IDENTIFYING AND MEASURING CRITICAL THINKING IN ONLINE ASYNCHRONOUS DISCUSSIONS

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Abstract

Engagement in critical thinking in an online asynchronous discussion (OAD) may be a desired educational outcome. However, tools are needed to determine if such engagement is actually occurring. This study presents such a tool through the development of a model for identifying and measuring critical thinking in an OAD. The model is tested through its application to the content analysis of the OAD transcripts of eight student participants in an online graduate course. The model, which included four critical thinking processes, descriptions, indicators, and examples, proved effective for the identification and measurement of individuals' critical thinking in OADs. Suggestions for further research include additional testing of the model using other raters and other OADs in order to promote reliability and validity.

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Chapter One – Introduction

1.1 Introduction

The purpose of this study is to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions (OADs) used in the context of university-based courses. Researchers have identified the value of OADs for supporting learners' engagement in processes such as critical thinking, problem solving and knowledge construction. However, there is a need to determine if and how this value is being realized. Researchers, instructors and instructional designers as well as students can benefit from tools that allow them to identify and m asure engagement in these processes. This study describes the creation of such a tool through the development of a model to identify and measure critical thinking in online asynchronous discussions.

Following this introductory chapter, the study presents a review of the literature outlining other approaches to the identification and measurement of critical thinking. The methodology used to create, apply and refine the model are outlined in the third chapter. This is followed by a chapter describing the actual development of the model using the methodology described in Chapter Three. The results of the application of the model to the transcripts of eight individuals who participated in OADs are reported in the fifth chapter. The final version of the model, and a discussion of the process and results, are presented in the final chapter.

This introductory chapter begins with a statement of the problem which describes the benefits of OADs in education, and the difficulty in determining whether these benefits are

being realized for individuals in university courses. The significance of the study is discussed next. It derives partly from the growing use of OADs in education, but mostly from the importance of critical thinking in education. The fourth section of Chapter One outlines the limitations of the study, while the fifth provides an overview of the entire study.

1.2 Statement of the Problem

Research into online asynchronous discussions (OADs) has revealed benefits of their use in an educational setting. For example, properly-structured online discussions will result in learning at the highest levels as a result of the group dynamics (Aviv, 2001). Tiene (2000) found that online discussions were a useful and enriching supplement in a graduate course. Zhu (1996) reported that most students were positive about their experiences with electronic discussion, and quoted a student as saying that the online discussion was easier for students who had difficulty keeping up with classroom discussions, and the time for reflection may have made them less apprehensive about expressing their opinions.

Markel (2001) states that learning in online discussions is not "a regurgitation of a lecture..." but is "deeper and more long lasting" (Maximizing Learning, para. 2). She also found that discussion forums provide "enfranchisement"; students have equal opportunity to participate, whereas in face-to-face classes, faster or less reflective students take most of the very limited time. Also, the online discussion can be saved and revisited in a way a face-to-face one cannot, allowing students to continue to reflect over or review the discussion (Markel, 2001; Tiene, 2000; Hiemstra, 1994). Jonassen and Kwan (2001), in their research on problem-solving, reported that the communication in the online group was more "complex

and consistent with problem-solving processes than F2F interactions" (p. 50). Benbunan-Fich, Hiltz and Turoff (2002) found that an OAD provided richer discussion than a face-to-face group, and that the breadth of the discussion in the OAD may explain why such discussions provide "superior performance and better subjective learning outcomes" (p. 466). Barab, Thomas and Merrill (2001) conclude that "...many educators have suggested that asynchronous computer-mediated communication actually promotes reflective and critical thinking due to the fact that it allows time for reflection and revision of postings..." (p. 110).

Although benefits of OADs, including those related to critical or higher level thinking, have been identified, the extent to which they are being realized has not yet been clearly determined. Bullen (1998), for example, concludes that there is "limited empirical support ... for the claims made about the potential of computer conferencing to facilitate higher level thinking" (p. 7). He is referring to the common, text-based, asynchronous form of computer conferencing. Garrison, Anderson and Archer (2000) state that the effects of computer-mediated communication, particularly computer conferencing on "the quality of the learning process and its outcomes have not been well studied" [although] "those leading the development...are convinced of its potential" (p. 1). The use of OADs has "...outstripped the development of theory..." according to Gunawardena, Lowe and Anderson (1997), who argue that we need to determine "how to assess the quality of interactions and the quality of the learning experience in a computer-mediated conferencing environment" (pp. 397-398). Moreover, as Gunawardena, Lowe and Anderson (1997) argued, it is not really clear "how to assess the quality of interactions..." (p. 139) in OADs.

Thus we do not have an effective means of determining whether or not individuals participating in OADs are actually engaging in cognitive processes, including critical thinking. Engagement in a cognitive process such as critical thinking in an online asynchronous discussion in a graduate course may be a desired outcome from both the instructor's and student's perspective. Yet how can an instructor or student verify the type and level of such engagement in an OAD? Methods are needed for identifying and measuring such processes in an online asynchronous discussion.

It is beyond the scope of this study to develop models to identify and measure all the processes related to benefits claimed for OADs. No doubt, there is value and significance in focussing on processes related to learning in OADs such as problem solving and knowledge construction. However, this study is premised on the argument that critical thinking constitutes an important skill that can be achieved in OADs, and will examine critical thinking rather than the other valuable cognitive processes.

Critical thinking was chosen as the focus of the study because students' critical thinking skills are central to any consideration of teaching and learning. Critical thinking skills are often cited as aims or outcomes of education. Oliver (2001) argues that the need for "critical thinking skills as an outcome of formal education has emerged as an important issue for universities and institutes of higher education..." (p. 99). He identifies this need based on both information from employers and the needs of lifelong learners, and posits that "[c]ritical thinking skills are inherent in the ability to make meaningful use of electronic information" (p. 100). In other words, such skills are important partly because of the application of modern technology to the storage and use of information. Hammond and Reader (n.d.) also identify

the importance of critical thinking in post-secondary education when they note that "[a] major aim of Higher Education is to enable students to think critically within their discipline of study." (Summary section, para. 1)

A broader case for including critical thinking skills as part of an education has been made by Norris and Ennis (1989), who refer to critical thinking as "a defensible educational ideal" (p. 22). They base this statement on certain assumptions: that education should transform the student's way of life, and that education should also promote individual autonomy and respect for the positions of others. This view of critical thinking assumes that thinking skills empower the individual by releasing him or her from dependence on the judgement of others. Siegel (1988) offers an extended justification of critical thinking as an educational ideal. He begins with the assumption that self-sufficiency and autonomy are desirable characteristics for everyone, and then proposes four considerations which support the role of critical thinking in education: 1. Respect for students as persons, 2. Self-sufficiency and preparation for adulthood 3. Initiation into rational traditions 4. Critical thinking and democratic living. Critical thinking can be considered an essential part of an education which is intended to help students prepare to be autonomous, independent thinkers in a modern democratic society.

1.3 Significance of the Study

While this study focusses on critical thinking, the results may provide insight into the development of methods to study the extent to which learners may be engaging in other cognitive processes in OADs. For example, the processes used for the development of a

model for identifying and measuring critical thinking might serve as a template for other researchers wishing to assess the engagement of the students in such processes as knowledge construction, collaborative learning, and problem-solving.

All stakeholders in educational institutions have an interest in finding out whether a teaching and learning environment (such as an OAD) supports educational goals such as student engagement in critical thinking skills. Therefore, the development of practical tools to identify and measure critical thinking in online asynchronous discussions is highly significant to instructors, students, administrators, researchers and instructional designers.

