr>
<tr>
<td>1</td>
<td>IIEF5</td>
<td>CSF-Com7</td>
<td>IIEF-Com7</td>
<td>Standard2</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>Standard2</td>
<td>CSF5</td>
<td>CSF-Com7</td>
<td>IIEF5</td>
<td>IIEF-Com7</td>
</tr>
<tr>
<td>3</td>
<td>Standard2</td>
<td>CSF5</td>
<td>IIEF5</td>
<td>CSF-Com7</td>
<td>IIEF-Com7</td>
</tr>
<tr>
<td>4</td>
<td>CSF5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>CSF5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Note.**

1. Rank ranges from 1 to 5, where 1 means highest frequency and 5 means lowest frequency.
2. *: Equal frequency with the condition on the right in the same row.
3. N/A: no occurrences

First the low-level Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) were examined. Comparisons of the five conditions show:

- The standard threaded discussion (Standard2) and the cognition-supported features discussion on Decision Making (CSF5) had the fewest Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) messages.
- The interactive intercultural elaboration features discussion on Decision Making (IIEF5) had the most Phase II (Discovery of Dissonance) messages, followed by the two combined features discussions on Persuasion.
- The combined features discussion on Persuasion from the less CSF-experienced group (IIEF-Com7) had the most Phase I (Sharing and Comparing) messages.
Next, the higher level phases Phase III (Negotiation and Co-construction), Phase IV (Testing and Modification), and Phase V (Agreement and Application) were examined. Comparisons of the five conditions show:

- The standard threaded discussions on Becoming a Peaceful Adult (Standard2) had the most Phases III Negotiation and Co-construction and IV Testing and Modification messages.
- The cognition-supported features discussion on Decision Making (CSF5) is the next condition with most Phases III and IV messages.
- The interactive intercultural elaboration features discussion on Decision Making (IIEF5) only had more Phase III (Negotiation and Co-construction) messages than the combined features discussion on Persuasion by the less CSF-experienced group.
- The combined features discussion on Persuasion by the more CSF-experienced group (CSF-Com7) only had more Phase IV (Testing and Modification) messages than the combined features discussion by the less CSF-experienced group.
- The combined features discussion on Persuasion by the less CSF-experienced group (IIEF-Com7) had the fewest Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) messages among all the conditions.

Table 4.43 shows the ranking for the average frequencies of knowledge construction phase occurrences per student according to the five knowledge construction phases and by the different conditions, with 1 indicating the phase with highest frequencies and 5 indicating the phase with lowest frequencies. This ranking was inferred from Table 4.41.
Table 4.43. Ranking of Average Frequency of Knowledge Construction Phase as the Highest Phase in a Message by Conditions

<table>
<thead>
<tr>
<th>Rank</th>
<th>Standard $^2$</th>
<th>CSF $^5$</th>
<th>IIEF $^5$</th>
<th>CSF-Com $^7$</th>
<th>IIEF-Com $^7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Phase III</td>
<td>Phase III$^*$</td>
<td>Phase I</td>
<td>Phase I$^*$</td>
<td>Phase I</td>
</tr>
<tr>
<td>2</td>
<td>Phase IV</td>
<td>Phase IV</td>
<td>Phase III</td>
<td>Phase III</td>
<td>Phase III</td>
</tr>
<tr>
<td>3</td>
<td>Phase II</td>
<td>Phase V</td>
<td>Phase IV</td>
<td>Phase IV</td>
<td>Phase II</td>
</tr>
<tr>
<td>4</td>
<td>Phase I</td>
<td>Phase I</td>
<td>Phase II</td>
<td>Phase II</td>
<td>Phase IV</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Note.*

1. Rank ranges from 1 to 5, where 1 means highest frequency and 5 means lowest frequency
2. $^*$: equal frequency with the condition below in the same column
3. Phase I: Sharing; Phase II: Dissonance; Phase III: Negotiation; Phase IV: Testing; Phase V: Agreement
4. N/A: no occurrences

Based on the ranking in Table 4.43, examination of the pattern of phases within each discussion board type showed:

- The standard threaded discussion (Standard2) and the cognition-supported features discussion on Decision Making (CSF5) had more Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) messages than messages reaching other phases. These two conditions also both had the fewest Phase I (Sharing and Comparing) messages compared to other phases.

- The interactive intercultural elaboration features discussion (IIEF5) on Decision Making and both combined features discussions on Persuasion (CSF-Com7 and IIEF-Com7) had more Phase I (Sharing and Comparing) and Phase III (Negotiation and Co-construction) than Phase II (Discovery of Dissonance) and Phase IV (Testing and
Modification) but the interactive intercultural elaboration features discussion and the combined features discussion by the more CSF-experienced group had more Phase IV than Phase II while the combined features discussion by the less CSF-experienced group had more Phase II than Phase IV.

In summary, there were differences between the different discussion board types in terms of frequencies of knowledge construction phases as the highest phase in a message. Compared to other conditions, the standard threaded discussions and the cognition supported features discussion had most Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) messages and fewest Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) messages. The interactive intercultural elaboration features discussion and the combined featured discussion by the more CSF-experienced group had a mid-range number of Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) messages compared to other conditions. The combined features discussion by the less CSF-experienced group had the fewest Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) messages.

Examining each condition individually, the standard threaded discussions and the cognition supported features discussion had more messages reaching high-level Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification) than messages reaching another phase as the highest phase. The interactive intercultural elaboration features discussion (IIEF5) on Decision Making and both combined features discussions on Persuasion (CSF-Com7 and IIEF-Com7) had more Phase I (Sharing and Comparing) and Phase III (Negotiation and Co-construction) than Phase II (Discovery of Dissonance) and Phase IV (Testing and Modification), but the interactive intercultural elaboration features
discussion and the combined features discussion by the more CSF-experienced group had more Phase IV than Phase II while the combined features discussion by the less CSF-experienced group had more Phase II than Phase IV.

**Knowledge Construction by Operations**

To determine if there was a difference between the five different conditions in the existence of knowledge construction operations in each phase, a difference between the conditions in the number of different knowledge construction operations in each phase was examined. The results may reveal the operations or cognitive processes more likely to be prompted by one condition versus another.

**Phase 1: Sharing/Comparing of Information**

As shown in Table 4.44, in all conditions, Phase I (Sharing and Comparing) operations included mostly Phase I/A (Share Observation), Phase I/B (State Agreement), and Phase I/C (Provide Examples). Phase I/D (Clarify Details) and Phase I/E (Identify Problem) operations were rare. Phase I/A (Share Observation) and Phase I/C (Provide Examples) operations also occurred more frequently than Phase I/B (State Agreement). Therefore, the conditions were similar in terms of which operations were found in their Phase I (Sharing and Comparing) occurrences: mostly Phase I/A and Phase I/C, followed by Phase I/B.
Table 4.44. Average Frequencies of Phase I (Sharing and Comparing) Operations

<table>
<thead>
<tr>
<th>Phase I Operation</th>
<th>Standard2</th>
<th>CSF5</th>
<th>IIEF5</th>
<th>CSF-Com7</th>
<th>IIEF-Com7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share Observation</td>
<td>1.63</td>
<td>1.00</td>
<td>1.63</td>
<td>1.57</td>
<td>1.75</td>
</tr>
<tr>
<td>State Agreement</td>
<td>0.31</td>
<td>0.38</td>
<td>1.13</td>
<td>0.29</td>
<td>1.25</td>
</tr>
<tr>
<td>Provide Examples</td>
<td>1.38</td>
<td>1.00</td>
<td>2.50</td>
<td>1.86</td>
<td>2.75</td>
</tr>
<tr>
<td>Clarify Details</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Identify Problem</td>
<td>0.06</td>
<td>0.13</td>
<td>0.00</td>
<td>0.14</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Note.* Average Frequency for Each Phase I Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

**Phase 2: Discovery and exploration of dissonance or inconsistency among ideas**

As shown in Table 4.45, in all conditions, Phase II (Discovery of Dissonance) operations included mostly Phase II/A (Identify Disagreement) and Phase II/C (Restate Position and Possibly Provide Support) and with rare to no occurrences of Phase II/B (Clarify Disagreement). Therefore, the conditions were similar in terms of which operations were found in their Phase II (Discovery of Dissonance) occurrences: mostly Phase II/A and Phase II/C, and rare to no occurrences of Phase II/B.
Table 4.45. Average Frequencies of Phase II (Discovery of Dissonance) Operations

Occurrences per Student

<table>
<thead>
<tr>
<th>PhII/A Identify Disagreement</th>
<th>Standard</th>
<th>CSF</th>
<th>IIEF</th>
<th>CSF-Com</th>
<th>IIEF-Com</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.06</td>
<td>0.13</td>
<td>0.63</td>
<td>1.43</td>
</tr>
<tr>
<td>PhII/B Clarify Disagreement</td>
<td></td>
<td>0.13</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhII/C Restate Position</td>
<td></td>
<td>0.75</td>
<td>0.00</td>
<td>0.63</td>
<td>1.29</td>
</tr>
</tbody>
</table>

Note. Average Frequency for Each Phase II Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

Phase 3: Negotiation of meaning/co-construction of knowledge

As shown in Table 4.46, consistently across all conditions, most of Phase III (Negotiation and Co-construction) operations were Phase III/D (Propose New Statements). Therefore, the conditions were similar in terms of which operations were found in their Phase III (Negotiation and Co-construction) occurrences: mostly Phase III/D.

Table 4.46. Average Frequencies of Phase III (Negotiation and Co-construction) Operations

Occurrences per Student

<table>
<thead>
<tr>
<th>PhIII/A Negotiate Meaning</th>
<th>Standard</th>
<th>CSF</th>
<th>IIEF</th>
<th>CSF-Com</th>
<th>IIEF-Com</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.00</td>
<td>0.38</td>
<td>0.00</td>
<td>0.14</td>
</tr>
<tr>
<td>PhIII/B Weigh Arguments</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhIII/C Identify Agreement</td>
<td></td>
<td>0.00</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhIII/D Propose New Statements</td>
<td></td>
<td>2.13</td>
<td>2.00</td>
<td>1.25</td>
<td>1.29</td>
</tr>
<tr>
<td>PhIII/E Integrate Metaphors</td>
<td></td>
<td>0.06</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note.
1. Average Frequency for Each Phase III Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

2. Phase III/A: Negotiate or clarify the meaning of terms. Phase III/B: Negotiate the relative weight to be assigned to types of argument. Phase III/C: Identify areas of agreement or overlap among conflicting concepts. Phase III/D: Propose and negotiate new statements embodying compromise, co-construction. Phase III/E: Proposal of integrating or accommodating metaphors or analogies.

**Phase 4: Testing and modification of proposed synthesis or co-construction**

As shown in Table 4.47, in the three conditions Standard2, CSF5, and CSF-Com7, Phase IV (Testing and Modification) operations included mostly Phase IV/A (Test against “Received Fact”), Phase IV/B (Test against Cognitive Schema), and Phase IV/C (Test against Personal Experience) and there were no occurrences of Phase IV/D (Test against Formal Data) and Phase IV/E (Test against Contradictory Testimony). However, the interactive intercultural elaboration features discussion had no Phase IV/A (Test against “Received Fact”), and the combined features discussion by the less CSF-experienced group had no Phase IV/A (Test against “Received Fact”) and Phase IV/B (Test against Cognitive Schema). In the conditions with Phase IV/B (Test against Cognitive Schema), this operation had the highest frequency compared to other operations. Therefore, except for the interactive intercultural elaboration features discussion and the combined features discussion by the less CSF-experienced group, the other discussions were similar in terms of which operations were found in their Phase IV (Testing and Modification) occurrences: mostly Phase IV/A, Phase IV/B, and Phase IV/C; Phase IV/B had the highest frequency.
Table 4.47. Average Frequencies of Phase IV (Testing and Modification) Operations

Occurrences per Student

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>CSF$_5$</th>
<th>IIEF$_5$</th>
<th>CSF-Com$_7$</th>
<th>IIEF-Com$_7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhIV/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test against “received fact”</td>
<td>0.13</td>
<td>0.25</td>
<td>0.00</td>
<td>0.29</td>
<td>0.00</td>
</tr>
<tr>
<td>PhIV/B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test against cognitive schema</td>
<td>1.00</td>
<td>1.13</td>
<td>0.50</td>
<td>0.29</td>
<td>0.00</td>
</tr>
<tr>
<td>PhIV/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test against personal experiences</td>
<td>0.56</td>
<td>0.75</td>
<td>0.13</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>PhIV/D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test against formal data</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhIV/E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test against contradictory testimony</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note. Average Frequency for Each Phase IV Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group

Phase 5: Agreement statement(s)/Application of newly constructed meaning

There were rare to no occurrences of Phase V (Agreement and Application) in all conditions (see Table 4.48).

Table 4.48. Average Frequencies of Phase V (Agreement and Application) Operations

Occurrences per Student

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>CSF$_5$</th>
<th>IIEF$_5$</th>
<th>CSF-Com$_7$</th>
<th>IIEF-Com$_7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhV/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summarize agreements</td>
<td>0.00</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhV/B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply new knowledge</td>
<td>0.00</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>PhV/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive statements</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note. Average Frequency for Each Phase V Operation per Student = Number of Operation Occurrences in the Discussion / Number of Students in the Group
In summary, in a similar pattern with when examining two Topic 7-based discussions and two Topic 8-based discussions to compare two discussion frameworks in Research Question 4, across the five conditions, most Phase I (Sharing and Comparing) operations were Phase I/A (Share Observation) and Phase I/C (Provide Examples), followed by Phase I/B (State Agreement); most Phase II (Discovery of Dissonance) operations were Phase II/A (Identify Agreement) and Phase II/C (Restate Position); most Phase III (Negotiation and Co-construction) operations were Phase III/D (Propose New Statement); most Phase IV (Testing and Modification) operations were Phase IV A/B/C (Test against “Received Fact”, Cognitive Schema, and Personal Experience) with Phase IV/B (Test against Cognitive Schema) having had the highest frequency.