Instructors using OADs in their classes need to adapt or design instruction, including assessment, for this comparatively new medium. The instructors' work involves using critical thinking, and encouraging the students' use of critical thinking, an important educational skill which has been supported by the use of OADs (Aviv, 2001; Bullen, 1997). Traditional methods of assessing critical thinking may be unsuited for the online environment, too expensive or time-consuming for use by instructors, or insufficiently integrated into the curriculum. For example, some approaches measure critical thinking in isolation rather than as it is used in the study of an academic subject. Therefore, the development of models designed specifically to identify and measure critical thinking in OADs is of great significance to instructors who teach using online asynchronous discussions.

This study is also of significance for students using OADs. Since critical thinking is an important part of their learning, any tools that their instructors can use to identify or measure its presence can provide information that may be used to improve the education the students are receiving. Students can also be asked to evaluate their own work, a strategy

which may develop critical thinking skills (see, for example, Emerson, Boes & Mosteller, 2002). Students' self-evaluation can also enhance their participation in an OAD. A model designed for use in an OAD could help students identify and measure their own use of critical thinking as part of a process of independent learning and self-evaluation.

Instructional designers who are creating online courses that use online asynchronous discussions may need to assess the extent to which the courses promote educational aims like critical thinking. A tool such as the model developed in this study can be adapted by them to help them measure the extent to which they have succeeded. It can also serve as a guide to help them design OADs.

Finally, the study has significance to educational administrators. Use of online asynchronous discussions requires a financial investment. Equipment must be purchased, installed and maintained, and training provided in its use. This investment has been justified by the claims for the benefits of OADs; therefore determining whether these benefits are actually being realized will help inform decisions regarding the deployment of financial resources.

1.4 Limitations of the Study

The purpose of this study is to develop a model to identify and measure critical thinking in online asynchronous discussions. Other aspects of learning supported by the use of OADs, such as problem-solving and collaborative learning, are outside the scope of this study. This study is also limited to the educational use of OADs, and did not study OADs that are used for other purposes. This study does not attempt to estimate the overall level of

critical thinking for an entire class or group, but instead, focusses on critical thinking as it is displayed by specific individuals participating in courses in education. Application of the model was limited to students in online graduate courses.

1.5 Organization of the Study

The study is organized into six chapters. Chapter One introduces the study. The statement of the problem, and the significance and limitations of the study are covered in this chapter. Chapter Two reviews the literature related to this study. It begins with a review of the literature on critical thinking in online asynchronous discussions. Since a relatively small number of studies were found focussing specifically on critical thinking in OADs, the chapter continues with a review of related research into online asynchronous discussions and discusses some issues in content analysis. The contribution of the current study to the literature is also presented in this chapter.

Chapter Three describes the methodology used in the study. The methodology begins with a description of the development of a model, and the describes the application of the model to support the analyses of transcripts of the contributions of eight individuals to an OAD. Chapter Four reports on the development of the critical thinking model in detail, showing how the methodology described in Chapter Three was used in this study. The first four sections of Chapter Four analyse the critical thinking concept in some detail. The analysis of critical thinking begins with a consideration of various definitions from the literature, and continues by distinguishing critical thinking from some closely-related concepts. This analysis is followed by an examination of some approaches to identifying

critical thinking, and cognitive processes associated with critical thinking. Some models of critical thinking that have been used with OADs are then evaluated in light of the preceding work, and a model for use in this study is proposed. Finally, indicators are identified and created, and the model is developed; first, in a preliminary version. Chapter Five describes the application of the model to the content analysis of the transcripts of eight individuals who participated in an OAD as part of the requirements for a graduate course in education. Chapter Six presents a discussion of the process of refining the model, and of its application to the content analysis of eight transcripts. The conclusions and implications for practice and research complete the chapter.

1.6 Summary

Research has shown that OADs improve equality in communication, reduce barriers of time and distance, and increase the use of certain thinking skills, such as critical thinking. However, there is comparatively little evidence as to the extent to which these potential benefits are being realized. In addition, suitable methods for assessing the effectiveness of OADs in supporting critical thinking are not available.

The purpose of this study is to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions. This study is significant for instructors, students, administrators, instructional designers and researchers since all have an interest in encouraging the use of thinking skills in all educational settings, including those which use an OAD. The study is limited to critical thinking in individuals rather than groups or classes, and the application of the model was limited to students in

online graduate-level courses in education. This chapter also describes briefly the organization of the study, which begins with the development of a model of critical thinking, continues through the development of the model and concludes with the application of the final model to the transcripts of eight individuals participating in OADs.

Chapter Two – Review of the Literature

2.1 Introduction

This chapter reviews the literature on critical thinking in online asynchronous discussions. The literature review is divided into three parts. First, studies on critical thinking in online discussions are reviewed. Few studies were uncovered in this category. The second part of the review focuses on studies which included some aspects of critical thinking, often as part of a related construct such as cognitive presence. The third part of the review covers the literature on the methodological issues related to content analysis in online discussions, such as the choice of the unit of analysis, and the creation of indicators. The final section describes the contribution this study will make to the literature.

2.2 Critical Thinking in Online Asynchronous Discussions

Henri was one of the first to research online asynchronous discussions (OADs). Henri (1992) developed a model of five dimensions which describe what happens in OADs. These are the participative, social, interactive, cognitive and metacognitive dimensions. Henri analysed the transcripts of OADs as her primary source of data. She used content analysis, dividing the text into "units of meaning" for the purpose of analysis. Of all her work, that on the cognitive dimension is the most relevant to this study, and it is on that aspect this review will focus. In defining the cognitive dimension, Henri incorporated "skills connected to reasoning which uses critical thought" (p. 129). These skills were elementary clarification, in-depth clarification, inference, judgement and strategies. Henri provided definitions and

indicators for each skill. Since she felt that these alone provided only a superficial view of the thinking during the discussion, she also classified the text as showing surface or in-depth processing. She points out that the results of this type of analysis should be interpreted with reference to the students and the cognitive tasks that are expected of them. Not all students are able to carry out all cognitive tasks, and if the purpose of learning is knowledge acquisition, students cannot be expected to make inferences. Henri concluded that content analysis is a very promising tool that should, with further development, provide teachers using online discussions with the information they need to monitor and improve learning.

Clulow and Brace-Govan (2001) applied Henri's (1992) model to a graduate course called Management of Retail Enterprises. Before the course started, four questions were designed to prompt student discussion of issues related to the course materials. There were four discussions, one on each question. The cognitive skills present were identified using Henri's classification and the level of information processing (surface or in-depth) identified. In addition, each message was assessed as being 'independent' or 'interactive'. This final classification is based on earlier work of Henri's, and refers to whether or not each posting is linked to a previous one. The authors conclude that this type of analysis is a useful tool for teachers who want to know what kind of thinking is going on in their courses. This information can guide implementation of online learning so that the best use can be made of such technologies. They also suggest that instructors should consider sharing this information with students.

Hara, Bonk and Angeli (2000) adapted the work of Henri (1992) and Howell-Richardson and Mellar (1996). Their study focussed on the use of content analysis to study

the social, cognitive and metacognitive aspects of an OAD. Their study built on Henri's work in an attempt to develop better guidelines for analysing the transcripts of online discussions. Hara, Bonk and Angeli (2000) used visual presentations of their data including graphical representations of the participants' interactions. The authors chose the paragraph as the unit of analysis. However, they appear to have been flexible in their approach. They report counting two paragraphs on one idea as one unit, and two ideas in one paragraph as two units. Depth of processing was reported for a message, not a paragraph, with messages containing both surface level and deep processing coded accordingly. They dealt with reliability issues by using multiple ratings by the same rater at different times, and also by using inter-rater comparisons. They found that the types and levels of cognitive skills in the discussion seemed to depend on the starter's questions. (The students who volunteered each week to begin the discussion by posing questions related to the readings were called 'starters'.) They also reported that 55% of the messages were at an in-depth processing level, which implies that critical thinking was occurring in the discussion.