Density of Knowledge Construction

As reported in Table 4.49, the interactive intercultural elaboration features discussion on Decision Making seemed to have the highest number of knowledge construction operations, followed by the cognition-supported features discussion. Overall, the discussions with highest density of knowledge construction were discussions on Topic 5 –Decision Making, followed by discussions on Topic 2-Becoming a Peaceful Adult, then discussions on Topic 7-Persuasion. A large number of knowledge construction operations do not necessarily mean better knowledge construction at the end but it would give another view into the knowledge construction process in a discussion and how different topics might contribute differently to the knowledge construction process.
Table 4.49. Average Number of Knowledge construction Operations per Student

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>CSF(_5)</th>
<th>IIEF(_5)</th>
<th>CSF-Com(_7)</th>
<th>IIEF-Com(_7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>9.19</td>
<td>11.38</td>
<td>12.38</td>
<td>8.71</td>
<td>7.25</td>
</tr>
</tbody>
</table>

*Note.*

1. Each type of knowledge construction operation was counted only one time in a message
2. Average number of knowledge construction operations per student = Number of knowledge construction operations in a discussion / Number of students participating in that discussion

**Critical Thinking**

Frequencies of critical thinking indicators in different categories were examined to determine how critical thinking is different in the different conditions.

As shown in Table 4.50, the discussions of Topic 5 - Decision Making (CSF\(_5\) and IIEF\(_5\) and Topic 7- Persuasion (CSF-Com\(_7\) and IIEF-Com\(_7\) had more AC+ indicator instances where students clearly clarified the subject. In terms of outside knowledge experience, students mostly referred to their personal experience (OE+) or course materials (OC+). Use of outside material was found in the discussions of Topic 2 - Peaceful Adult and Topic 5 – Decision Making, but rarely. In the discussions on Peaceful Adult (Standard\(_2\)) and Decision Making (CSF\(_5\) and IIEF\(_5\)), more course materials were referred to than in the discussions on Persuasion (CSF-Com\(_7\) and IIEF-Com\(_7\)). In the discussions on Persuasion (CSF-Com\(_7\) and IIEF-Com\(_7\)), more personal experiences were drawn on rather than course materials. Regarding critical assessment, there were more critical assessment indicators (C+) in the cognition-supported features discussions on Decision Making (CSF\(_5\)) than in any other condition. Comparing the two discussions of Topic 7 - Persuasion, conditions CSF-Com\(_7\) and IIEF-Com\(_7\), critical assessment indicator occurred more frequently when the discussion
came from the group with more experience with cognition-supported features. Regarding the NP+ indicator for problem-related issues, the discussions on Decision Making (CSF5 and IIEF5) had the most problem-related issues compared to the discussions on Becoming a Peaceful Adult (Standard2) and the discussions on Persuasion (CSF-Com7 and IIEF-Com7). Problem-related issues were found in the problem definition stage of the Garrison’s critical thinking stages. Therefore, more problem-related issues could mean students were in this stage during the discussions on Decision Making (CSF5 and IIEF5) more than during the discussions on Becoming a Peaceful Adult (Standard2) and Persuasion (CSF-Com7 and IIEF-Com7). Regarding indicators for novelty, justification, and linking and interpretation of ideas, the cognition-supported features discussion on Decision Making (CSF5) and the combined features discussion on Persuasion by the more CSF-experienced group (CSF-Com7) had more occurrences of justifications and linking ideas than the interactive intercultural elaboration features discussion on Decision Making (IIEF5) and the combined features discussion on Persuasion by the less CSF-experienced group (IIEF-Com7). Regarding novelty, the cognition-supported features discussion and the interactive intercultural elaboration features discussion (CSF5 and IIEF5) had more new problem-related issues as well as more new ideas and solutions (counted together) than the standard threaded discussion on Peaceful Adult (Standard2) and the combined features discussions (CSF-Com7 and IIEF-Com7). In terms of relevancy, the cognition-supported features discussion had more occurrences of relevancy indicators than the interactive intercultural elaboration features discussion. For all conditions, occurrences for W+ (widening discussion) were very rare, and were only found when the cognition-supported features were available.
Table 4.50. Average Frequencies of Critical Thinking Indicators per Student

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>CSF&lt;sub&gt;5&lt;/sub&gt;</th>
<th>IIEF&lt;sub&gt;5&lt;/sub&gt;</th>
<th>CSF-Com&lt;sub&gt;7&lt;/sub&gt;</th>
<th>IIEF-Com&lt;sub&gt;7&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambiguities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>AC+</td>
<td>0.00</td>
<td>1.25</td>
<td>2.00</td>
<td>1.63</td>
<td>1.63</td>
</tr>
<tr>
<td>Outside Knowledge and Experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OC+</td>
<td>1.00</td>
<td>1.00</td>
<td>1.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>OE+</td>
<td>0.94</td>
<td>0.50</td>
<td>0.25</td>
<td>1.63</td>
<td>1.75</td>
</tr>
<tr>
<td>OK+</td>
<td>0.06</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>OM+</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>OP+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>OQ+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Critical Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C+</td>
<td>0.63</td>
<td>1.38</td>
<td>0.50</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>CT+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Importance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I+</td>
<td>1.00</td>
<td>1.50</td>
<td>2.25</td>
<td>1.38</td>
<td>1.13</td>
</tr>
<tr>
<td>Justification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP+</td>
<td>0.13</td>
<td>1.25</td>
<td>1.50</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>JS1+</td>
<td>2.50</td>
<td>1.75</td>
<td>0.50</td>
<td>1.25</td>
<td>0.75</td>
</tr>
<tr>
<td>JS2+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Linking ideas, interpretations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1+</td>
<td>0.75</td>
<td>0.63</td>
<td>0.50</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>L2+</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Novelty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NI+</td>
<td>0.50</td>
<td>1.25</td>
<td>0.25</td>
<td>1.25</td>
<td>0.38</td>
</tr>
<tr>
<td>NP+</td>
<td>0.63</td>
<td>0.88</td>
<td>0.88</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>NS+</td>
<td>0.94</td>
<td>1.00</td>
<td>1.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Practical utility, grounding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1+</td>
<td>0.13</td>
<td>0.13</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>P2+</td>
<td>0.19</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Relevance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R+</td>
<td>2.19</td>
<td>1.63</td>
<td>0.63</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Width of understanding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>0.00</td>
<td>0.13</td>
<td>0.00</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Note:

1. Average frequency of a Critical Thinking indicator per student = The number of the Critical Thinking indicator in a discussion / Number of students participating in that discussion
2. Each indicator was only used to code a message one time.
3. Each student wrote 3 messages in a discussion
In summary, in the Ambiguities category, there were more clarifications of the subject (AC+) in both the cognition-supported features discussion and the interactive intercultural elaboration features discussion on Decision Making as well as in the combined features discussions on Persuasion than in the standard threaded discussions on Peaceful Adult. In the Outside knowledge/experience category, combined features discussions on Persuasion had more use of personal experience (OE+) than use of course material (OC+). These combined features discussions on Persuasion also had more use of personal experience (OE+) than the discussions of Peaceful Adult and of Decision Making while the discussions of Peaceful Adult and of Decision Making had more occurrences of course material use (OC+) than the combined features discussions on Persuasion. In the Novelty category, both the cognition-supported features discussion and the interactive intercultural elaboration features discussion on Decision Making had most occurrences of novelty-related indicators.

In addition, in the two discussions on Decision Making with either cognition-supported features or interactive intercultural elaboration features and in the combined features discussions on Persuasion, the discussions from the group more experienced with cognition-supported features had more indicators of critical assessment, justification, and linking.
Summary of Results

Research Questions 1, 2, 3

A summary of results for research questions 1, 2, and 3 is reported in Table 4.51.

Table 4.51. Results Summary of Research Questions 1, 2, 3

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Score</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question 1.1. Hypothesis: Students will have a significantly higher level of knowledge construction in discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.</td>
<td>Two-message score</td>
<td>The hypothesis is confirmed. The effect size, as indexed by Eta Squared ($\eta^2$), was 0.21.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three-message score</td>
</tr>
<tr>
<td>Research Question 1.2. Does prior knowledge and experience in the subject domain influence this effect?</td>
<td>Two-message score</td>
<td>ANCOVA assumptions not satisfied</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three-message score</td>
</tr>
<tr>
<td>Research Question 1.3. Does prior experience in online discussion influence this effect?</td>
<td>Two-message score</td>
<td>ANCOVA assumptions not satisfied</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three-message score</td>
</tr>
<tr>
<td>Research Question 2.1. Students will have a significantly higher level of critical thinking in discussion messages in a discussion board with cognition-supported features than in a discussion board without cognition-supported features.</td>
<td>Two-message score</td>
<td>The difference in critical thinking level between the two groups was not statistically significant, t(86) = 1.662, p = 0.100, 2-tailed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three-message score</td>
</tr>
<tr>
<td>Research Question</td>
<td>Score</td>
<td>Results</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Research Question 2.2. Does prior knowledge and experience in the subject domain influence this effect?</td>
<td>Two-message score</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>Three-message score</td>
<td>No effect</td>
</tr>
<tr>
<td>Research Question 2.3. Does prior experience in online discussion influence this effect?</td>
<td>Two-message score</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>Three-message score</td>
<td>No effect</td>
</tr>
<tr>
<td>Research Question 3.1. Does the use of intercultural interactive elaboration features integrated into the online discussion board system affect students’ level of intercultural sensitivity?</td>
<td></td>
<td>Hypothesis is not supported.</td>
</tr>
<tr>
<td>Research Question 3.2. Does prior cross-cultural experience influence this effect?</td>
<td></td>
<td>No effect</td>
</tr>
</tbody>
</table>

**Research Question 4**

In the case of a constraint-based discussion board, how different are the patterns of knowledge construction in discussions following argumentation and problem solving discussion frameworks in terms of knowledge construction phases, knowledge construction operations under each phase, and the density of knowledge construction?

The following similarities and differences between the two discussion frameworks were observed:

**Similarities:**

- There were no Phase V (Agreement and Application) occurrences in either argumentation-based discussions or problem solving-based discussions.
- The group which have had more experience with the cognition-supported features tended to have more occurrences of higher knowledge construction phases than the group with less experience.

- At the knowledge construction operation level, Phase I (Sharing and Comparing) operations included primarily three out of five possible operations, with mostly occurrences of Sharing Observation and Providing Examples, followed by Stating Agreement. Phase II (Discovery of Dissonance) operations included primarily two out of three possible operations, with mostly occurrences of Identifying Disagreement, then Restating Position. Phase III (Negotiation and Co-construction) operations included primarily only one out of five possible operations, Proposing New Statements. Phase IV (Testing and Modification) operations included primarily three out of five possible operations, with mostly occurrences of Testing against “Received Fact”, Cognitive Schema, and Personal Experience.

**Differences:**

- Argumentation-based discussions had more low-level Phase I (Sharing and Comparing) and Phase II (Discovery of Dissonance) while problem solving-based discussions had more high-level Phase III (Negotiation and Co-construction) and Phase IV (Testing and Modification).

- For the CSF-Com group, the argumentation-based discussion generated more Phase II (Discovery of Dissonance) occurrences than the problem solving-based discussion.

- While the argumentation-based discussions had similar frequencies of Phase IV operations, the problem solving-based discussions had more Phase IV/B Testing against Cognitive Schema than other Phase IV operations.
• In terms of knowledge construction density, for the CSF-Com group, the argumentation-based discussion involved more knowledge construction operations than the problem solving-based discussion. The opposite was true for the IIEF group.

**Research Question 5**

How different are the patterns of knowledge construction and critical thinking in the four types of discussion boards (standard; constraint-based and discourse map; interactive intercultural elaboration, constraint-based, discourse map and interactive intercultural elaboration)?

The results showed some differences between these discussion types. However, since the discussion topics were different for these discussions, it is not clear whether the difference is due to the type of the discussion board or due to the difference in discussion topic contents. Therefore results should be read with caution.

**Research Question 5.1**

How different are the patterns of knowledge construction in the four types of discussion boards (standard; constraint-based and discourse map; interactive intercultural elaboration, constraint-based, discourse map and interactive intercultural elaboration)?

In summary, differences were observed in the different conditions in terms of knowledge construction phases that students went through in the knowledge construction process. There were also differences between the different discussion board types in terms of frequencies of knowledge construction phases as the highest phase in a message (see Table 4.52).
Table 4.52. Comparing Across Five Conditions

<table>
<thead>
<tr>
<th>Knowledge Construction Phases</th>
<th>Standard2</th>
<th>CSF5</th>
<th>IIEF5</th>
<th>CSF-Com7</th>
<th>IIEF-Com7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Went Through</td>
<td>Most Phases III, IV after CSF5</td>
<td>Most Phases III, IV, V</td>
<td>Mid-range</td>
<td>Mid-range</td>
<td>Least Phase III, IV</td>
</tr>
<tr>
<td>Construction Phases</td>
<td>Students</td>
<td>Went</td>
<td>CSF5</td>
<td>IIEF5</td>
<td>CSF-Com7</td>
</tr>
<tr>
<td>Phases</td>
<td>Standard2</td>
<td>I</td>
<td>I</td>
<td>CSF-Com7</td>
<td>IIEF5</td>
</tr>
<tr>
<td>Knowledge Construction Phases</td>
<td>Most messages reached Phases III &amp; IV after Standard2</td>
<td>Most messages reached III, IV after Standard2</td>
<td>Least messages reached Phase III (except for IIEF-Com7 condition)</td>
<td>Least messages reached Phase IV (except for IIEF-Com7 condition)</td>
<td>Least messages reached III and Phase IV messages</td>
</tr>
<tr>
<td>Students Reached</td>
<td>Least Phases I &amp; II messages</td>
<td>Least Phases I &amp; II messages</td>
<td>Mid-range number of Phase IV messages</td>
<td>Mid-range number of Phase III messages</td>
<td>Least Phase III and Phase IV messages</td>
</tr>
</tbody>
</table>

*Note. Phase I: Sharing and Comparing; Phase II: Discovery of Dissonance; Phase III: Negotiation and Co-construction; Phase IV: Testing and Modification; Phase IV: Agreement and Application*

In addition:

- Knowledge construction density is highest in the cognition-supported features discussion and the interactive intercultural elaboration features discussion on Decision Making, the standard threaded discussion on Peaceful Adult, then the combined features discussions on Topic 7. This means the cognition-supported features discussion and the interactive intercultural elaboration features discussion on Decision Making had the most knowledge construction operations occur.

- Across the five conditions, most Phase I (Sharing and Comparing) operations were Phase I/A (Share Observation) and Phase I/C (Provide Examples), followed by Phase I/B (State Agreement); most Phase II (Discovery of Dissonance) operations were
Phase II/A (Identify Disagreement) and Phase II/C (Restate Position); most Phase III (Negotiation and Co-construction) operations were Phase III/D (Propose New Statements); most Phase IV (Testing and Modification) operations were Phase IV A/B/C (Test against “Received Fact”, Cognitive Schema, and Personal Experience) with mostly Phase IV/B (Test against Cognitive Schema).

Research Question 5.2

How different is critical thinking in the four types of discussion boards (standard; constraint-based and discourse map; interactive intercultural elaboration, constraint-based, discourse map and interactive intercultural elaboration)?

In summary:

- In the Ambiguities category: both the cognition-supported features discussion and the interactive intercultural elaboration features discussion on Decision Making had more clarifications of the subject (AC+) than the combined features discussions on Persuasion.

- In the Outside Knowledge/Experience category, the combined features discussions on Persuasion had more use of personal experience (OE+) than use of course material (OC+). These discussions also had more use of personal experience (OE+) and less use of course material (OC+) than discussions on Peaceful Adult and on Decision Making.

- In the Novelty category, the discussions on Decision Making (each with one set of features) had most occurrences of novelty-related indicators.
In the discussions on Decision Making and on Persuasion, the discussions from the group more experienced with the cognition-supported features had more indicators in the following three categories: Critical Assessment, Justification, and Linking Ideas and Interpretation.
CHAPTER 5

DISCUSSION

Summaries of Findings

The results of this study showed that students demonstrated a significantly higher level of knowledge construction when using a discussion board with cognition-supported features than when using one without cognition-supported features. However, prior knowledge and experience in the subject domain (psychology) was found not to influence the effect of the cognition-supported features on students’ knowledge construction in online discussions. Prior experience with online discussion also did not influence this effect.

Regarding the influence of cognition-supported features on critical thinking, combining results from both two-message analysis and three-message analysis, it can be concluded that cognition-supported features had a positive influence on students’ critical thinking in online discussions. Similar to the knowledge construction case, prior knowledge and experience in psychology as well prior experience in online discussion did not influence this effect. In addition, the results also indicated that the cognition-supported features had a stronger positive effect on students’ knowledge construction than on students’ critical thinking in online discussions.

The interactive intercultural elaboration features did not influence students’ intercultural sensitivity in this study. In addition, students’ prior cross cultural experience also did not influence this result.

When comparing argumentation and problem solving discussion frameworks, the results showed a difference between these two frameworks. It is important to note that the
two discussion frameworks were used with different discussion topics. Further exploration revealed that argumentation-based discussions had more low-level Phases I (Sharing and Comparing) and II (Discovery of Dissonance) while problem solving-based discussions had more high-level Phases III (Negotiation and Co-construction) and IV (Testing and Modification). In addition, argumentation-based discussions generated more Phase II (Discovery of Dissonance) occurrences. For both discussion frameworks, the group which had more experience with the cognition-supported features tended to have more occurrences of higher phases than the group with less experience with these features. There was similar knowledge construction density in both discussion frameworks, discussions from the group more experienced with cognition-supported features had higher knowledge construction density than discussions from the group less experienced with cognition-supported features.

At the knowledge construction operation level, the two discussion frameworks were similar in terms of which operations were found in their Phase I (Sharing and Comparing) occurrences (Phase I/A – Share Observation, I/B – State Agreement, I/C – Provide Examples), which operations were found in Phase II (Discovery of Dissonance) occurrences (Phase II/A – Identify Disagreement, then Phase II/C – Restate Position), and which operations found in Phase III (Negotiation and Co-construction) occurrences (mostly Phase III/D – Propose New Statement). For both frameworks, Phase IV (Testing and Modification) occurrences mostly included Phase IV/A – Test against “Received Fact”, Phase IV/B – Test against Cognitive Schema and Phase IV/C – Test against Personal Experience. However, while in the argumentation-based discussions, the frequencies of these Phase IV operations are similar, Phase IV/B was more prominent in the problem solving-based discussion. There
were no Phase V (Agreement and Application) occurrences in both argumentation-based
discussions and problem solving-based discussions.

To compare descriptively and explore patterns of knowledge construction and critical
thinking in the four discussion types (standard threaded discussion board, with only
cognition-supported features, with only intercultural interaction-supported features, and with
both sets of features), discussions of three topics from two groups were examined. Each topic
was in a different phase of the study. The results showed some differences between these
discussions. However, since the discussion topics were different for these discussions, it is
not clear whether these differences were due to the type of the discussion board or due to the
discussion topics. Therefore no clear conclusion can be drawn, however, looking closely at
these results, it seems more likely that these differences were due to the differences in nature
of the discussion topics. Further details will be discussed in a subsequent section of this
chapter.

**Discussion of Findings**

**Cognition-Supported Features’ Influence on Knowledge Construction and Critical
Thinking**

**Effects on Knowledge Construction and Critical Thinking**

Based on both two-message knowledge construction scores and three-message
knowledge construction scores, students had a significantly higher level of knowledge
construction in messages in a discussion board with cognition-supported features than in a
discussion board without cognition-supported features. However, it is interesting to note that
the effect size was greater for two-message knowledge construction scores. For a student
who wrote three messages, her two-message score would be the sum of the two highest message scores out of her three message scores. In this case, two-message scores did not include the lowest message score. In addition, since many students in both groups had similar lowest knowledge construction message scores (e.g. from Phase I messages) and there was often a big gap between the lowest message score and the other two message scores, the lowest message score’s contribution to a three-message score would reduce the difference between the two groups. This may explain why the difference was greater for two-message knowledge construction scores. In addition, three-message scores could only be obtained for students who wrote three messages. On one hand, three message-scores were based on more information than two-message scores, which might reflect more accurately students’ overall performance in online discussions. On the other hand, this could introduce a sample bias by creating a sample of students who satisfied the three posting requirement and leaving out students who did not satisfy the requirement. This sample bias may also contribute to the smaller difference between the two groups for three-message scores.

On the contrary, there was a greater difference between the two groups for three-message than for two-message critical thinking scores. This could be due to the difference in how knowledge construction scores and critical thinking scores were obtained. For three-message knowledge construction scores, as explained above, the lowest message score reduced the difference between the two groups. However, for critical thinking, since there was less variance between the three critical thinking message scores than between the three knowledge construction message scores, lowest message scores help to enlarge the difference between the two groups’ critical thinking mean scores.
Based on two-message critical thinking scores, students’ critical thinking in groups using cognition-supported features was higher than students’ critical thinking in groups not using cognition-supported features. Although the difference was not statistically significant, the low p value of 0.100 does suggest a possible positive effect of cognition-supported features on students’ critical thinking. In addition, results from analysis based on three-message critical thinking scores show that cognition-supported features had a positive influence on students’ critical thinking in online discussions. This means that as students wrote more messages, we can see more clearly a difference in the critical thinking level between the groups with and without cognition-supported features. When critical thinking was examined with fewer messages, the difference was not as great as when it was examined with more messages. This may indicate that critical thinking was supported by cognition-supported features as the discussions became larger and that the cognition-supported features did have a positive effect on students’ critical thinking in online discussions. The cognition-supported features may be more helpful when students participate in complex and long discussions.

In this study, cognition-supported features included the use of constraints via an argumentation discussion framework and an automated discourse map that allows students to see the logical flow of the discussion. These features make visible the thinking process. The positive effect of these cognition-supported features on students’ knowledge construction and critical thinking is consistent with the literature of using constraints and structure in online discussion and with the literature of using visuals to represent complex information. The combination of these features was to support important collaborative learning processes such as meaning making, conflict resolution, negotiation and argumentation. Allowing students to
label their messages and representing these labels clearly in the map allow for clear indication of the roles of the messages in a discussion. Since these cognition-supported features support students in navigating a discussion and identifying a line of reasoning or a discussion thread that they want to contribute to, they facilitate the turn-taking procedures which keep the discussions on topic and following a logical flow.

**Constraints, Structure, and Making Thinking Visible:**

Cohen (1994) provides evidence that knowledge construction can be enhanced in a learning environment where learners are encouraged to articulate and structure ideas. Using constraints is supported by cognitive research results which show that knowledge structures can assist information processing (Bossche et al., 2006). Through this process, thinking is made visible, which provides essential cognitive value of externalization in social interaction (Collins, Brown, & Holum, 1991; Lehtinen & Rui, 1996). According to Barron (2003), making thinking visible had positive effect on students’ solution generation to problems. Empirical literature has shown positive effects of constraint or structure on students’ learning outcome such as a positive effect of sentence openers on children’s planfullness and reflectivity (Scardamalia & Bereiter, 1984), an increase in the generation of coherent arguments and problem solving actions (Cho & Jonassen, 2002), an increase in frequency of elaboration in replies to challenges (Jeong, 2003), appreciation for other disciplines (Fruchter and Emery, 1999), and an increase in frequency of constructive conflict and therefore potentially lead to more critical discourse (Brooks & Jeong, 2006). There was also evidence of positive effects of constraint and structure in different noted collaborative systems. When students label their discussion messages with a component of the discourse structure they
also form and become aware of their message’s purpose in the discussion and how the message will contribute to the group’s argumentation process. The message may have a clearer focus and therefore better guide students’ thinking and help them express their ideas and opinions with more clarity. Also, by giving students labels for messages, especially labels that prompt high order thinking processes like the components of the argumentation framework, students may then be more likely to engage in critical thinking processes or higher phases of knowledge construction. According to Dillenbourg (1999), engagement in challenging cognitive activities could be a catalyst for knowledge articulation. Students would then not stop at the sharing or comparing information phase, which normally happens in a standard threaded discussion board according to De Laat (2002). Standard discussion boards often lack a clear relational structure for messages (except for a neutral hierarchical structure that indicates which messages are replies to a message) and therefore might not be sufficient in supporting novice students’ metacognition.

In addition to giving a general sense of structure and guidance for challenging cognitive activities in a discussion, the argumentation framework used in this study may also directly support the argumentation process, an important process in collaborative learning. Collaborative argumentation has been used in online learning environments to promote critical thinking (Derry, Levin, Osana, Jones, & Peterson, 2000). Through the argumentation process, students also engage in a negotiation process in order to resolve socio-cognitive conflict and reach a shared understanding, which is very important for building new knowledge in collaboration. Each component of this framework helps students focus on an important component of argumentation. For example, the component Rebuttal prompts students focus on expressing disagreement or conflict with another student’s ideas, the
Ground component prompts students to give evidence or reasoning to support a claim. With such messages labeled as Rebuttal, other students can easily see the intent of the message from the first glance, given that the message is labeled correctly. They can then form their reply accordingly. This process would make the discussion more focused and on track. Preliminary examination of several online discussions in term of students’ message labeling showed most rebuttal messages were indeed rebuttals. The correct labeling observed showed some evidence for a correct use of the features at some level and therefore might have contributed to the positive impact of the cognition-supported features on students’ knowledge construction and critical thinking in online discussion.

**Discourse Map**

Giving students a visual representation of the discussion in the form of a discourse map allows students to navigate through the discussion and have an overview of how the discussion occurs. The discourse map helps to create a visual logical flow for the discussion and helps students process complex information. Being able to see the discussion’s flow and how the discussion’s messages are connected visually may make it easier for students to organize ideas and contribute to the group’s knowledge building process. Since the students in this course were undergraduate students with about half of the students being first year and second year students, their metacognitive skills as well as their knowledge of the subject could be limited. Therefore, the discourse map with its navigation aids may have allowed students to better monitor and regulate what is going on in the discussion. According to Lehtinen (2003), monitoring and regulation skills have been considered very important for high level learning by thousands of studies. Supporting students’ monitoring and regulation
activities then means supporting high level thinking or critical thinking as well as supporting knowledge construction. Therefore, in this study, when students used the discourse map, they may have been able to think more critically and contribute more meaningfully to a discussion.

As summarized in the literature review section, even though there are quite a few applications of constraint-based collaborative systems, there are few experimental studies to study the effects of constraint-based discussion boards. In the 1990s, most studies had middle school or high school students as participants. After 2000, there have been studies with college students and graduate students as participants but only a few studies had comparison groups. In addition, only a few studies focused on critical thinking and knowledge construction. There is also limited literature on the effect of discourse maps in an online discussion context. This experimental study added more empirical evidence to the literature for the positive influence of a constraint-based discussion and a discourse map in online discussions, in this case, positive effects on students’ knowledge construction and critical thinking. In most studies, the effect of constraints only was examined. However, in this study, a combination of constraints and a discourse map was examined.

**Students’ Use of the Cognition-Supported Features**

In Jonassen and Remidez (2005)’s study, the authors gave a cautious yes to the question of whether or not students could use constraint-based discussion board effectively and an overall yes to the question of whether or not students could label messages correctly. However, these results were found in a study with graduate students who can be assumed to have more metacognitive skills and more knowledge than undergraduate college students.
Data from a final survey at the end of the semester asking questions about students’ use of the discussion board showed that students may have not used the cognition-supported features of the discussion board to their full potential. Also, not all students have used these features correctly. Study findings indicated the students who were more experienced with the cognition-supported features tended to indicate higher level of knowledge construction and had more indicators in Critical Assessment, Justification, and Linking Ideas and Interpretation than students less experienced with cognition-supported features. From this finding, it might be speculated that the effectiveness of these features would increase after students have used it for some time or that students would need some time to get used to the features. Especially in this case, the argumentation framework used was a complex framework. Therefore, it could be somewhat unnatural for students who have not learned about argumentation writing or an argumentation method before. In order to help students use the cognition features better and correctly, it would be helpful to provide students with more time to practice and more demonstrative examples of how to use the features. A face to face session could also be more effective than an online tutorial in this case where students can be made sure to understand and know how to use the features instead of being left on their own with the online tutorials.

**Prior Knowledge and Experience**

According to Fruchter and Emery (1999), students with high prior knowledge and experience tended to more actively participate in the discussion and provide feedback to others while students with low prior knowledge and experience often just wrote one or two line messages. Findings from Fruchter and Emery also indicated that the level of group
structure and instructor support did not matter for students with high prior knowledge and experience. However in this study, the results showed that students’ prior knowledge and experience with the subject domain did not influence the effect of these cognition-supported features on students’ knowledge construction and critical thinking. This result could be explored more with a subject domain test at the beginning of the semester rather than only a measure on students’ perceived knowledge and experience in the subject domain for a more reliable measure of prior knowledge and experience of the subject.