Newman, Webb and Cochrane (1995) based their comparison study of critical thinking in online discussions and in face-to-face groups on the work of Henri (1992) and Garrison (1992). They identified critical thinking as a process involving five steps: identification, definition, exploration, evaluation, and integration of the new understanding with existing knowledge. Their methodology included the use of content analysis and a student questionnaire. Their conclusions, both in their 1995 paper, and discussed at greater length in a later paper (see Newman, Johnson, Cochrane & Webb, 1996) are that critical thinking can be identified in both face-to-face and online settings. In fact, they found

computer conferencing appeared to increase the 'depth of critical thinking ratio', even though students said less in the online setting than they did when face-to-face.

Newman et al. found that their methodology allowed them to examine separate aspects of critical thinking, and by doing this, to notice that the online setting seemed to encourage more inclusion of outside experience, linking ideas, and making major points, while some of the face-to-face sessions seemed to produce more new ideas. They also noted some difficulties with the analysis. The cumbersome nature of the process made it too time-consuming to use outside a research project; in the authors' opinion, it would not be feasible for a teacher to use this method to study his or her own class. In addition, scorers must have subject knowledge, which limits the pool of potential raters, making it difficult to control for rater subjectivity. Their work was criticized by Bullen (1998), who found that their indicators tended to overlap. He also pointed out that they did not allow for the effect of participation on the critical thinking ratios, and that their method would rate differently two participants who made the same number of critical thinking statements, depending on their total number of statements.

2.3 Related Research on Online Asynchronous Discussions

There are some studies which either examine critical thinking from a different theoretical perspective than the current study, or focus on particular aspect of critical thinking. Some of these are included in this review because of their relevance to this research.

One such study is that of Garrison, Anderson and Archer (2000). They propose a "Community of Inquiry" model to describe the educational experience that should be available at the post-secondary level. Their work, like that of Henri (1992), is intended to encompass all of the learning experience rather than focus on a single cognitive process, as was the case with this study. In the case of Garrison, Anderson and Archer (2000), learning is described in terms of the interaction of three "presences": social, cognitive and teaching presence. Each element contains three or four categories, and the authors provide examples for each category. For example, the categories for cognitive presence are: triggering event, exploration, integration, and resolution. The examples are: sense of puzzlement, information exchange, connecting ideas and apply new ideas. Therefore, Garrison et al. demonstrate the interactive aspect of critical thinking, which is a different approach to the concept of critical thinking than that used by some other writers in the field.

By using critical (or reflective) thinking, the individual can integrate a solution to a problem or develop new knowledge only through sharing and relating with others, through interaction with external influences as well as internal reflection. Although the approach is somewhat different from that of other papers reviewed in this section, the work of Garrison, Anderson and Archer (2000) is still relevant because it examines the same basic cognitive processes in the same type of online environment. It is also an attempt to develop a tool to describe and facilitate higher-order learning in online situations. This aim has obvious relevance to the aim of the current study. Garrison et al. conclude that their tool is "worth further investigation" (p. 22). In addition, Garrison et al's research is relevant because of their approach to measuring cognitive presence, which will be discussed in the next section.

Gunawardena, Lowe and Anderson (1997) focus on the interaction and knowledge construction in an online debate using content analysis. Although they were not specifically researching critical thinking, aspects of critical thinking are included among the indicators the authors were looking for. For example, Phase III of their model ("Negotiation of Meaning/Co-construction of Knowledge") includes among the operations "Restating the participant's position, and possibly advancing arguments or considerations in its support...", and Phase IV, operation D states "Testing against formal data collected" (Gunawardena, Lowe & Anderson, 1997, p. 414). Both of these clearly imply the presentation of logical arguments or the evaluation of evidence for and against arguments that are so central a part of critical thinking.

Gunawardena et al.'s results showed the great majority of the messages as being in Phase I: Sharing/Comparing of Information. While some of the descriptors of this phase may represent critical thinking ("Asking and answering questions to clarify details of statements") others do not ("A statement of observation or opinion"). The authors concluded that there was little construction of knowledge, possibly because the forum was a debate, rather than a class or a work-team discussion. It appears from their description of the results that there may have been little critical thinking either. Gunawardena et al. conclude that their model is an appropriate one to use in studying online discussions, and that it could be applied to situations in which there is a moderator (e.g., a teacher in an online course can act as a moderator).

Kanuka and Anderson (1998) used the same general approach to studying online discussions as did Gunawardena, Lowe and Anderson (1997). Kanuka and Anderson found

the model proposed by Gunawardena et al. to be a useful preliminary tool for analysis, but one which needed fewer and more explicit boundaries between phases. Most of the thinking observed in this study was in the social interchange category, one of the two Kanuka and Anderson added to Gunawardena et al's original list as a result of the preliminary analysis of the data. Kanuka and Anderson suggested some possible explanations for this, one of which was that the context was not that of a university course, in which there is more demand for demonstration of an understanding of the content.

In his doctoral dissertation, Bullen (1998) reported on the results of a study of undergraduate students in a course taught using asynchronous computer conferencing. His research focussed on the degree to which the students participated in the course and thought critically, the factors affecting student participation, and the way those factors affect participation. This research used a case study approach, with both quantitative and qualitative methods of data collection. The data collected included information on the messages posted by each student and on the apparent extent of critical thinking. In addition, the students were interviewed about their participation and use of critical thinking. Several different methods of data collection were employed, including content analysis. Bullen's list of critical thinking skills includes clarification, assessing evidence, making and judging inferences, and using appropriate strategies and tactics. He developed descriptions for each category, along with positive and negative indicators.

Using questions designed to guide the classification, the transcript was analysed using the indicators, and the students classified as showing high, medium or low levels of critical thinking depending on the results of the transcript analysis. These results were examined

further — for example, time series graphs were prepared to show whether the amount of critical thinking changed over time. Some comparisons were also made with student characteristics as revealed in a pre-course survey. In-depth, semi-structured interviews on participation and critical thinking were also carried out. The interview data were checked both by confirmation of interpretations during the interview, and by sending the transcripts to the interview subjects for review. During the transcript analysis, the three judges generally agreed on the student's overall level of critical thinking, but there was less agreement on the identification of the type of critical thinking exhibited. This lack of agreement was attributed in part to one of the judges misinterpreting the 'strategies' category. No relationship was found between participation and critical thinking.

In the interviews, most students showed an incomplete understanding of critical thinking. Most of them understood the basic requirements of the online discussion (e.g., logging on, participation requirements) but many did not understand the role of the discussion in the course. Some appeared to think it was simply a matter of reading posts and answering questions, rather than engaging in learning through discussion and critical thinking. Students also identified several factors as affecting their critical thinking, some positively and some negatively. These included aspects of computer conferencing (e.g., time independence, text-based, many-to-many communication), aspects of the pedagogical design (e.g., mandatory participation and instructor participation) and their cognitive maturity. The instructor felt that the online class had higher quality participation than did the face-to-face classes. In spite of this, Bullen concluded that the amount of participation was not as great as it could have been. It also appeared that female students may have shown more critical

thinking, supporting the idea that online discussions encourage discussion from people who traditionally participate less. However, no firm conclusion could be reached on this point because of the small sample size.

Oliver (2001) studied 75 undergraduate students who used web-based learning to work on problem-solving in groups. Data included results from questionnaires and reflective journals kept by some of the students. The students' marks for the activities were also recorded, along with the type of strategies they chose. Oliver identified a number of factors which limited the development of critical thinking skills during this activity, including the way the collaboration tended to reduce the amount of critical thinking required from any one student. However, he believed that the study showed that it was possible to support critical thinking online, without using direct instruction in critical thinking.