**Prior Experience in Online Discussion**

In this study, prior experience in online discussion did not influence the effect of the cognition-supported features. This could be because most students had low experience with online discussion (71% of students had not had online discussion experience in other courses besides this course). For most students, this was their first time to participate in online discussion in a course. Therefore, there may have not been enough variance in the group in term of prior experience in online discussion. Thus, this result should be further investigated.

**Knowledge Construction and Critical Thinking**

The results showed that the cognition-supported features seem to have more positive effect on students’ knowledge construction than on critical thinking. Why do these cognition-supported features influence knowledge construction to a larger extent than they influence critical thinking?
According to Dirks (1998), critical thinking plays an important role in assuring the quality of the knowledge construction process, where learning is “shaped within the context of the broader concepts and understanding” (Constructivist Learning section, para. 8). When there is a low level of critical thinking, the quality of knowledge construction can suffer: knowledge can be poorly or even erroneously constructed. According to Dirks, good knowledge construction or high level of critical thinking requires learners to have “a substantial body of understanding and background in the subject” (What is Art? section, para. 8). This is what novice learners do not have. This could explain why the cognition-supported features did not support critical thinking as much as knowledge construction. In this study, even though the cognition-supported features greatly supported knowledge construction, the knowledge construction’s quality may not be optimal or the new knowledge may not be as well and thoroughly constructed as it should be. Therefore, a knowledge construction coding scheme that takes into account to a larger extent the quality of the knowledge construction process is desired.

The relationship between knowledge construction and critical thinking can be further demonstrated by looking specifically into Gunawardena et al. (1997)’s knowledge construction model and Newman at al. (1995)’s critical thinking indicators used in this study. Law (2005) presented a comparison of the knowledge construction model from Gunawardena et al. and the categories of critical thinking indicators from Newman et al. In this comparison, the first phase of knowledge construction, Phase I (Sharing and Comparing Information), is paired with the following critical thinking indicators: novelty, relevance, outside knowledge/experience, and importance. Phase II, Phase III and Phase IV are paired with the following critical thinking indicators: linking ideas, treatments of ambiguities,
Justification and assessment. Lastly, Phase V (Agreement and Application) of knowledge construction is paired with practical utility and width of understanding. Newman et al. (1996) also presented a pairing of these critical thinking indicators with different stages in Garrison (1992)’s critical thinking framework, which gives a different perspective of the critical thinking indicators. Despite being different, these two different ways of pairing share a common theme where the critical thinking indicators are evidence of quality of a knowledge construction phase from Law’s perspective or a critical thinking stage from Newman et al. (1996)’s perspective. Table 5.1 shows both Law’s approach and Newman et al.’s approach.

Table 5.1. Knowledge Construction and Critical Thinking

<table>
<thead>
<tr>
<th>Gunawardena’s Knowledge Construction Phase</th>
<th>Newman et al. (1995)’s Categories of Critical Thinking indicators</th>
<th>Garrison (1992)’s Stages of Critical Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I: Sharing and Comparing</td>
<td>Novelty</td>
<td>Stage 2: Problem Definition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stage 3: Problem Exploration</td>
</tr>
<tr>
<td></td>
<td>Relevance</td>
<td>Stage 1: Problem Identification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stage 4: Problem Applicability</td>
</tr>
<tr>
<td></td>
<td>Outside knowledge/experience</td>
<td>Stage 2: Problem Definition</td>
</tr>
<tr>
<td></td>
<td>Importance</td>
<td>Stage 5: Problem Integration</td>
</tr>
<tr>
<td>Phase II: Discovery of Dissonance</td>
<td>Linking ideas</td>
<td>Stage 3: Problem Exploration</td>
</tr>
<tr>
<td>Phase III: Negotiation and Co-construction</td>
<td>Treatment of ambiguities</td>
<td>Stage 2: Problem Definition</td>
</tr>
<tr>
<td>Phase IV: Testing and Modification</td>
<td>Justification</td>
<td>Stage 3: Problem Exploration</td>
</tr>
<tr>
<td></td>
<td>Assessment</td>
<td>Stage 4: Problem Applicability</td>
</tr>
<tr>
<td>Phase V: Agreement and Application</td>
<td>Practical Utility</td>
<td>Stage 5: Problem Integration</td>
</tr>
<tr>
<td></td>
<td>Width of Understanding</td>
<td>Stage 1: Problem Identification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stage 3: Problem Exploration</td>
</tr>
</tbody>
</table>

These two approaches, being consistent with Dirks (1998)’s perspective, show that to some extent, critical thinking is more about the quality of the knowledge construction process. The critical thinking indicators are expressions of quality of a message and quality of different knowledge construction phases. Fewer positive critical thinking indicators in a
phase indicate less critical thinking and therefore lower quality of knowledge construction. High knowledge construction indicates the existence of high knowledge construction phase(s), but how well constructed that phase is would still be in question to some extent. For example, there are two messages and each message reaches the same phase III of knowledge construction. However, even though they are in the same phase, these two messages can still demonstrate different levels of critical thinking: one can have a higher level of critical thinking, therefore higher quality, than the other.

Below are two messages from two different students taken from a discussion transcript of a discussion on Weaknesses in Human Decision Making (with editing only for spelling). Both of these messages are considered Phase III messages since the highest phase reached in these messages were Phase III. However, there was a higher level of critical thinking in message 2 than in message 1: in message 1, there were only five positive indicators of critical thinking while in message 2, there were seven positive indicators of critical thinking. In the Phase III passage of message 2, there was also evidence of linking ideas, justification, and widening of understanding, which were not found in the Phase III passage of message 1.

Message 1:

(Phase I/A) From my experiences and observations, I would assert that human decision-making is hurt most by failure to consider the actual utility of the various options involved in any decision. Many decisions can be easily clouded by emotion or pre-prescribed morals. Morals and heuristics can often times be very helpful, but they are mental shortcuts that discourage us from considering the costs and benefits of each individual decision. Actively open-minded thinking means actively seeking new
information about a decision that may (or may not) contradict your initial opinion. I believe that not enough people go through this process, but simply settle with their initial thought, instinct, or heuristic.// (Phase III/D) In order to improve human decision-making, I would propose that the education system apply a more utilitarian backdrop to the existing curriculum. Teaching kids from a young age to approach decisions from an open-minded standpoint and to seek alternative perspectives would be an invaluable start to raising better decision-makers.//

*Critical Thinking indicators for message 1: AC+, OC+, I+, NP+, NS+

**Message 2:**

(Phase II/A) Unfortunately, I think that there are several pitfalls for people in decision making. But, in my opinion, the one that should be fixed first is the effects of conformity. Overweighing emotions, not being open minded, and the illusory correlation are certainly factors.// (Phase III/D) But I think before we can fix a person's individual thinking, we have to get them thinking for themselves. We're talked a little about this before on here, but I think that presenting people with studies on the effects of conformity can make them aware of them, which is the first step in avoiding merely conforming to the ideas of those around you. And, I think we should start this (and encouraging those who think for themselves) for an early age. This could hopefully get people starting to think for themselves at a young age. Once they're doing that, then we can work on helping them make better decisions - once they're making their OWN decisions.//

*Critical Thinking indicators for message 2: OC+, I+, JS1+, LI1+, NP+, NS+, W+
It is important to note that there is no clear cut distinction or hierarchy between knowledge construction and critical thinking. They are interrelated and different to some extent in different aspects. These two constructs are also overlapping in many senses. In order to have a good and meaningful discussion, the supporting features should support both knowledge construction (advancing students through the phases) and critical thinking.

*Interactive Intercultural Elaboration Features and Intercultural Sensitivity*

**Effect of Interactive Intercultural Elaboration Features on Intercultural Sensitivity**

The text-based discussion environment is an ambiguous environment, especially in a multicultural context where students can have different cultural characteristics such as low context cultures versus high context cultures. The negotiation and meaning making processes are very important in collaboration. However, negotiation and meaning making can be challenging in a multicultural context. Interactive intercultural elaboration features were designed to support students’ intercultural interactions and hence support the negotiation and meaning making processes as well as students’ intercultural sensitivity. Students needed to elaborate and explain culturally loaded words to reveal the cultural hidden meanings of these words. Through explanation of different cultural words, students have the opportunity to externalize their understanding of those words in the context of their culture. Students could also view other students’ explanations of cultural words and have access to multiple perspectives of the same concepts. Through these processes, students may become more aware of cultural differences and see that the same word can have different cultural meanings underlined for people from different cultural backgrounds. From being culturally aware, students could then become more willing to understand, appreciate, and accept the
differences between different cultures rather than considering all cultures the same. This is
the definition of intercultural sensitivity, as defined Chen and Starosta (1998, p. 231).

Despite all the theoretical benefits of interactive intercultural elaboration features, it is
interesting to find that these cultural features did not influence students’ intercultural
sensitivity. This result is however not conclusive due to different competing explanations.

The fact that the participants had very high intercultural sensitivity as well as high
prior cross cultural experience could have created a ceiling effect on the results, where
students’ intercultural sensitivity could not have improved significantly any more. The mean
score for intercultural sensitivity pretest scores in the control group and in the interactive
intercultural features group were 4.14 and 4.05 respectively on a five-point scale. In addition,
59.2% of students had been abroad before and 95% of students indicated that they have
friends from other countries. It is still unknown whether or not these interactive intercultural
elaboration features would be more beneficial for students who have not had a lot of prior
cross cultural experience or their intercultural sensitivity is not as strong as this student
sample.

In addition, there seemed to be issues with treatment fidelity. There were possibilities
that many students did not understand the purpose of these interactive intercultural
elaboration features or how they should use them. This was indicated by some students in
individual interviews as well as through students’ explanations of cultural words. These
students did not seem to think beyond the regular meaning of a cultural word. When asked to
provide an explanation for a cultural word, they did not put the word in the context of their
culture. Therefore, cultural nuances and meanings of such words were not brought out. For
example, for the word *family* in which one might expect to find different cultural nuances
when people have different cultural backgrounds, many explanations provided showed very general descriptions and these descriptions were often similar among group participants. Hence, it is possible that the meaning making process and intercultural sensitivity were not supported as much as it could have been if the cultural words had been explained in the context of their culture. Table 5.2 showed several example descriptions of the words *family* and *community* provided by different students. Since students seemed to mostly define words literally by giving dictionary-like definitions, asking students to focus on elaborating on characteristics of something (e.g. general characteristics of a *family* in a culture) might bring out more cultural nuances in the descriptions.

Table 5.2. Examples of Cultural Word Explanations

<table>
<thead>
<tr>
<th>Family</th>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>members of the household, can be extended or nucleus</td>
<td>people you are surrounded by</td>
</tr>
<tr>
<td>the unit consisting of some combination of fathers, mothers, significant others, and their biological or adopted children</td>
<td>Where you live and the people around you who hold the same values and beliefs</td>
</tr>
<tr>
<td>immediate siblings and parents</td>
<td>a group of individuals who live and work in geographical proximity to each other and as a result share some cultural attributions</td>
</tr>
<tr>
<td>Biological/not biological ingroup that consists of the people who are closest to you emotionally and provisionally. Or (warm + fuzzy) The people who love you no matter what happens, and as such, “have your back”.</td>
<td>a group of individuals who share at least one characteristic.</td>
</tr>
<tr>
<td>The set of people who are related to you, usually within the range of 2nd cousin or so. Sometimes a group of people brought together by a common interest will refer to themselves as a family.</td>
<td>area in which people live</td>
</tr>
<tr>
<td>Kin. People related to you either by blood or marriage. People you can rely on/who rely on you.</td>
<td></td>
</tr>
</tbody>
</table>
In addition, it is interesting to note that students’ frequency of cultural word explanation was significantly correlated with their perceived usefulness of the interactive intercultural elaboration features for different discussion tasks (see Table 5.3). A causal direction is unknown but exploring this aspect would give insightful information on these features.

Table 5.3. Pearson Correlations of Frequency of Cultural Word Explanation and Perceived Usefulness for Different Discussion Tasks

<table>
<thead>
<tr>
<th>Read Messages</th>
<th>Write Messages</th>
<th>Understand Messages</th>
<th>Understand Cultural Meanings Hidden in Messages</th>
<th>Respond/Comment on Others’ Postings</th>
<th>Think Critically</th>
<th>Learn about other cultures</th>
<th>Interact with other students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.311**</td>
<td>0.309**</td>
<td>0.353**</td>
<td>0.418**</td>
<td>0.305**</td>
<td>0.375**</td>
<td>0.338**</td>
<td>0.314**</td>
</tr>
<tr>
<td>93</td>
<td>93</td>
<td>92</td>
<td>93</td>
<td>93</td>
<td>93</td>
<td>93</td>
<td>92</td>
</tr>
</tbody>
</table>

Note.
1. The 2nd row includes Pearson Correlations r; the 3rd row includes the number of students.
2. ** p < 0.01.

From a design perspective, the instruction for feature use could be made clearer and more examples could be given to demonstrate effective use of the features. The important issue here is then how to support students use these interactive intercultural elaboration features effectively. A more demonstrative or face-to-face introduction to the use of these features could be more helpful. In a face-to-face introduction, students could be asked to explain cultural words to each other.

Another explanation is that some discussion topics may not have been advantageous for integrating the use of these cultural features. This leads to the question of whether or not the use of these features could be better promoted in topics with some visible cultural
aspects, such as topics that explore the cultural dimension of a subject or topics that may prompt cultural observations. In this experiment, on a first glance, the topic of decision making could seem culturally neutral to students, and therefore it may not make sense to students that they need to explain cultural words. According to Keller (1983), one of the important contributing factors to motivation is relevance. Therefore, in order to increase students’ perceived usefulness of the features and help students feel motivated to use these features, it may be meaningful to directly frame these cultural words in the context of the discussion topic. For example, instead of asking students to simply explain cultural words (which they may not see connections between these words with the discussion at hand), questions or prompts relating to the cultural words can be incorporated. These prompts can ask students to reflect on the new concepts in that discussion from the perspective of their cultures. For example, for the Weaknesses in Human Decision Making topic in this course, there are different psychological processes involved in the decision making process: questions can then be asked about if the same phenomenon can be observed in their culture or if what they learn now is consistent with their prior experience.