Fahy (2002) also reported on an attempt to assess critical thinking in an online discussion group. His approach was based on the practical inquiry model which was proposed by Garrison, Anderson, and Archer (2001), and used a Transcript Analysis Tool (TAT) based on Zhu's (1992) work. He used the sentence as the unit of analysis, and compared the results from the TAT analysis with Garrison et al.'s model, using three different 'alignments' of the two approaches. Fahy found this approach to be useful, and that one alignment matched 'almost perfectly'. There appeared to be much variation in the interactions, and the detail provided by using the sentence as the unit of analysis seemed to be helpful in showing this.

2.4 Issues in Content Analysis

Several authors have discussed the application of content analysis to online asynchronous discussions, either as part of their own research, or in the form of a general overview of research or methodology. Kuehn (1994) includes a discussion of content analysis in instructional online discussions in his paper on a research agenda for computer-mediated communication in instruction. He considers content analysis to be a very promising tool. He reports on the use of content analysis to research the effects of teacher discourse style, content of student-student communication and the effect of type of task and level of group acquaintance on group effectiveness. He classified the research into two broad categories: the study of communication phenomena, and the testing of hypotheses. Kuehn recommends content analysis as a tool for answering questions about "*what* is shared on the instructional medium and *how* messages are conveyed" (p. 177). He also points out that a complete picture of instructional computer communication, including patterns of use, requires other methodologies.

Howell-Richardson and Mellar (1996) studied patterns of participation in two online asynchronous discussions. Although their focus is not on critical thinking, they use content analysis, discuss Henri's approach to content analysis, and identify some methodological issues which are relevant to the current study. The authors highlight the danger of inconsistency and lack of reliability in Henri's choice of 'unit of meaning' as the unit of analysis. Howell-Richardson and Mellar choose instead to base their analysis on both the entire message and a definition of the illocutionary act derived from Speech Act theory. They analysed their transcripts using message length, message maps, links between messages, and interaction analysis. The authors concluded that content analysis is a useful tool for studying

online discussions, and that combining two approaches for identifying the unit of analysis (messages and 'discourse choice') is useful.

As mentioned earlier, Garrison, Anderson and Archer (2000) proposed a three-part model to describe the interactions in an online discussion group. In a later paper, Garrison, Anderson and Archer (2001) describe their use of content analysis to assess cognitive presence in two online discussions. For each of their categories (triggering event, exploration, integration, and resolution), they provide descriptors, indicators, and sociocognitive processes. This information is intended to increase the reliability of the ratings. Their level of analysis was the message, and they dealt with multiple levels in the same message by "coding down" to the lower level if it is unclear which phase is present, and by 'coding up' to the higher level if it is clear that more than one phase is present. Inter-rater reliability was calculated.

The results of the reliability calculations were somewhat below what would have been hoped for, but the authors cite evidence that such results may be acceptable when the research is breaking new ground. They conclude that content analysis is worth further investigation as a tool for understanding the processes occurring in this new and popular method of education, online asynchronous discussions. In a similar vein, Fahy (n.d.) identifies discrimination and reliability as common problems in content analysis. He claims these problems are related to indicators that are excessive in number and/or representing overlapping concepts, and to the use of any unit of analysis other than the sentence.

Rourke, Anderson, Garrison and Archer (2001) reviewed the issues involved in applying content analysis to online discussions. They selected 19 studies, and reported the

unit of analysis, variables investigated, reliability and research design. They concluded with a lengthy discussion of the identified issues. The first is objectivity. Although content analysis is considered an objective technique, some researchers have reported difficulty with inter-rater reliability, an essential measure of objectivity. Rourke, Anderson, Garrison and Archer (2001) claim that this is usually a sign that the indicators need to be improved. They also conclude that it is too early to define a minimum acceptable reliability figure; nevertheless, such data should be reported. The next issue is replicability. Lack of replication is a serious issue; only Henri's model has been used, although in modified forms, by many other researchers. Finally, Rourke, Anderson, Garrison and Archer (2001) point out that many studies, including Henri (1992) and Bullen (1998), are not consistent in their theoretical approaches. This lack of consistency was explained as being a result of the immaturity of the field.

The characteristics of the studies were also described by Rourke et al. Most of the studies were descriptive; a few were experimental. Some of the studies were on 'manifest content': material that requires relatively little in the way of interpretation, such as participation. Others were on 'latent content', which includes whether or not higher order learning outcomes are being achieved. This type of content is less easily measured than manifest content, since it requires interpretation as well as observation of surface characteristics. Researchers chose a number of different units of analysis, but none of them were without disadvantages. Fixed units (messages, sentences) are easy to recognise, but may not correspond to single ideas or constructs. Trying to identify particular ideas or constructs

is difficult to do reliably. Rourke et al. conclude that more research is needed in this area, but care must be taken to measure and report on reliability.

2.5 The Contribution of This Study

This review reveals that, although some aspects of critical thinking in online asynchronous have been studied, few of the studies focus specifically on critical thinking, and few focus on individuals. Many studies focus on overall patterns of the interactions among the entire group participating in an OAD. Some studies use a different conceptualization of critical thinking than does the study reported in this thesis. Henri (1992); Newman, Webb and Cochrane (1995); Garrison, Anderson and Archer (2000); and Gunawardena, Lowe and Anderson (1997) all use a different conceptualization of critical thinking than is used in this study. Some use a different population or context than the current study. Gunawardena, Lowe and Anderson (1997) studied critical thinking in a debate, not a class, and were interested in the online interactions, not in individuals' thinking processes. Fahy (2002) uses a different conceptual basis than is used in the current study, and, in addition, looks at a comparison of two approaches to the unit of analysis problem rather than at the discussion itself. Fahy also studies interactions and the social environment rather than individuals.

Bullen's (1997) study is most similar to the current one in its approach to measuring critical thinking in OADs, but this study is not a replication of Bullen's work. There is a significant and very basic difference; Bullen's understanding of the term 'strategies' as

applied to a critical thinking process is quite different from the one used in this study. Bullen refers to thinking strategies rather than plans for action.

There is a need for a study which focusses on the individuals rather than the group interactions, unlike many of the studies in the literature, and which uses a conceptualization of critical thinking that includes taking action, or suggesting an appropriate action, as an important critical thinking process. Without this characteristic, critical thinking would be relegated to the status of a mental exercise of no particular practical benefit.

Another reason for carrying out this study is to provide assistance (in the form of the model) for instructors and others might want to use content analysis to understand which critical thinking processes are occurring in an OAD. According to Henri (1992): "...if content analysis is to become a workable tool for educators who are not trained as scientists, progress must be made at the conceptual level...and at the technical level..." (p. 134).

This study provides a tool that simplifies the task of content analysis for non-researchers who are interested in analysing OAD transcripts. In addition, it examines critical thinking in OADs using a model which, although rooted in the wider critical thinking literature, is not found in the literature on critical thinking in OADs. Finally, this study looks at critical thinking in individuals, whereas the other studies consider the interactions of the group as a whole.

2.6 Summary

This chapter reviewed the literature on critical thinking in online asynchronous discussions, organized in three parts. First, studies on critical thinking in online discussions

were reviewed. This section begins with an examination of a seminal study in this area, that of Henri (1992). The review continues with the work of Clulow and Brace-Govan (2001), Hara, Bonk, and Angeli (2000), and Newman, Webb and Cochrane (1995), all of which use approaches closely related to that of Henri (1992). Since so few studies were uncovered in this category, the second part of this review included related studies. This section included studies which included some aspects of critical thinking, or which looked at OADs that were not used as part of classes. The work of Garrison, Anderson and Archer (2000, 2001) on critical thinking in OADs, for example, is part of a broader study of interactions, much as Henri's (1992) is, but uses a significantly different model of critical thinking.

Fahy (2002) used the same model as Garrison, Anderson and Archer (2000, 2001) but tested a different method of analysis. Gunawardena, Lowe and Anderson's (1997) study was on a debate rather than a course, and Kanuka and Anderson's (1998) study was based on the work of Gunawardena, Lowe and Anderson (1997). Some research examined the interrelationships among critical thinking and other factors. Bullen's (1997) dissertation focussed on participation and critical thinking, and Oliver (2001) studied the development of critical thinking in online problem-based learning.