**Prior Cross-cultural Experience**

The results showed that prior cross cultural experience did not influence the effect of interactive intercultural elaboration features on students’ intercultural sensitivity. Nevertheless, this result is not conclusive. First, students’ prior cross cultural experience and intercultural sensitivity were both quite high. The prior cross cultural experience construct could also be explored more since certain dimensions under this overall construct might be more relevant than others.
Knowledge Construction using Toulmin Argumentation Framework and Problem Solving Framework

First, it is important to note that the two discussion frameworks were compared using two different discussion topics. It would have been better if the two were compared using only one discussion topic. Therefore most of the results here need to be interpreted in the context that the discussion topics are different. Topic 7 with the Argumentation framework was about persuasion and Topic 8 with the Problem Solving framework was about influence of cultural understanding on contemporary problems. It would be interesting to analyze the nature of these two discussion frameworks to infer their characteristics. Understanding their characteristics may provide insights for how these frameworks influence the knowledge construction process differently.

Characteristics of Argumentation and Problem Solving Frameworks

The Toulmin argumentation framework and the problem solving framework are two discussion frameworks of different nature. The argumentation framework is more constrained and with a more focused purpose. However the problem solving framework is more flexible with more room for what the message could be about, therefore in a sense less constrained. In addition, the argumentation framework is more complex, and probably more difficult to use. One could say that the problem solving framework is less structured than the argumentation framework.

Comparison at the Knowledge Construction Phase Level and Level of Structure

Argumentation-based discussions had more lower-level Phase I (Sharing and Comparing) occurrences while problem solving-based discussions had more high-level
Phases III (Negotiation and Co-construction) and IV (Testing and Modification) occurrences. Argumentation-based discussions also had more messages with the highest phases as Phase I (Sharing and Comparing) than problem-based discussions while problem based-discussions had more messages with the highest phase as a higher-level phase. There are some possible explanations of these results. It could be due to the discussion topics or due to the nature of the discussion frameworks. Topic 7 on Persuasion may be a more difficult topic while Topic 8 on Contemporary Problems and Culture may be more intuitive. Persuasion is also a more theoretical topic and therefore it could be more challenging to move to higher phases with this topic.

It is important to note that, for the group more experienced with the cognition-supported features, the argumentation-based discussion had more Phase II (discovery and exploration of dissonance or inconsistency) occurrences than the problem solving-based discussion. On the contrary, for the group less experienced with the cognition-supported features, the problem solving based discussion had more Phase II occurrences than the argumentation-based discussion. However, the difference in Phase II occurrences between the two frameworks for the more experienced group was more noticeable than the difference for the less experienced group. This may indicate that once students get more used to the Argumentation framework, there would be more Phase II occurrences in argumentation-based discussions than in problem-solving based discussions. The more frequent Phase II occurrences could mean a framework with a component that explicitly called for rebuttals like the argumentation framework will enable more constructive conflict.

However, it is also important to advance to higher phases of knowledge construction by resolving this conflict. The dilemma is that the argumentation framework seems to
provide more conflicts which can serve as a catalyst for knowledge construction but at the same time still have fewer high-level phases than the problem solving framework. This leads to a question about the level of structure that a framework provides to students. Could too much structure inhibit knowledge construction? Students’ characteristics might also play a role in the amount of structure that should be integrated in an online discussion. Student comments indicated that there were students who did not like too much structure and want to freely express their opinions without having to label their messages every time. One disadvantage of the argumentation framework might be its high level of structure. This high level of structure helps students form a logical flow but at the same time can also inhibit their flow of thought. For example, if students’ thoughts cover more than one message type, students would need to break their thoughts into fragments of thoughts in order for their messages to fit into one message type. This could be annoying to students and at the same time inhibit their thought flow, which may make them forget the bigger picture and focus on smaller details instead. The amount of structure is then a factor worth considering when integrating constraint into an online discussion. The discussion topic might also play a role in the decision of what discussion framework/structure to use.

**Comparison at the Knowledge Construction Phase Level and Length of Use**

There was also evidence that for both discussion frameworks, Group A, the group who used the cognition-supported features first tended to have more occurrences of higher phases than Group B, the group who only used these features towards the end of the semester. The differences between these two groups were larger in the argumentation-based discussions than in problem solving-based discussions. In addition, knowledge construction
richness or density (total number of knowledge construction operations) is also higher in
Group A than in Group B. These results could mean that there were benefits associated with
a longer use of these cognition-supported features and a longer use of a specific discussion
framework and the benefits of this longer use might have been transferred or retained.
Especially, since the argumentation framework could be a difficult to use framework,
students would probably need time to get used to this framework. These cognition-supported
features seem to be more beneficial after using them for some time. Therefore, there is a
learning curve for using these cognition-supported features. A demonstrative tutorial and
extended use might be useful.

**Comparison at the Knowledge Construction Operation Level**

At the operation level of Phase I, in both types of discussion frameworks, there was
more Phase IA (Share Observation) and Phase I/C (Provide Examples), followed by Phase
I/B (State Agreement) in the problem solving based discussion. The lack of Phase I/D
( Clarify Details) and Phase I/E (Identify Problem) may be due to the clear nature of the topic.
It would be interesting to see if a complex problem solving task would elicit more Phase I/D
and Phase I/E.

In both types of discussion frameworks, among Phase II (Discovery of Dissonance)
occaurrences, there was mostly Phase II/A where students identified and stated areas of
disagreement, followed by Phase II/C where students advanced the arguments in support of
the disagreement. Phase II/B occurrences where students asked and answered questions to
clarify the source and extent of disagreement were rare. Asking and answering questions to
further understand a disagreement is important in resolving a conflict. Therefore, some
scaffolding tools to encourage students to ask questions to further understand a disagreement may be helpful.

Most Phase III (Negotiation and Co-construction) operations were Phase III/D (Propose New Statement). Encouraging other forms of negotiation of meaning can help make the knowledge construction process richer, bring more perspectives to the issues at hand, more ways to look at a problem, and therefore more quality knowledge construction. For example, with more PhIII/A comes more questioning of the meaning of different terms; with Phase III/B, students negotiate the relative weight to be assigned to types of agreements; with Phase III/C, students identify areas of agreement or overlap among conflicting concepts; and with Phase III/E, students can propose to integrate or accommodate metaphors or analogies in their negotiation of meaning/co-construction of knowledge. Therefore, making novice students aware of different ways to negotiate meaning and co-construct knowledge can facilitate the knowledge construction process. This can be done by integrating these different ways into the discussion framework or by providing relevant prompts along the discussion.

Regarding Phase IV (Testing and Modification) occurrences, it is no surprise that most Phase IV occurrences include Phase IV/A, B and C (Test against “Received Fact”, Cognitive Schema, and Personal Experience) since there was no formal data collected in these discussions as well as no extensive literature research from students for these discussions. Most students tested the proposed synthesis or co-construction against “received fact” as shared by the discussion participants and/or their culture, against their existing cognitive schema as well as against their personal experience. One would expect to find more Phase IV/D (Test against Formal Data) and E (Test against Contradictory Testimony) in
discussions where data are collected or where students are more knowledgeable of the literature.

Phase V (Agreement and Application) occurrences were very rare in both discussion frameworks. It could be due to the nature of the discussion questions which didn’t explicitly call for action and application of new knowledge. In order to increase Phase V (Agreement and Application) occurrences in the discussion, there could be prompts for summarizing of the discussion and reflection on the discussion as well as how students can apply this knowledge.

**Variations of Discussion Boards**

Similarly to when discussing the comparison of the two discussion frameworks in the previous section, it is important to take into account the different discussion topics in these compared discussion board types: standard threaded discussion board, with cognition-supported features, with interactive intercultural elaboration features, and with both sets of features.

**Discussion Topic’s Characteristics**

First, it is important to analyze the nature and focus of these discussions. Discussion Topic 2 on Becoming a Peaceful Adult included the most detail and suggests different solutions for how to educate a child to become a peaceful, affectionate and cooperative adult. The question then goes on and asks students to comment on these solutions and suggest any other solutions that might work. The focus of this discussion question was on solutions to a problem, with various solutions presented in advance already. Therefore, there was less need for students to clarify problems here. The problem caused by the existence of violent toys
and media in the surrounding environment was already implicitly agreed upon. Students needed to work on reviewing the solutions and give their opinion on different solutions.

Topic 5 on Weaknesses of Human Decision Making had a focus on both the problems in decision making and solutions to improve the decision making process. However, much less information was given in advance in this discussion topic. Therefore students needed to both identify problems and then suggest solutions. Hence, there was more need for problem clarification here in this discussion topic than in Topic 2 on Peaceful Adult.

Topic 7 on Persuasion had a focus on students’ personal experience with persuasion so students tended to share more personal experience in this discussion, then decided whether there should be formal education or training on persuasion for children.

**Discussion Topic’s Influence on Knowledge Construction**

For the Decision Making topic discussed at the end of the experimental period, the discussion with cognition-supported features had more high-level Phases III (Negotiation and Co-construction) to IV (Testing and Modification) occurrences than the condition with interactive intercultural elaboration features, while the condition with interactive intercultural elaboration features had more Phases I (Sharing and Comparing) and II (Discovery of Dissonance) occurrences. This is consistent with the result from Research Question 1, where it was found that cognition-supported features had a positive effect on students’ knowledge construction in discussion.

Among all the conditions, the discussion on Decision Making with cognition-supported features had most Phases III (Negotiation and Co-construction), IV (Testing and Modification) and V (Agreement and Application) occurrences. In addition, the combined
features discussion on Persuasion from the group more experienced with cognition-supported features had less Phases III, IV, and V occurrences than both the standard threaded discussions on Peaceful Adult and the discussion on Decision Making with cognition-supported features. It is more reasonable to attribute these differences to the discussion topics’ characteristics rather than to the types of discussion board here. For example, the discussion on Persuasion and the discussion on Decision Making with cognition-supported features both had the cognition-supported features; however, the Persuasion discussion did not only have fewer high-level phases than the Decision Making discussion but also have fewer high-level phases than the Peaceful Adult discussion with no special features. The clear difference between these two cognition-supported Decision Making and Persuasion discussions at the knowledge construction phase level points to the influence of the discussion topic on the knowledge construction process. Since one of the Persuasion topic’s foci is on sharing personal experience, most students when discussing this topic stayed on sharing and comparing information phases, followed by expressing disagreement with others. However, as analyzed above, in the Decision Making topic, the focus is not on personal experience, but on finding problems and then thinking about how to solve problems; therefore it makes sense to see more high-level phases in the Decision Making decision. The Peaceful Adult topic had a lot of details given, therefore students had more information to build on, and hence, students could advance faster to higher phases. These results showed that discussion topics also need to be chosen properly depending on students’ characteristics. For example, novice students with a more narrow knowledge base may need more information (more hints) at the beginning.
Observing that a discussion without special features had a better level of knowledge construction than a discussion with cognition-supported features does not imply that a topic that can produce high levels of knowledge construction is enough and these special features are not necessary. The goal is to help students to improve their knowledge building on any given topic, both topics that allow students to advance fast to higher phases and topics where students need to go through a lot of comparing and sharing of information as well as exploring dissonance and inconsistencies between ideas before advancing to higher phases. In this regard, choosing a topic depends a lot on the intended learning outcomes for the learners.

At the same time, knowledge construction density is highest in the Decision Making discussions (with either of cognition-supported features or interactive intercultural elaboration features), then the standard threaded discussions on Peaceful Adult, and then the combined features discussions on Persuasion. This means the Decision Making discussions had the most knowledge construction operations occurring. This could be because the topic focuses on both problems and solution. Students were not given so many details as well as not asked to focus on personal experience. Therefore, there might have been more room for exploration in this discussion.

In a similar pattern when examining discussions of Topics 7 and 8 for comparing two discussion frameworks, most Phase I (sharing and comparing) operations were Phase I A/C (Share Observation/Provide Examples), followed by Phase I/B (State Agreement); most Phase II operations were Phase IIA/C (Identify Disagreement/Restate Position); most Phase III operations were Phase III/D (Propose New Statement); most Phase IV operations were Phase IV A/B/C (Test against “Received Fact”, Cognitive Schema, and Personal Experience).
with mostly Phase IV/C (Test against Personal Experience). We can comment the same like when we compare the two discussion frameworks.

**Comparison at the Knowledge Construction Operation Level**

In a similar pattern with the comparison of the Argumentation and Problem Solving discussion frameworks at the operation level, in all discussion board types, most Phase I operations were Phase I A/C, followed by Phase I/B; most Phase II operations were Phase II A/C; Most Phase III operations were Phase III/D; most Phase IV operations were Phase IV A/B/C with mostly Phase IV/C. Therefore, like suggested previously, prompts for different approaches in the negotiation of meaning and co-construction of knowledge might be helpful in increasing the variety of Phase III occurrences, which may lead to more quality knowledge construction.

**Discussion Topic’s Influence on Critical Thinking**

The difference in critical thinking found in different discussion board types could also be due to the difference in the nature of the discussion topic than the feature difference in the types of the discussion boards themselves.

In the Ambiguities category, there were more clarifications of the subject (AC+) in the Decision Making discussions and the Persuasion discussions than in the discussions on Peaceful Adult. As analyzed above, Peaceful Adult topic focuses more on possible solutions to a problem. Therefore, it had fewer clarifications of the subject than Decision Making and Persuasion topics.
In the Outside knowledge/experience category, since students were explicitly asked to share their personal experience in the Persuasion topic, this discussion had more use of personal experience (OE+) than use of course material (OC+). This discussion also had more use of personal experience (OE+) and fewer occurrences of course material use (OC+) than discussions on Peaceful Adult and on Decision Making. This is understandable since Peaceful Adult and Decision Making topics do not have a focus on sharing personal experience. Forming discussion topics is then very important in guiding or framing what students will learn or talk about.

In the Novelty category, since there was not much information given initially, the Decision Making topic might have had more room for discussion and therefore had most occurrences of novelty-related indicators as well as the highest knowledge construction density.