The third part of the review covered the literature on the methodological issues related to content analysis in online discussions, such as the choice of the unit of analysis, and the creation of indicators. Kuehn (1994) evaluates content analysis as a tool for studying computer-mediated instruction in education. Howell-Richardson and Mellar (1996) discuss issues related to choice of the unit of analysis in content analysis. Garrison, Anderson and Archer (2000, 2001) describe how they applied content analysis in their studies, and Rourke,

Anderson, Garrison and Archer (2001) summarize the use of content analysis in 19 studies, and draw some conclusions about this approach to studying online asynchronous discussions.

A description of the contribution this study will make to the literature follows the review of the literature and concludes the chapter. This study emphasizes critical thinking processes in individual participants in online asynchronous discussions. This approach is not one that has been the specific focus of previous studies, which generally focus on group interactions. In addition, this study develops and uses a model which differs from those reported in the literature.

Chapter Three – Methodology

3.1 Introduction

Chapter Three presents the methodology adopted for this study. This chapter begins with a description of the development of a model of critical thinking showing how the model is rooted in the literature, and how it was adapted to better suit the requirements of this particular study. This development begins with the identification of four critical thinking processes. The third part of the chapter continues with an outline of the way the descriptions and indicators for the critical thinking processes were defined and selected in order to further develop the model.

The fourth part of the chapter contains a description of the application of the model to transcripts of individuals who participated in OADs. The purpose of the application was to further refine the model, its descriptions, indicators, and content analysis procedures. This section also contains information about the context in which the study was carried out: the course, and the procedures followed to identify the participants. Some information is then provided about the application of the model to the transcripts provided by all eight of the participants in the study. The final section of the chapter contains a brief consideration of reliability, validity and the steps taken in the study to increase reliability and validity of the model.

3.2 Development of a Critical Thinking Model

This study is based on the premise that it is essential to develop a model of critical thinking as the first step to measure critical thinking in online asynchronous discussions. A

model specifies the critical thinking construct as completely as possible, ensuring that all relevant thinking processes, but no extraneous ones, are included. This approach ensures that any work based on the model also represents all aspects of critical thinking, while omitting other thinking processes. It also avoids a common threat to construct validity: an inadequate explanation of the constructs (Trochim, 2002).

The process of developing a model begins with understanding the underlying construct that the model is intended to represent (i.e., critical thinking). The model's representation of the construct must be complete and discrete – that is, nothing important is omitted, and nothing overlaps with another related concept or construct. The understanding of the construct can be enriched by a study of the related literature, which can also be a source of various models that can be examined for their suitability for the current project. The focus of this study of the construct (such as critical thinking) and existing models is on the extent to which the models gave a comprehensive picture of the construct, yet were not too detailed to be practical for use. This part of the process resulted in the identification of the cognitive processes which are to be the core of the final model, and the creation of a brief description of each.

3.3 Development of the Model

The list of critical thinking processes which form the core of the model cannot be used alone to identify or measure critical thinking in OADs. The list is too broad and leaves too much room for interpretation, which reduces reliability when it is applied to the content analysis of a transcript. This list of critical thinking processes was used to identify the main

aspects of the construct. It does not provide actual indicators of the processes at an operational level. Nor does it describe in detail the processes. Indicators and descriptions are necessary in order to promote a shared construct of critical thinking. It is this shared construct articulated by the use of indicators that promotes reliability in the analysis of an OAD transcript.

Development of the model began with describing each thinking process identified in the model. This description served two purposes. It was useful in guiding the next step, the writing and selection of the indicators. The descriptions of the processes, kept as part of the final model, also provided the potential user with some guidance as to what each of the critical thinking processes included. When writing these descriptions, every effort was made to keep them short and clear, but detailed enough to clearly indicate the dimensions of each critical thinking process.

The next step in the development of the model was to add indicators. An indicator is a short statement which, if it describes a phrase or passage in an OAD transcript, 'indicates' that a particular critical thinking process was occurring. An indicator, therefore, is a very brief and clear description of one particular aspect of a critical thinking process, and is derived from an understanding of the critical thinking construct in general, and specifically, the critical thinking process in question. In this case, indicators were based on the descriptions of each critical thinking process, but were more specific. In order to increase reliability and validity, each indicator should refer to only one aspect of a critical thinking process, and no two indicators referred to the same aspect of critical thinking. In addition, the indicators, taken together, covered all the aspects of critical thinking processes without

being so numerous as to make applying the final model too time-consuming and cumbersome.

3.4 Application and Context

As has been described, the model was constructed using a list of critical thinking processes, their descriptions, and indicators, all based on the critical thinking literature. At this point in the process, the model was still not in its final form. Although the descriptions and indicators were based on the understanding of the critical thinking construct arrived at through the study of the literature, they were not yet been applied to the content analysis of transcripts of individuals who participated in online asynchronous discussions. This application was necessary in order to identify any vague or confusing wording in the descriptions or indicators. Such problems could affect reliability by creating confusion over which indicator best matches particular passages from the transcripts. The application was necessary to note any passages showing evidence of critical thinking but which are not represented by an indicator, and write an appropriate indicator to add to the model.

Before describing the application of the model, it is important to understand the context in which the transcripts used in this study were produced. Therefore, this section begins with a description of the course, the students, and the methodology used to identify the participants who volunteered to have their transcripts analysed. This section provides the necessary context before the application of the model, and subsequent revisions of the model are described.

3.4.1 The Context – The Course

The OAD transcripts used in this study were obtained from a web-based graduate course in education during 2002 and 2003. The transcripts came from two different sections of the course; Fall, 2002 and Spring, 2003. Information on the course, obtained from the course web site with permission of the instructor, showed that the two sections of the course were the sa

3.4.1 The Context – The Course

The OAD transcripts used in this study were obtained from a web-based graduate course in education during 2002 and 2003. The transcripts came from two different sections of the course; Fall, 2002 and Spring, 2003. Information on the course, obtained from the course web site with permission of the instructor, showed that the two sections of the course were the same. Twenty percent of the final course grade was assigned to the students' participation in the OAD. The instructor also supported the OAD by providing guidelines (see Appendix 1) for both the online discussion itself and its evaluation. The guidelines cover the basics of netiquette and practical details, such as where and how often to post. The grading rubric indicates that students were expected to include many aspects of critical thinking in their posts. For example, for a score of 18-20, students would be expected to write postings that "...reflect a superior level of insight, originality, analysis and critical thinking...". (See Appendices 2 and 3 for the full rubric). This rubric clearly supports critical thinking, however, it does not take the place of a model such as was developed in this study. It is not as detailed, and is designed to produce a grade, rather than a balanced picture of the students' critical thinking, including all of the critical thinking processes.

3.4.2 The Context – The Participants in the OADs

Once permission had been obtained from the instructor, volunteer participants were sought from the courses. Twelve of the thirty-five students in the two sections of the course responded to an email request for volunteers to participate in this study. In order to maintain confidentiality, the name of each participant who sent in an initial response was listed, and

each participant was assigned his or her number on the list as a codename, and was referred to using these codes. Some participants who responded to the original email request were not included in the study for various reasons, including no or delayed return of the signed consent form, and extremely brief or atypical postings. The final list of participants whose transcripts are part of the study included Participants 1, 2, 5, 6, 7, 8, 9, 10; referred to for convenience and brevity as P1, P2, P5, P6, P7, P8, P9, and P10. Of the twelve people who had responded to the original call for volunteers, these eight were included in the study.

All the participants were graduate students in the Faculty of Education at Memorial University, Newfoundland, Canada. Each provided some personal information in an introductory post, and from these posts it is possible to conclude that almost all of the participants were working in education in Canada, most in a K-12 education system, and most were part-time graduate students. Some of the participants had experience with technology in education, and referred to this experience in their contributions to the OADs.

3.4.3 Application of the Model

The next step was to use the preliminary version of the model to guide the content analysis of one or more transcripts, and use the results to improve the indicators by refining them or adding new ones if that appeared to be necessary. The process of refining the model is intended to improve its validity while keeping the number of indicators to a minimum, for ease of use. This application of the model involved reading transcripts, marking passages representing a unit of meaning and coding each passage. Two approaches to coding were tried during the application of the preliminary version of the model. One was to code the

units of meaning by indicator, and then cluster the indicators according to the critical thinking process. The second was to use the indicators as guides, but code each unit of meaning according to the appropriate critical thinking process directly. The second procedure worked best, and was adopted for the application of the final version of the model. Only one code was used for each unit of meaning. This approach was repeated with different sections of different transcripts as changes were made to the indicators, until the list of indicators was complete and the remaining indicators were unambiguous. Every effort was made to keep the list short and as easy to use as possible.

This procedure could have been done with pencil and paper. However, in this study, the text was marked using Ethnograph™. This program allows the user to select and code text according to the user's criteria, in much the same way as the user would manually mark a paper copy. With Ethnograph™, the unit of meaning is highlighted with the mouse, and then either a new code is typed, or, as in this case, a pre-defined code is assigned to the text with a click of the mouse. This approach has the effect of labelling each unit of meaning at the beginning with the code, and marking the exact length of the unit of meaning along the side of the transcript. These markings are visible on the screen, and in printouts of the transcript. This procedure is exactly parallel to carrying out the rating with paper and pencil. However, Ethnograph™ has several advantages. It can import the transcript files, numbering each line for easy reference. It can produce summaries showing all the coded passages, sorted by code, and it allows the user to create families of codes, which were useful for comparing coding by critical thinking process and coding by indicator during the application of the preliminary model.

3.5 Refinement of the Model

In the application of the model, although all of the transcripts selected for the study were coded, not all text in all transcripts received a code. Most of the text that was not included was material of a personal or social nature, such as the personal introductions at the beginning of the course. While important for creating a sense of community among the online students, these passages were clearly not part of the discussion and analysis of issues which the course was intended to address, and which were expected to produce examples of critical thinking. Other passages that were omitted from the analysis included the one or two line comments about the student web sites, which were mainly straightforward compliments or reports of problems. For example, 'Excellent Site!! Beautiful job on the images!' or 'M, Your graphics did not load when I looked at your site.' However, some of the practical, web site design discussion showed characteristics of critical thinking, and these were included. The discussion about the types of web site design software clearly showed Assessment, including making a judgement and providing supporting evidence. P1 compared FrontPage™ and Dreamweaver™ in terms of browser compatibility, ease of use, power, and HTML quality. These passages were included in the analysis. Finally, posts looking for partners for group work or taking care of other such practical details were not included in the analysis, for the same reasons that the personal introductions were omitted. In some cases, more than one critical thinking process appeared within a given passage, and the passage was coded as demonstrating the process that appeared most important in that context.

3.6 Validity and Reliability

The validity of the model is ensured by its base in the literature. The processes being identified are therefore clearly part of the critical thinking construct. Validity, in this sense refers to the degree to which the material is mutually intelligible to all users, and also to the extent to which the construct is shared across different groups of people. (See, for example, LeCompte and Preissle, 1993, pp. 351-352.) Specifying and describing the model clearly, and basing it on a critical thinking constructs which are available in the literature and used, adapted, and therefore shared by various researchers help establish its validity by ensuring it is mutually intelligible and shared.

Reliability, on the other hand, is somewhat more difficult to ensure and test. The danger to reliability from overlapping or poorly-constructed indicators (Fahy, n.d.) can be addressed by careful development and selection of indicators. This, as was described, has been done. However, estimating the success of these efforts in ensuring reliability would require expansion of the research beyond the limitations of this study. One possibility for further related research would be to measure the extent to which the efforts to ensure reliability were successful by, for example, having the same transcripts rated by several different raters.

3.7 Summary

Chapter Three presented the procedures adopted for this study. This chapter began with a description of the development of a model of critical thinking showing how the model is rooted in the literature, and how it was adapted to better suit the requirements of this

particular study. This development process produced detailed descriptions and indicators for the thinking processes found in the model of critical thinking. This part of the chapter outlines how such descriptions and indicators were defined and selected.

The next section of the chapter contained the description of the application of a preliminary version of the model. This application was needed to refine the descriptions, indicators, and procedures. The description is in four parts. The first two described the context of the study, including information on the course and the participants. These described the course for which the online asynchronous discussion was organized, some characteristics of the participants, and the procedures followed to identify and obtain consent from the participants in the study. The application and revision of the preliminary model is described, along with differences in the procedures and in the purposes of both the preliminary and final application of the versions of the model to the content analysis. Specifically, it explains why some sections of the transcripts were not coded, and which of the coding procedures that were evaluated in the preliminary testing was used in the application of the final version. The chapter concludes with a brief consideration of reliability, validity and the steps taken in the study to increase reliability and validity.

Chapter Four - Development of a Critical Thinking Model

4.1 Introduction

Chapter Four describes how the methodology described in Chapter Three was used to develop a critical thinking model for use in identifying and measuring critical thinking in online asynchronous discussions. The chapter begins with a discussion of definitions of critical thinking, the selection of one definition for this study, and the justification for that selection. The chapter continues with an examination of some concepts that are closely related to critical thinking, including problem solving and higher order thinking skills. This section looks at the similarities and differences among these concepts, and clarifies the critical thinking construct that is used in this study. The next section discusses approaches that have been used to measure critical thinking. This part of the chapter includes the reasoning behind the decision to develop a method for measuring critical thinking in context, rather than as an isolated construct. The chapter then discusses the different thinking processes that have been identified as part of the critical thinking construct. This discussion focusses on those thinking processes represented in the literature on critical thinking in online asynchronous discussions.

To this point, the chapter reports the broad underlying concepts that are either part of the critical thinking construct or the closely-related concepts which can assist in understanding critical thinking. The rest of the chapter builds on this work by presenting the first step in the construction of a model of critical thinking. This step begins with the identification of the critical thinking processes which are used as the base for the selection

and creation of indicators; that is, short sentences or phrases describing actions and statements which can be used to indicate that certain critical thinking processes are occurring. Descriptions and examples are added to complete the model.

4.2 Defining Critical Thinking

"Critical thinking is reasonable and reflective thinking that is focussed on deciding what to do or believe" (Norris & Ennis, 1989, p.1). This definition has been used and adapted by a number of researchers (Anderson & Soden, 2001; Williams, Wise and West, 2001; Bullen, 1997). Siegel (1988) states that "a critical thinker is one who is *appropriately moved by reasons*" (p. 32). Scriven and Paul (n.d.) describe critical thinking as having two components: "1) a set of information and belief generating and processing skills, and 2) the habit, based on intellectual commitment, of using those skills to guide behavior" (Summary section, para. 2).

Hammond and Reader (n.d.) include in their definition of critical thinking "abstracting commonalities, structures or arguments from study material, integrating across learning experiences, critically assessing a position or argument, and being able to communicate critical ideas to others" (Summary section, para. 1). Sies (1999) characterizes good critical thinking as "skillful and responsible thinking in which you study the problem from all angles, and then exercise your best judgment to draw conclusions" (para. 1). He breaks critical thinking down into five components: he indicates that critical thinking is skillful, responsible, relies on sound criteria, is sensitive to context and self-correcting. Rocchio (n.d.) defines critical thinking as "The ability to read theory accurately, appropriate

it meaningfully, apply it independently, generate results through that application, analyse the results, and make an argument based on those results that is defended through a specific line of reasoning" (para. 2). Critical Thinking and Information Literacy Across the Curriculum [CTILAC] (1998) add to the critical thinking concept the ability to recognize "what is irrelevant or extraneous information ... preconceptions, bias, values and the way that these affect our thinking ... that these preconceptions and values mean that any inferences are within a certain context ...ambiguity — that there may be more than one solution or more than one way to solve a problem" (Definition section, para. 1).