In addition, in the Decision Making discussions where Group A used the cognition-supported features and Group B used the cultural features and in the Persuasion discussions where both groups used both sets of features, Group A had more indicators of critical assessment, justification, linking, and novelty than Group B in both discussions on Decision Making and discussions on Persuasion. Group A’s the cognition-supported features Decision Making discussion and combined features Persuasion discussion had more Critical Assessment indicator (C+) than the Decision Making and Persuasion discussions from Group B. These are indicators of high order learning and this again indicates Group A might have benefited from longer use of the cognition-supported features than Group B. This also further confirms that cognition supported features do support students’ critical thinking in online discussion.
Motivation, Instructor Involvement, Deadline and Students’ Participation in Online Discussion

Data from a final survey at the end of the semester asking questions about students’ use of the discussion board showed that the majority of students either enjoyed or was not sure if they enjoyed the online discussion experience (see Table 5.4). Almost 60% of the students thought that the online discussion activities deepened their understanding of the course topics and 17% was not sure. Enjoyment and perceived usefulness of the activity is related to students’ motivation to participate. Since 26% of the students did not enjoy the online discussion experience and 24% of the students did not think the activity deepened their understanding of the course topics, that could mean these students had low motivation to participate. Further, in another study of students’ motivation in online discussion activities integrated into a traditional face-to-face undergraduate course by Xie, DeBacker, and Ferguson (2006), the authors found that as the semester progressed, student’s intrinsic motivation in online discussion decreased steadily. If this result was to be generalized to the students in this study, decreased motivation might have had an influence on how students used these features introduced in Phase II and Phase III of the study.

Table 5.4. Students’ Perception of the Online Discussion Experience

<table>
<thead>
<tr>
<th>Questions</th>
<th>N</th>
<th>Yes</th>
<th>I’m not sure</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you enjoy the online discussion experience in this course?</td>
<td>95</td>
<td>44%</td>
<td>30%</td>
<td>26%</td>
</tr>
<tr>
<td>Did the online discussion activities deepen your understanding of the course topics?</td>
<td>97</td>
<td>59%</td>
<td>17%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Motivation is an important factor in promoting participation in online discussions activities and as a result, learning from these activities. Therefore it is important to know the factors that might have influenced students’ motivation. Xie et al. (2006) found students’
lack of time, instructor’s involvement, interaction between peers, discussion topics, discussion requirements, and the usability of the system to be factors that might affect students’ motivation in online discussion.

In this study, student comments showed many students enjoyed the opportunities to interact with their peers and know about others’ perspectives, which interaction with peers being a motivating factor. Even though Pawan (2003) suggested giving students detailed requirements for the discussion activity with deadlines for initial posts and subsequent postings, many students thought that the posting requirements three times/a week with each posting due by a certain day of the week was overwhelming. Even though the posting timeline was suggested and strongly encouraged, discussion board data showed that many students did not follow the posting timeline requirements and many waited until the last few days (or last day) of the discussion posting cycle to post messages. This influenced group interactions and group dynamics. In such situations, a meaningful discussion could not occur and special features integrated into the discussion board would not be used in the way they should be used.

In addition, there was no instructor involvement in regards to giving students’ feedback to their contributions and that could lower students’ motivation. Students in the Xie et al. (2006)’s study indicated that “instructors’ participation, guidance and feedback in the online discussion were critical to their motivation to participate in the discussion” (p.84). Without feedback from the instructor, another concern is students’ low prior experience in online discussion in the current study. Wu and Hiltz (2004) suggested that students with more experience with and online discussions “should feel less anxiety and uncertainty, resulting in higher motivation and higher enjoyment” (p. 142).
Factors such as no instructor involvement to give students feedback, last minute-postings which impact group dynamics, and low prior experience with online discussion might have negatively influenced students’ motivation to participate, and as a result, influence how they use the cognition-supported features and interactive intercultural elaboration features.

**Implications for Instructional Design**

Based on the results from this study, instructional designers are recommended to use constraint-based discussion boards with a discourse map when designing online discussion activities for novice learners. In addition, the following factors should be taken into account: learners’ characteristics, discussion topic features, interface design of the features, selection of discussion framework (including its level of structure and its ability to support negotiation and argumentation processes), instruction/tutorial for feature use, length of use, and when to withdraw the scaffoldings. In addition, contextual factors that may influence students’ motivation and group dynamics such as instructor involvement, students’ prior experience with online discussions, frequency of postings, and posting requirements also need to be taken into account.

The use of interactive intercultural elaboration features need to be furthered studied. Theoretically, these features may be beneficial to students with low prior cross cultural experience and in discussions with more direct cultural aspects. It is important that students understand the purpose of the features that they use and use the features correctly.
Figure 5-1 shows an online discussion design framework for designing online discussion activities that employ cognition-supported features and interactive intercultural elaboration features.

**Figure 5-1. Cognition and culture online discussion design framework**

**Implications for Future Research**

In future research, tutorials will be revised so that students can know well how to use the features correctly. Future research includes more controlled experiments to compare variations of discussion board types using the same discussion topic for each discussion board type and using a more refined version of the discussion board system with a more user-friendly interface. This approach will provide better insights into the effects of these cognition-supported features and interactive intercultural features.
With regards to the cognition-supported features, characteristics of discussion topics should also be explored, including the connection between discussion topics and appropriate discussion frameworks, as well as which types of discussion frameworks work with which types of topics. Various discussion frameworks with different levels of structure could also be explored to see what works and what does not work or what works better and what works less for what audience. Investigating the different ways to support online discussions is especially important for novice learners who have limited metacognitive skills and limited knowledge of the domain subject.

Interactive intercultural elaboration features can be further explored with a student sample that is diverse but has a low level of prior cross cultural experience. It would also be important to know which types of topics can benefit from the interactive intercultural elaboration features and how cultural words selected may impact student use of the features.

Students’ use of the different supporting features could also be explored in order to understand the cognitive processes they go through when using these features. For example, information on how students labeled messages may reveal difficulties students encountered when labeling messages; studying different discourse maps may reveal to what extent the maps can be useful to students; exploring the explanations of cultural words may reveal even more information on how students used the interactive intercultural elaboration features, how students view a cultural word and whether or not a word should be considered a cultural word in the online discussion context. In addition, instead of measuring the effects of interactive intercultural elaboration features on intercultural sensitivity using a survey instrument, one can also explore the influence of these features by exploring the qualitative discussion transcripts to detect evidence of culture-related inquiries, self-reflection on one’s
own background, and indicators of intercultural sensitivity such as changes in attitudes towards cultural differences. The qualitative information extracted from each online discussion will tremendously help the design and improvement of these features.

Ultimately, these features are scaffoldings to help students to improve their knowledge building abilities and critical thinking skill as well as their intercultural competence. Therefore, after an extended use of these features, it would be helpful to see if what they learn is retained and transferred to other situations where these features are not available. In this study’s scope, the scaffoldings have not been removed but in future research, during the course of the study, the special features could be removed from the discussion board to study this transfer effect.

**Limitations**

More questions could have been answered if there had been four treatment groups: one group using standard discussion board without any special features, one group using each set of the special features and one group using both sets of features. In this case, discussion topics would be the same for all groups and more insights into the effects of the cognition-supported features an interactive intercultural elaboration features could be gained. These features also were not used to their full potential. Students did not seem to gain all the full benefits that these features could provide. A part of this study is to enhance students’ intercultural sensitivity through the interactive intercultural elaboration features. However, most students in this course already had high level of intercultural sensitivity and high prior cross cultural experience. A student sample that does not have much prior cross cultural experience may benefit more from the interactive intercultural elaboration features. The two
discussion frameworks could have been used with the same discussion to enable better comparison of the two discussion frameworks.

Another limitation is related to the coding of online discussions. To estimate the reliability of knowledge construction scores and of critical thinking scores, two raters coded a selected sample of messages. However, only one coder coded all the discussion messages needed to compute students’ knowledge construction and critical thinking scores. Since the scores were based on only one rater’s coding results, the fluctuation in the knowledge construction and critical thinking scores might be greater than when two or more raters evaluated all messages. Thus, there could be increased noise and random error in the results. Results from D studies of the rubrics’ reliability are presented in Figure 5-2 and Figure 5-3.

![Figure 5-2. D study for critical thinking coding scheme](image-url)
The D study results show how G-coefficient would change based on different numbers of raters and different numbers of messages per student. This information provides implications for how to increase the reliability of critical thinking scores and knowledge construction scores for future study.

The instruments for prior knowledge and experience in psychology, prior experience in online discussion and prior cross cultural experience also had their limitations. The scale for prior knowledge and experience in psychology is on a Likert scale, which makes it
somewhat unclear when interpreting the score of this scale. The prior knowledge and experience scale is also based on students’ perception rather than on a real knowledge test, therefore, it may not reflect students’ prior knowledge and experience with sufficient accuracy. This may influence the result. Both the prior knowledge and experience in psychology and prior experience in online discussion scales had a low number of items which might have caused the low reliability coefficients. The prior cross-cultural experience instrument is a multidimensional instrument and there could be dimensions less relevant than others in influencing intercultural sensitivity.

The interface design of the discussion board system was still not sufficiently user-friendly, which could lead to students’ resistance to the features.

**Conclusion**

Since this study was conducted in a university-level psychology course, the results of these studies could be generalized to other social science or humanities college courses since the nature of these courses, like psychology, is conducive to discussion. This study found positive effects of cognition-supported features on students’ knowledge construction and critical thinking in online discussion and explored interactive intercultural elaboration features in the design of online discussions to facilitate interaction between learners from different cultures. The study results suggested that constraint-based discussion and discourse map features should be used in online discussion activities in college classrooms and suggested that extended use of these cognition-supported features might be beneficial for students. Also, the level of structure in a discussion framework and the designing of discussion topics should be considered in relation to learners’ characteristics and intended
learning outcomes when designing online discussion activities using constraints. This experimental study added more empirical evidence to the literature for the positive influence of a constraint-based discussion and a discourse map in online discussion, and offered implications for further research in the area of constraint-based online discussions and for designing online discussion activities using constraints and a discourse map. In addition, the study may stimulate future research in facilitating cross-cultural interaction and intercultural learning in online discussion through the interactive intercultural elaboration process and supporting multicultural learning environments.
REFERENCES


Hewitt, J. (2002). From a focus on tasks to a focus on understanding: The cultural transformation of a Toronto classroom. In T. Koschmann, R. Hall, & N. Miyake (Eds.), CSCL 2: Carrying forward the conversation (pp. 11-41). Mahwah, NJ: Lawrence Erlbaum.


APPENDIX A1. Online Discussion Guidelines
**ONLINE DISCUSSION ACTIVITIES**

**DISCUSSION GUIDELINES SHEET (2 PAGES)**

**Benefits**
- Deepen your understanding of the lecture topics through online discussions with your classmates.
- Have time to reflect on the topic
- Develop your critical thinking through:
  - thoughtful reflection
  - interaction with others
  - expressing your ideas/thoughts in writing
  - taking into account others’ ideas
- Flexibility: You can contribute to an online discussion anytime anywhere as long as you have access to a computer connected with Internet!
- Allows you to voice your opinion even when you feel uncomfortable speaking up in class

**Logistics**
- Sign up for an account on the forum website
- You will be assigned into a discussion group of 6-9 students.

**Discussion Timeline**
- Each week, there will be a new discussion topic posted.
- A new discussion topic will be posted in the forum website every Thursday at 5pm.
- A discussion will end on the following Thursday at 4:59pm.
- First discussion starts on Thursday September 25!

**Posting Requirements: Posting Quantity**
- You are to contribute to the discussions by posting at least 3 messages throughout the week for each weekly discussion.

**Posting Requirements: Posting Quality**
- The minimum length of the first posting should be about 150 words; the minimum length of the subsequent postings should be about 120 words.
- The length can be flexible, however, your postings should demonstrate thoughtfulness.
- Your postings should not be simple repeats of postings previously posted by others.
- Please be courteous and respectful of various viewpoints expressed in the discussions.

**Recommended Posting Timeline**

We strongly encourage you to follow this timeline for meaningful online discussions:
- The first posting should be a direct response (your thoughts/ideas) to the discussion topic and should be posted by Monday midnight following the Thursday the discussion topic was posted.
  - This will give others in your group enough time to respond to you posting.
- The next two postings should be responses/comments to the postings from others in your discussion group.
  - 2nd posting should be posted by Tuesday midnight.
  - 3rd and additional posting should be posted by Thursday 4:59pm!
- Additional postings are encouraged to be made in order to generate meaningful discussions.
- Try to post messages on time to make sure meaningful interactions can happen in your online discussions
- Check the forum site often to make sure you follow and stay engaged in your group’s discussions

RECOMMENDED POSTING TIMELINE

- A new discussion topic is posted
- 1st Posting is Due
- 2nd Posting is Due
- 3rd & Additional Postings are Due

- Response directly to the topic
- Response to others’ postings
- Response to others’ comments on your postings
APPENDIX A2. Embedded Instruction in Discussion Questions

Note: The embedded instruction can be found at the end of each discussion question.

Warm-up Discussion: Getting to know each other!

Before participating in the main discussion of this week, introduce yourself (name, where you are from, your major or intended major, etc.) to your group members and briefly share something about yourself that will help your fellow group members understand where your point of view comes from.

1. Example Discussion Question in a Standard Threaded Discussion

Discussion 1: Conformity and the Power of Situations
Research on conformity, such as Milgram's obedience studies and Zimbardo's prison simulation, indicates that under certain conditions people who are otherwise moral and decent are capable of engaging in acts of considerable cruelty toward others. First, discuss what issues do these findings raise regarding the problem of holding individuals responsible for their actions? Second, given our understanding of the power of situations in influencing behavior, can you think of ways of using this knowledge to reduce the likelihood of conformity-based acts of cruelty in prisons, such as Abu Ghraib?

-- Everyone's prompt input is important to ensure a meaningful online discussion. You are strongly encouraged to post your 1st posting by Monday midnight, 2nd posting by Tuesday midnight, and 3rd and any additional postings by Thursday 5pm. Please refer to the online discussion guidelines for more details.

2. Example Discussion Questions with Cognition-Supported Features

Discussion 3: A Society free of prejudice?
(Note: This is the first discussion where students in the cognition-supported features group used the cognition-supported features)
Discuss the following in your group:

"Is everyone prejudiced to one degree or another? That is, is it possible to be entirely free of prejudice in our society? Why do you think that this is or is not the case? How could people become more aware of the subtle ways in which they hold or express prejudiced beliefs and behavior? Describe any experiences you might have had in which you suddenly realized you were acting or feeling prejudiced towards another person or group. What were your feelings upon discovering this about yourself?"