The National Council of Teachers of English [NCTE] Committee on Critical Thinking and the Language Arts (cited in Fowler, 1996, para. 13) define critical thinking as "a process which stresses an attitude of suspended judgment, incorporates logical inquiry and problem solving, and leads to an evaluative decision or action." Elder and Paul (cited in Fowler, 1996, para. 17) claim that "Critical thinking is best understood as the ability of thinkers to take charge of their own thinking. This ability requires that they develop sound criteria and standards for analysing and assessing their own thinking and routinely use those criteria and standards to improve its quality." Fisher and Scriven (cited in Fisher, 2001, p. 10) argued that critical thinking is "skilled and active interpretation and evaluation of observations and communications, information and argumentation."

There are some common themes running through these definitions. These include the ability to make decisions about some issue or solve some problem. In addition, the quality of the decision or solution is important — the definitions refer to assessment of both the thinkers' own skills and of the arguments others put forward. They include references to

logic (although not usually to formal logic), and to reason. Critical thinking is described as skillful, meaningful, and accurate. It may be understood as a set of thinking skills, or, instead, as those skills combined with a disposition to use them. It may be considered a separate subject of study in its own right, or as something that is most meaningful in context, integrated with the knowledge and skills of a particular field of study.

In this study, critical thinking will be defined according to Norris and Ennis: "Critical thinking is reasonable and reflective thinking that is focussed upon deciding what to believe or do." (Norris & Ennis, 1989, p. 3). This definition is brief, but covers the essential core concepts: critical thinking is good thinking that is "reasonable and reflective". "Reasonable" implies the ideas of quality, of logic, of evaluating and choosing supporting evidence. "Reflective" implies both self-evaluation and evaluation of others' thoughts. And the final part of the definition: the "decision about what to believe or do" covers some of the reasons for including critical thinking in the education system in the first place.

Writers sometimes use different terminology for what appears to be the same or similar concept or process; and sometimes use the same terminology in different ways. Such is the case with critical thinking. The next step in developing the model, therefore, is to clarify some of the terminology and related concepts. The next section considers the relationship of critical thinking to other concepts such as problem solving and higher order thinking skills.

4.3 Related Concepts

Phye (1996) notes disagreement about what is meant by critical thinking, problem solving and higher order thinking skills. He states that 'higher order thinking skills' can be seen as a broad term which includes critical thinking skills and problem-solving strategies. A different theoretical approach produces a different definition: "...higher order learning is not a change in behavior but the construction of meaning from experience (Kerka, 1992, Why Vocational Education?, para. 4). However, Ennis (1986) considers the term 'higher order thinking skills" too vague to be useful. Schrag (1992), when discussing critical thinking in the context of Bloom's Taxonomy claims "... the taxonomy is useful in focussing teacher attention on the degree to which the tasks they design require students to think critically" (p. 256), which implies that some of the terms used in Bloom's Taxonomy refer to critical thinking. Houghton (n.d.) goes further when he claims that evaluation (from Bloom's Taxonomy) is "synonymous with the term critical thinking" (para. 2). This claim may over-simplify matters; evaluation does not usually include defining terms or making deductions, to list only two skills often included as part of critical thinking.

In summary, the term 'higher order thinking skills' is usually used as a very broad, general term including but not limited to critical thinking skills . 'Higher order thinking skills' has a more specific meaning when it is used to refer to the top levels of Bloom's Taxonomy, but it still refers to a wide range of skills (usually, evaluation, application, analysis and synthesis). The term 'higher order thinking skills' may be used to include critical thinking, but 'critical thinking' does not appear to be synonymous with either a single level

of Bloom's Taxonomy or to higher order thinking skills in general. In other words, higher-order thinking skills include critical thinking, but are not limited to critical thinking.

The relationship between critical thinking and problem solving is also unclear. Problem solving skills are sometimes included in lists of critical thinking skills. The reverse occurs too – Norris and Ennis (1989) view critical thinking "broadly as part of problem solving"(p. 7). The North Central Regional Educational Laboratory (n.d.) includes aspects of metacognition in their definition of problem solving, pointing out that it involves students evaluating their own thinking about their strategies for solving the problem. Paul (n.d.) also stresses the importance of students learning to assess their own thinking — but he does so when he is writing about critical thinking. In spite of these contradictions, researchers do distinguish between problem solving and critical thinking.

There are theories of problem solving that are distinct from theories of critical thinking. Kearsley (n.d.) considers the information processing paradigm to be dominant. He mentions other approaches as well, for example, Schoenfeld's (n.d.) theory of problem solving in mathematics, and DeBono's (n.d.) theories about the importance of novel perspectives. The skills involved in problem solving and critical thinking may overlap considerably. In fact, the relationship between critical thinking and problem solving may be even deeper than similarities between critical thinking skills and problem-solving strategies. The underlying cognitive processes may also be similar (Quellmalz, 1986).

Are higher order thinking skills, problem solving skills and critical thinking distinct from each other? Phye (1996) answers this with both a 'yes' and a 'no':

> The answer to our query is *yes* in the sense that formal reasoning involves a set of procedures and rules that characterize a particular way of thinking. The

> answer is *no* in the sense that reasoning is typically involved as an important part of both critical thinking and problem-solving activities. (p. 452)

For the purposes of the model being developed in this study, the terms will not be used interchangeably. Nevertheless, it should be recognised that some skills which are found in critical thinking are also discussed in studies of problem-solving or higher order thinking skills. The ways in which critical thinking skills can be identified is the topic of the next section.

4.4 Approaches to Identifying Critical Thinking

Thinking processes cannot be observed directly; they must be inferred from the behaviour, reports, or performance of the person(s) involved. There are two major approaches to identifying or inferring the existence of critical thinking in someone's thinking processes. The first is to give the person one of the tests of critical thinking which have been developed. The second approach is to look for evidence of critical thinking in some particular context; for example, by examining the evidence available in the person's writings or conversation. The choice of approach is influenced by the researcher's understanding of the concept of critical thinking. If critical thinking is understood as a series of thinking skills that can be taught independently of context or subject area, the first approach, that of using a test, is the most obvious way of determining whether a person can perform these skills.

On the other hand, some authors believe that critical thinking depends on the context in which it is performed. For example, McPeck (1992) argues for a "subject specific" view of critical thinking, and Blatz (1992) affirms that critical thinkers must deal with contextual differences. He classifies these as differences in community of discussion (background

assumptions and procedures accepted as valid by members of the community) and differences in informational context (the amount of common knowledge available). This approach to identifying critical thinking does not imply that it is impossible to test for or detect critical thinking skills. The approach, however, requires that any such tests or observations be developed taking the context into consideration. It also suggests that tests based on the assumption that critical thinking skills are generalizable across subject areas may be flawed. This argument provides support for an approach to identifying critical thinking which searches for evidence of critical thinking in the record of the actual interactions of a class – in other words, searches for critical thinking in the context in which it is said to be carried out.

If we adopt this approach to identifying critical thinking, the next step is to decide what we should look for when identifying the main processes associated with critical thinking. This step may be accomplished by relying on theory to identify the main processes which define critical thinking, and then identifying indicators associated with these processes. The processes and indicators, organized in the form of an assessment model, can then be used with transcripts from an online asynchronous discussion in order to identify and measure critical thinking of the individuals participating in the OAD.