This discussion follows a discussion framework called 'Toulmin Argumentation Model': This
discussion framework helps you to critically discuss controversial issues with others and helps your group to address problems posed through collaborative reasoning. *Before participating in this discussion*, you need to view the Introduction module near the top of this page for descriptions and brief examples of each component of this discussion framework.

-- Everyone's prompt input is important to ensure a meaningful online discussion. You are strongly encouraged to post your 1st posting by Monday midnight, 2nd posting by Tuesday midnight, and 3rd and any additional postings by Thursday 5pm. Please refer to the online discussion guidelines for more details.

**Discussion 5: Weaknesses of human decision making**

Discuss the following:
"Imagine that you were writing a proposal for a book about what is wrong with human decision making and how to fix it. What are the main weaknesses of human decision making that you would emphasize? How would you suggest that people could go about improving their decision-making?"

--The large view of the discussion map can be better viewed using Firefox browser. Like the previous discussion, this discussion will follow the Toulmin Argumentation discussion framework to support your group's collaborative reasoning.

-- Everyone's prompt input is important to ensure a meaningful online discussion. You are strongly encouraged to post your 1st posting by Monday midnight, 2nd posting by Tuesday midnight, and 3rd and any additional postings by Thursday 5pm. Please refer to the online discussion guidelines for more details.

3. Example Discussion Questions with Interactive Intercultural Elaboration Features

**Discussion 3: A Society free of prejudice?**

*(Note: This is the first discussion where students in the interactive intercultural elaboration features group used the interactive intercultural elaboration features)*

Discuss the following in your group:

"Is everyone prejudiced to one degree or another? That is, is it possible to be entirely free of prejudice in our society? Why do you think that this is or is not the case? How could people become more aware of the subtle ways in which they hold or express prejudiced beliefs and behavior? Describe any experiences you might have had in which you suddenly realized you were acting or feeling prejudiced towards another person or group. What were your feelings upon discovering this about yourself?"

Several cultural features are integrated into this discussion. *Before participating in this discussion*, you need to view the Introduction module near the top of this page for
Consider the self-esteem of women. Given that some women experience a significant amount of overt prejudice and prejudice-related negative outcomes in their daily life, how do you think the responses of women compare to the responses of men when asked how satisfied/happy they are with their lives? Answer this question according to each of the following perspectives or tendencies (i.e., what would the following concepts lead you to predict?):

a) "looking-glass self"
b) downward social comparisons
c) self-serving attributional biases

Some empirical evidence suggests that the self-esteem and life satisfaction of women are not significantly different from those of men. Given that fact, which of the 3 concepts that you considered seem to be most influential in the self-concept formation of women?

--When you are prompted to enter an explanation for a cultural-loaded word/concept, you do not need to search for what it formally means (i.e. dictionary meaning). You just need to state your understanding of what it may mean and its key characteristics in your culture in a couple of sentences. For example, if you are prompted to enter an explanation for the word/concept "family", you just need to enter what "family" means to *you* and some key characteristics of a family in the context of your culture. To some, "family" may mean a very close-knit and big group of people (including all relatives) living in the same neighborhood or even in the same house. To others, family may only mean parents and children and it is common for members of a family to live very far from each other.

-- Everyone's prompt input is important to ensure a meaningful online discussion. You are strongly encouraged to post your 1st posting by Monday midnight, 2nd posting by Tuesday midnight, and 3rd and any additional postings by Thursday noon. Please refer to the online discussion guidelines for more details.

4. Example Discussion Question with Both Sets of Features

Discussion 6: Rewarding System and Cognitive Dissonance
Elementary-school teachers often use a reward system (such as offering children small prizes) in order to motivate their students to do well on their schoolwork and to maintain discipline in the classroom. Based on your knowledge of cognitive dissonance theory, what are the possible drawbacks of relying on such a system? Do you think such systems should be avoided all together? What steps could teachers take to avoid or counteract these potential negative effects?

––There are both discussion framework/discussion map features and cultural features integrated into this discussion. The large view of the discussion map can be better viewed using Firefox browser. With other browsers like Internet Explorer, part of this large view might be missing when the map gets big. *Before participating in this discussion*, you need to view either Part 1 or Part 2 of the NEW Introduction module near the top of this page for an overview of the new features (read the description under the link to see which part you should view).

-- This discussion follows a discussion framework called 'Toulmin Argumentation Model': This discussion framework helps you to critically discuss controversial issues with others and helps your group to address problems posed through collaborative reasoning. Part 1 of the introduction module will give you descriptions and brief examples of each component of this discussion framework.

-- Everyone's prompt input is important to ensure a meaningful online discussion. You are strongly encouraged to post your 1st posting by Monday midnight, 2nd posting by Tuesday midnight, and 3rd and any additional postings by Thursday 5pm. Please refer to the online discussion guidelines for more details.

**Discussion 7: Persuasion**
Discuss the following:

"To the best of your knowledge, how easily are you influenced by attempts to change your attitudes or behavior? Under what conditions are you more or less likely to be persuaded? Do you think your knowledge about strategies of persuasion can help you resist unwelcome attempts at persuasion? Since we live in an age of mass communication - in which we are subject to a daily onslaught of influence attempts - should children receive some kind of formal training or education about persuasion? Why or why not?"

--There are both discussion framework/discussion map features and cultural features integrated into this discussion. Like the previous discussion, this discussion follows the Toulmin Argumentation Model to support your group's collaborative reasoning. When you are prompted to enter an explanation for a cultural-loaded word/concept, you do not need to search for what it formally means (i.e. dictionary meaning). You just need to state *your* understanding of the concept and its key characteristics in your culture in a couple of sentences.
### APPENDIX B. Database of Cultural Words

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<th>abusive</th>
<th>cult</th>
<th>happy</th>
<th>moral</th>
<th>satisfies</th>
</tr>
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<td>nature</td>
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<td>heroic</td>
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<td>immoral</td>
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<td>services</td>
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<td>modern</td>
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</table>

Note. Words in white cells were added by the researcher; Words in shaded cells were added by students.
APPENDIX C. Questionnaire for Student Demographics Information

1>…your name ____________________

2>…your classification
a. First year student b. Second year student c. Third year student
d. Forth year student e. Fifth year student and above

3>…your gender
a. Male b. Female

4>…please name your country of origin (in other words, which country do you come from?)
____________________________________

5>…please describe your location of upbringing (i.e. Northeast, West, Southwest; name of country if brought up outside of Australia): If more than one location, please specify the most representative location
____________________________________

6>…please describe your ethnicity (i.e. French, English, Chinese, Mexican, Spanish, etc.). If two or more ethnicities, please specify those that are most representative.
____________________________________
APPENDIX D. Questionnaire for Student Prior Knowledge and Experience in Psychology

Please select your agreement level regarding the following statements:
1 = Strongly Disagree
2 = Disagree
3 = Undecided
4 = Agree
5 = Strongly Agree

1. I have high knowledge of psychology.
2. I have practical experience involving psychology.
3. I have encountered many situations where knowledge of psychology is useful.
APPENDIX E. Questionnaire for Prior Experience in Online Discussion

1. My level of experience in online discussion in classroom context prior to this course is:
   None  Some  Adequate  High

2. My level of experience in online discussion outside of classroom context (e.g. any discussion forum on the web) is:
   None  Some  Adequate  High
APPENDIX F. Questionnaire for Prior Cross-Cultural Experience

1> …please name your native language(s)
__________________________________

2> …please name any other languages you speak fluently
__________________________________

3> …How many times have you been abroad?

If you were abroad before, for each time you are abroad, please fill in the information in the following table. If you have been abroad more than 3 times, fill out information for the three longest times.

<table>
<thead>
<tr>
<th>Time</th>
<th>Country</th>
<th>Duration</th>
<th>Purpose (e.g., travel, internship)</th>
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<td>1</td>
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<td></td>
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</tr>
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<tr>
<td>3</td>
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<td></td>
</tr>
</tbody>
</table>

4> …Have you had experience working in a group project where all team members are located in the same place and there was at least one person from another country?
   Yes No
   If Yes:
   …How many times approximately?

5> Approximately, including working in the cross-cultural project in this course, how many times have you worked in a cross-cultural group projects where at least one of your team members are located in a different country?
   Yes No
   If Yes
   …How many times approximately?

6> I have friends who are from other countries. Yes No
7> I have many opportunities to meet people that I perceive as foreigners in my daily life. Yes No
8> There are foreigners in most of my classes. Yes No

Scoring Guide:

Question 1:
Score = number of native languages – 1

Question 2:
Score = number of other languages spoken fluently
Question 3:

Score = number of times being abroad + score for total duration of being abroad

Duration: one week to one month
Score for total duration of being abroad = 0

Duration: more than one month to six month
Score for total duration of being abroad = 1

Duration: more than six month to one year
Score for total duration of being abroad = 2

Duration: more than one year to three years
Score for total duration of being abroad = 3

Duration: more than three years
Score for total duration of being abroad = 4

Question 4:

Score = number of time working in co-located cross-cultural groups

Question 5:

Score = number of time working in distributed cross-cultural groups

Question 6:

If Yes, score = 2

Question 7:

If Yes, score = 1

Question 8:

If Yes, score = 1
APPENDIX G. Intercultural Sensitivity Scale  
(Chen & Starosta, 2000)

Below is a series of statements concerning intercultural communication. There are no right or wrong answers. Please work quickly and record your first impression by indicating the degree to which you agree or disagree with the statement. Thank you for your cooperation.

5 = Strongly Agree  
4 = Agree  
3 = Uncertain  
2 = Disagree  
1 = Strongly Disagree

1. I enjoy interacting with people from different cultures.  
2. I think people from other cultures are narrow-minded.  
3. I am pretty sure of myself in interacting with people from different cultures.  
4. I find it very hard to talk in front of people from different cultures.  
5. I always know what to say when interacting with people from different cultures.  
6. I can be as sociable as I want to be when interacting with people from different cultures.  
7. I don’t like to be with people from different cultures.  
8. I respect the values of people from different cultures.  
9. I get upset easily when interacting with people from different cultures.  
10. I feel confident when interacting with people from different cultures.  
11. I tend to wait before forming an impression of culturally-distinct counterparts.  
12. I often get discouraged when I am with people from different cultures.  
13. I am open-minded to people from different cultures.  
14. I am very observant when interacting with people from different cultures.  
15. I often feel useless when interacting with people from different cultures.  
16. I respect the ways people from different cultures behave.  
17. I try to obtain as much information as I can when interacting with people from different cultures.  
18. I would not accept the opinions of people from different cultures.  
19. I am sensitive to my culturally-distinct counterpart’s subtle meanings during our interaction.  
20. I think my culture is better than other cultures.  
21. I often give positive responses to my culturally different counterpart during our interaction.  
22. I avoid those situations where I will have to deal with culturally-distinct persons.  
23. I often show my culturally-distinct counterpart my understanding through verbal and nonverbal cues.  
24. I have a feeling of enjoyment towards differences between my culturally-distinct counterpart and me.
Note. Items 2, 4, 7, 9, 12, 15, 18, 20 are reverse-coded before summing the 24 items. Interaction Engagement items are 1, 11, 13, 21, 22, 23, and 24, Respect for Cultural Differences items are 2, 7, 8, 16, 18, and 20, Interaction Confidence items are 3, 4, 5, 6, and 10, Interaction Enjoyment items are 9, 12, and 15, and Interaction Attentiveness items are 14, 17, and 19.
APPENDIX H1. Rubric for Assessing Students’ Level of Critical Thinking
(Newman et al., 1995)

R+-- **Relevance**
R+  relevant statements
R-  irrelevant statements, diversions

I+-- **Importance**
I+  Important points/issues
I-  unimportant, trivial points/issues

N+-- **Novelty. New info, ideas, solutions**
NP+ New problem-related information
NP- Repeating what has been said
NI+ New ideas for discussion
NI- False or trivial leads
NS+ New solutions to problems
NS- Accepting first offered solution
NQ- Squashing, putting down new ideas
NQ+ Welcoming new ideas
NL+ learner (student) brings new things in
NL- dragged in by tutor

O+-- **Bringing outside knowledge/experience to bear on problem**
OE+ Drawing on personal experience
OC+ Refer to course material
OM+ Use relevant outside material
OK+ Evidence of using previous knowledge
OP+ Course related problems brought in (e.g. students identify problems from lectures and texts)
OQ+ Welcoming outside knowledge
OQ- Squashing attempts to bring in outside knowledge
O- Sticking to prejudice or assumptions

A+-- **Ambiguities: clarified or confused**
AC+ Clear, unambiguous statements
AC  Confused statements
A+  Discuss ambiguities to clear them up
A  Continue to ignore ambiguities

L+-- **Linking ideas, interpretation**
L+  Linking facts, ideas and notions
L+  Generating new data from information collected
L-  Repeating information without making inferences or offering an interpretation.
L  Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments.
**J+-** Justification
JP+ Providing proof or examples
JS+ Justifying solutions or judgments
JS+ Setting out advantages and disadvantages of situation or solution
JP- Irrelevant or obscuring questions or examples
JS- Offering judgments or solutions without explanations or justification
JS- Offering several solutions without suggesting which is the most appropriate.

**C+-** Critical assessment
C+ Critical assessment/evaluation of own or other contributions
C- Uncritical acceptance or unreasoned rejection
CT+ Tutor prompts for critical evaluation
CT- Tutor uncritically accepts

**P+-** Practical utility (grounding)
P+ relate possible solutions to familiar situations
P+ discuss practical utility of new ideas
P- discuss in a vacuum (treat as if on Mars)
P- suggest impractical solutions

**W+-** Width of understanding (complete picture)
W- Narrow discussion. (Address bits or fragments of situation. Suggest glib, partial, interventions)
W+ Widen discussion (problem within a larger perspective. Intervention strategies within a wider framework.)
### APPENDIX H2. Critical Thinking Coding Examples

*Note.* The example messages were taken from a discussion transcript on Topic 5, Decision Making

<table>
<thead>
<tr>
<th>Message and Coding</th>
<th>Coding Explanation</th>
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</table>
| **From my experiences and observations, I would assert that human decision-making is hurt most by failure to consider the actual utility of the various options involved in any decision. Many decisions can be easily clouded by emotion or pre-prescribed morals. Morals and heuristics can often times be very helpful, but they are mental shortcuts that discourage us from considering the costs and benefits of each individual decision. Actively open-minded thinking means actively seeking new information about a decision that may (or may not) contradict your initial opinion. I believe that not enough people go through this process, but simply settle with their initial thought, instinct, or heuristic. In order to improve human decision-making, I would propose that the education system apply a more utilitarian backdrop to the existing curriculum. Teaching kids from a young age to approach decisions from an open-minded standpoint and to seek alternative perspectives would be an invaluable start to raising better decision-makers.**  
*(AC+, OC+, I+, NP+, NS+)* | In this message, the student tried clarified the problem (stage 2 of critical thinking process) and then explored the problem (stage 3 of critical thinking process) by offering a solution for improving human decision making. He/she mentioned “the failure to consider the actual utility of the various options.” This is an important problem and a new problem in the discussion, therefore, I+ and NP+ were given. He/she also further elaborated on the issue. The clarification was clear and unambiguous. Therefore, AC+ was given. He/she also mentioned the concept of heuristic, a dominant concept in the course materials; therefore, OC+ was given. After presenting the problem, the student proposed a new solution for the education system; therefore, NS+ was given. |

<p>| <strong>Unfortunately, I think that there are several pitfalls for people in decision making. But, in my opinion, the one that should be fixed first is the effects of conformity. Overweighing emotions, not being open minded, and the illusory correlation are certainly factors. But I think before we can fix a person's individual thinking, we have to get them thinking for themselves. We're talked a little about this before on here, but I think that presenting people with studies on the effects of conformity can make them aware of them, which is the first step in avoiding merely</strong> | In this message, the student clarified the problem (critical thinking stage 2), explored the problem (critical thinking stage 3) by offering a solution, as well as showed some thoughts on why the solution is meaningful (critical thinking stage 4). First, he/she mentioned the problem of conformity. Since this problem is important and raised for the first time in the discussion, I+ and NP+ were given. In addition, conformity is a major concept in this course, therefore OC+ was given. The message also showed the student’s effort to take a step back and bring in an |</p>
<table>
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<tr>
<th>Message and Coding</th>
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</thead>
<tbody>
<tr>
<td>conforming to the ideas of those around you. And, I think we should start this (and encouraging those who think for themselves) for an early age. This could hopefully get people starting to think for themselves at a young age. Once they're doing that, then we can work on helping them make better decisions - once they're making their OWN decisions. <em>(OC+, I+, JS1+, L1+, NP+, NS+, W+)</em></td>
<td>original interpretation of the problem: getting individuals thinking for themselves, which potentially widened the discussion. Therefore, L1+ and W+ were given. He/she then went on to present a new solution for this problem as well as show some thoughts on why the problem is meaningful. Therefore, NS+ and JS1+ were given.</td>
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*That's a great way of looking at this topic! You're right: there are many, many errors people make in judgment and decision making, but the first step to correcting these error's isn't picking the most troublesome and fixing it; the first step should be to make sure people are making their own decisions in the first place! It'd be impossible for them to understand their rationalization for their decisions if it was simply made in a conformity-inducing environment.*

Many times, when shopping, I'll be stuck between two similar items. Either two sizes, two colors, two styles, etc. I'd often ask the opinion of the friend or family member I'm shopping with. Instead of picking which one I like better, I'll go with their preference. Later, I experience a kind of uneasiness, wondering if I made the right choice. But now I realize that this dissonance isn't about my own decision; maybe I experience dissonance because I don't actually understand why I chose the item I did.

Before we can fix the weaknesses of human decision making, we must first learn to make our own decisions ourselves.

*(OE+, C+, JS1+, R+)*
**APPENDIX II. Rubric for Assessing Group Knowledge Construction**

Interaction Analysis Model for Examining Social Construction of Knowledge in Computer Conferencing (Gunawardena et al., 1997)

<table>
<thead>
<tr>
<th>PHASE I: SHARING/COMPARING OF INFORMATION. Stage one operations include:</th>
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<tbody>
<tr>
<td>A. A statement of observation or opinion</td>
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<tr>
<td>B. A statement of agreement from one or more other participants</td>
</tr>
<tr>
<td>C. Corroborating examples provided by one or more participants</td>
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<tr>
<td>D. Asking and answering questions to clarify details of statements</td>
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<tr>
<td>E. Definition, description, or identification of a problem</td>
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<tr>
<th>PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS (This is the operation at the group level of what Festinger calls cognitive dissonance, defined as an inconsistency between a new observation and the learner’s existing framework of knowledge and thinking skills.) Operations which occur at this stage include:</th>
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<tbody>
<tr>
<td>A. Identifying and stating areas of disagreement</td>
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<tr>
<td>B. Asking and answering questions to clarify the source and extent of disagreement</td>
</tr>
<tr>
<td>C. Restating the participant’s position, and possibly advancing arguments or considerations in its support by references to the participant’s experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view</td>
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<thead>
<tr>
<th>PHASE III: NEGOTIATION OF MEANING/CO-CONSTRUCTION OF KNOWELEGE</th>
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<tbody>
<tr>
<td>A. Negotiation or clarification of the meaning of terms</td>
</tr>
<tr>
<td>B. Negotiation of the relative weight to be assigned to types of argument</td>
</tr>
<tr>
<td>C. Identification of areas of agreement or overlap among conflicting concepts</td>
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<tr>
<td>D. Proposal and negotiation of new statements embodying compromise, co-construction</td>
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<tr>
<td>E. Proposal of integrating or accommodating metaphors or analogies</td>
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<tr>
<th>PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR CO-CONSTRUCTION</th>
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<tbody>
<tr>
<td>A. Testing the proposed synthesis against “received fact” as shared by the participants and/or their culture</td>
</tr>
<tr>
<td>B. Testing against existing cognitive schema</td>
</tr>
<tr>
<td>C. Testing against personal experience</td>
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<tr>
<td>D. Testing against formal data collected</td>
</tr>
<tr>
<td>E. Testing against contradictory testimony in the literature</td>
</tr>
<tr>
<td>PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY-CONSTRUCTED MEANING</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>A. Summarization of agreement(s)</td>
</tr>
<tr>
<td>B. Applications of new knowledge</td>
</tr>
<tr>
<td>C. Metacognitive statements by the participants illustrating their understanding their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction</td>
</tr>
</tbody>
</table>
**APPENDIX I2. Knowledge construction coding examples**

*Note.* The example messages were taken from a discussion transcript on Topic 5, Decision Making

<table>
<thead>
<tr>
<th>Message and Coding</th>
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</table>
| **Phase I/A**  
*From my experiences and observations, I would assert that human decision-making is hurt most by failure to consider the actual utility of the various options involved in any decision. Many decisions can be easily clouded by emotion or pre-prescribed morals. Morals and heuristics can often times be very helpful, but they are mental shortcuts that discourage us from considering the costs and benefits of each individual decision. Actively open-minded thinking means actively seeking new information about a decision that may (or may not) contradict your initial opinion. I believe that not enough people go through this process, but simply settle with their initial thought, instinct, or heuristic.*  

**Phase III/D**  
*In order to improve human decision-making, I would propose that the education system apply a more utilitarian backdrop to the existing curriculum. Teaching kids from a young age to approach decisions from an open-minded standpoint and to seek alternative perspectives would be an invaluable start to raising better decision-makers.*  

**Phase II/A**  
*Unfortunately, I think that there are several pitfalls for people in decision making. But, in my opinion, the one that should be fixed first is the effects of conformity. Overweighing emotions, not being open minded, and the illusory correlation are certainly factors.*  

**Phase III/D**  
*But I think before we can fix a person's*
**Message and Coding**

*individual thinking, we have to get them thinking for themselves. We're talked a little about this before on here, but I think that presenting people with studies on the effects of conformity can make them aware of them, which is the first step in avoiding merely conforming to the ideas of those around you. And, I think we should start this (and encouraging those who think for themselves) for an early age. This could hopefully get people starting to think for themselves at a young age. Once they're doing that, then we can work on helping them make better decisions - once they're making their OWN decisions.*

**Coding Explanation**

first passage. Therefore, the second passage was coded as **Phase III/D**.

---

**Phase IV/B/C**

That's a great way of looking at this topic! You're right: there are many, many errors people make in judgment and decision making, but the first step to correcting these error's isn't picking the most troublesome and fixing it; the first step should be to make sure people are making their own decisions in the first place! It'd be impossible for them to understand their rationalization for their decisions if it was simply made in a conformity-inducing environment. Many times, when shopping, I'll be stuck between two similar items. Either two sizes, two colors, two styles, etc. I'd often ask the opinion of the friend or family member I'm shopping with. Instead of picking which one I like better, I'll go with their preference. Later, I experience a kind of uneasiness, wondering if I made the right choice. But now I realize that this dissonance isn't about my own decision; maybe I experience dissonance because I don't actually understand why I chose the item I did.

**Phase V/A**

Before we can fix the weaknesses of human decision making, we must first learn to make our own decisions ourselves.

---

In this message, the student tried to related their own understanding and their personal experience with the ideas presented in the message in the previous row. This process is similar to testing new ideas/solutions with existing cognitive schema and with personal experience. Therefore, the first passage of this message was coded with Phase IV/B/C.

After that, he/she came to a conclusion or a summarization of agreement in the second passage of the message. Therefore, the second passage of this message was coded with Phase V/A.
<table>
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<th>Message and Coding</th>
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<tr>
<td><strong>Phase IV/B</strong></td>
<td>This message is a reply to the message in the previous row. In the first passage of this message, the student evaluated the ideas expressed in the previous message (by testing with his/her existing cognitive schema or understanding) and showed some level of disagreement as the result of this evaluation. Therefore, this passage was coded with Phase IV/B.</td>
</tr>
<tr>
<td>While this is a very good point, it still leaves us with many bad decision-makers. Getting people to think for themselves is definitely a great first step. But once you accomplish that, you are still left with a wealth of bad decision makers. Conformity implies that people are sacrificing their personal identity or opinion in order to fit underneath a larger umbrella. Each &quot;umbrella,&quot; by definition of conformity, has to house at least two or more people. Therefore, these two (or more) people will all make one common set of mistakes as they act together like an individual. If you break down conformity, then all you are doing is taking that one set of mistakes being made by a group of people and letting them each make their own individual set of mistakes. I don't see that situation being much better in terms of total mistake being made.</td>
<td>From this disagreement, in the following passage of the message, he/she tried to negotiate his/her own idea (coming back from Phase IV to Phase III of the knowledge construction process). Therefore, this passage was coded with Phase III/D.</td>
</tr>
<tr>
<td><strong>Phase III/D</strong></td>
<td>There is definitely no ONE aspect of decision making that we can fix in order to solve every problem, but if you at least addressed one of the issues previously mentioned (illusory correlation, open-minded thinking, base rate neglect, etc.), you might actually cut down on the total number of mistakes being made. Whereas, I don't believe that ridding us of conformity alone would actually do that.</td>
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APPENDIX K. Informed Consent Form
Consent Form for Social Science Research
The Pennsylvania State University

Title of Project: Collaborative Learning in Multicultural Learning Environments

Principal Investigator: Hien Nguyen, Graduate Student
201 Hammond Building, Penn State University
University Park, PA 16802, USA
1 (814) 404-3122; htn126@psu.edu

Advisor: Dr. Barbara Grabowski
314 F Keller Building, Penn State University
University Park, PA 16802, USA
(814) 863-7380; bgrabowski@psu.edu

1. Purpose of the Study: The purpose of this research study is to study the effectiveness of different collaborative learning strategies in multicultural learning environments such as different strategies used in online discussion and group projects. The results of the study may improve the design of collaborative learning activities in multicultural learning environments and as a result, improve student learning in this kind of environment.

2. Procedures to be followed: We would like to ask for your permission to use for research purposes your course online discussions, the related information that you provide when using the course discussion board, your feedback (if any) on the course’s different collaborative learning activities, and the surveys you fill out in this course.

Your name will only be used to match all the data together and will be excluded from the final data set once the data are matched.

3. Benefits: The goal of this research is to improve the quality and effectiveness of learning in a multicultural environment. To this end, this research might improve the design of online discussion activities and provide meaningful implications for designing collaborative activities in a multicultural learning environment.

4. Duration: Data will be drawn based on your normal class work. It will not require any extra time from you.

5. Statement of Confidentiality: Your participation in this research is confidential. The data will be stored and secured in a password-protected computer. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared.

6. Right to Ask Questions: Please contact Hien Nguyen at htn126@psu.edu or 1 (814) 404-3122 with questions, complaints or concerns about this research.

7. Payment for participation: Your participation (i.e. giving permission) will count towards one hour of required research participation in this course. Another option to receive this research credit is to participate in experiments within the Psychology Department. Please also consider giving your
consent for this study if you already have enough research credit, as it may yield valuable educational research and requires no extra effort from you beyond the course requirements.

8. **Voluntary Participation:** Your decision to be in this research is voluntary. You can choose not to answer certain questions. However, this does not excuse you from completing the required coursework. You can withdraw your participation anytime. To do so, please contact Hien Nguyen at htn126@psu.edu or 1 (814) 404-3122.

You must be 18 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

May the researchers have permission to use for research purposes your course online discussions, the related information that you provide when using the course discussion board, your feedback (if any) on the course’s different collaborative learning activities, and the surveys you fill out in this course? Please choose one response and mark with an X.

______No

______Yes

You will be given a copy of this consent form for your records.

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<th>Last Name</th>
<th>First Name</th>
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</table>

Participant Signature ____________________________ Date ____________________________

Person Obtaining Consent ____________________________ Date ____________________________
Hien Thu Nguyen
VITA

Education

2009 Ed.D. in Instructional Systems, the Pennsylvania State University (PSU)
Minor in Educational Psychology (Measurement)

2003 B.S. in Computer Science, Texas A&M University
Supporting Area in Management Information System

Employment

2007-2009 Graduate Assistant
The Leonhard Center for the Enhancement of Engineering Education, PSU

2003-2007 Graduate Assistant/Educational Support
Center for Engineering Design and Entrepreneurship, PSU

2005 Instructional Designer Intern
University of Applied Sciences, Kiel, Germany

2002-2003 Computer-Based Learning Module Developer
Department of Computer Science, Texas A&M University

Selected Recent Publications

Nguyen, H. T., Kapli, N., Ching, Y. H., Dileo, M. A., Lim, K. Y., Grabowski, B., & Miller, S.