4.5 Processes Associated with Critical Thinking

There are similarities among the processes researchers chose to define their concepts of critical thinking. Norris and Ennis (1989) chose five 'topics' or processes – elementary clarification, basic support, inference, advanced clarification, strategies and tactics – to

encompass their understanding of critical thinking. They also developed a detailed breakdown of each, which can be used to assist teaching or identification of critical thinking. Henri (1992) also used five processes or topics, adapted from Ennis (1986) into a form that would facilitate analysis. Her adaptation included elementary clarification, in-depth clarification, inference, judgement and strategies. Clulow (2001) also used Henri's model.

Newman, Webb and Cochrane (1995) developed their model based on the work of Garrison (1992) and Henri (1992). Their analysis is also based one five processes: clarification, in-depth clarification, inference, judgement and strategy formation. Bullen (1997) combined the characteristics of critical thinking into four categories or processes: clarification, assessing evidence, making and judging inferences and using appropriate strategies and tactics. Garrison (1992) and Garrison, Anderson and Archer (2001) use a different model from those discussed here. Theirs is rooted in the practical inquiry approach and based on a "cognitive and constructive view of the thinking/learning process" (Garrison, Anderson and Archer , 2001, p. 139). This approach includes four steps: triggering events, exploration, integration and resolution.

Table 4.5.1 summarizes the main processes identified from the literature, showing similarities and differences. Most of these include five steps: elementary clarification, elementary and advanced/in depth clarification, inference, judgement and strategies or tactics. Different authors have combined the same basic processes in different ways in order to facilitate analysis (Henri, 1992, p. 130).

Table 4.5.1
Summary of Critical Thinking Models

Norris & Ennis (1989)	Henri (1992) Clulow (2001)	Garrison, Anderson & Archer (2001)	Newman, Webb & Cochrane (1995)	Bullen (1997)
elementary clarification	elementary clarification	triggering events	clarification	clarification
basic support	in-depth clarification	exploration	in-depth clarification	assessing evidence
inference	inference	provisional	inference	Making and judging inferences
advanced clarification	judgement	resolution	judgement	Using appropriate strategies and tactics
strategies and tactics	strategies	—	strategy formation	—

Several considerations, such as theoretical compatibility and practicality, must be weighed in making the selection of the critical thinking processes to be included in a model of critical thinking. For example, the easiest approach to the selection of critical thinking processes would be to simply choose a list of processes from the literature. However, this approach is only feasible if the processes are derived from and organised by a method which is compatible with that used in this research. The Community of Inquiry model (see, for example, Garrison, Anderson and Archer (2001), Archer, Garrison, Anderson and Rourke (2001)) clearly uses a quite different approach from that used in this research. The Community of Inquiry model focuses on "critical thinking within a group dynamic as

reflected by the perspective of a community of enquiry" (Garrison, Anderson & Archer, 2001, p. 11). This focus on the group dynamic is pertinent when the goal is to examine evidence of critical thinking in the online community as a whole; however, this approach would not be relevant in cases where the focus is on the individual member of the online community. For example, an instructor might well be more interested in focussing on the critical thinking of the individuals in a class rather than on the entire class as a group. In addition, Newman, Webb and Cochrane (1995) note that it is difficult to track Garrison's stages in an OAD if individuals in the OAD are at different stages in Garrison's model.

The other researchers listed in Table 4.5.1 all give comparable lists of processes. They all use clarification, making inferences, and strategies, and contain some reference to providing and assessing evidence. How exactly these processes are organized – for example, is 'clarification' a single group of processes, or split into two – depends on the needs of the researchers, who adapt earlier approaches to identifying critical thinking to their present purposes (see, for example, Bullen (1997), pp. 93-94). The choice of processes should be practical. In this case, 'practical' refers to whether or not the model created from the chosen list of critical thinking processes can be used to achieve the ultimate purpose of the research. In the case of the current study, the purpose was to develop a model to identify and measure students' engagement in critical thinking processes in OADs. In this context, a practical list of critical thinking processes must be as simple and short as possible, while still representing the essential aspects of a critical thinking construct which is supported by the literature. Lengthy lists, requiring fine distinctions among processes, would be time-consuming to use and difficult to apply reliably.

The list of critical thinking processes to be adopted to develop the model for this study has been influenced by many researchers (Norris & Ennis, 1989; Henri, 1992; Clulow, 2001; Garrison, Anderson & Archer, 2001; Newman, Webb & Cochrane, 1995, and Bullen, 1997 and 1998). These were examined with an eye to creating as short, yet complete, list of processes as possible. Garrison's 'Triggering Event' was eliminated, partly because the holistic approach makes it difficult to apply to individual transcripts from a online asynchronous discussion structured and limited by the time and subject matter requirements of a university course. In addition, the equivalent of the 'sense of puzzlement' (Garrison, Anderson and Archer, 2000), to use one example of a 'Triggering Event' indicator, in a course transcript, would be the topic suggested by either the instructor or a student. In a model designed for simplicity and ease of use, the initial question or 'triggering event' can easily be included as part of clarification, which is described as 'Observing or studying a problem' by Henri (1991) or 'Focussing on a question' by Norris and Ennis (1989).

Upon examining the models in Table 4.5.1, another modification was judged as both reasonable and useful in developing a model that can be used as a basis for assessing individual's use of critical thinking in an OAD for a university course. This modification consisted of combining elementary and advanced or in-depth clarification into one category, as they are similar. This follows the precedent set by Bullen (1997). The final list of processes contains four categories: clarification, assessing evidence, inference, and strategies. In fact, the final model has the same categories as that of Bullen (1997), but their descriptions are slightly different, possibly reflecting a slightly different concept of critical thinking. This

difference will be discussed when the model is described in the next section. In addition, the thinking behind the selection and description of the four processes will be described in detail.

4.6 A Model of Critical Thinking

This section will outline the model of critical thinking arrived at through the initial stages of development. At this stage, the model consists of a list of four critical thinking processes. However, there some differences between this model and those summarized in Table 4.5.1. For example, this model uses one category of clarification. The single clarification category in this model includes Norris and Ennis (1989)'s elementary clarification, and some parts of their advanced clarification – those dealing with defining or terms and identifying assumptions; but not those dealing with judgements, which in this model, are part of assessment. 'Clarification' in this model is similar to a combination of Henri (1991)'s elementary and in-depth clarification, and also to Bullen's (1997) clarification.

Another difference, which was mentioned previously, is the understanding of 'strategies'. Although in many respects, the model being developed in this study is similar to Bullen's (1997), there is one major difference. Bullen (1997) uses 'strategies' to refer to thinking strategies, such as using algorithms, models, and changing focus (looking at the big picture). Other researchers tend to consider strategies to be taking action as a result of thinking critically about a problem or issue. Garrison, Anderson and Archer (n.d.) write of a "resolution ...by means of direct or vicarious action" (p. 2); Newman, Webb and Cochrane (1995) use strategy formation, which they describe as "Proposing co-ordinated actions for

the application of a solution, or following through on a choice or decision" (Evaluating critical thinking, para 8). In this study, 'Strategies' will be understood as a plan for action, not a way to analyse the problem in the model in this study.

This study also differs from Henri (1992) in the understanding of the term 'judgement'. Henri (1992) draws the line between judgement and strategies differently than is done in this study; Henri's (1992) 'making decisions' would be classified as a strategy in this model, while judgement is a type of assessment.

These differences are a result of the process of drawing on the earlier models to create one that can easily be used in an online asynchronous discussion in an academic setting. For simplicity, ease of use, and increased reliability, the number of processes has been reduced to four, and the understanding of the processes ' strategies' and 'judgement' or 'assessment' modified. The four remaining processes begin with clarification which includes everything involved in proposing, describing and defining the issue. Next is assessment, which covers all kinds of judgements, including the use of evidence to support or refute a judgement. The third process is inference, which covers thinking skills – not only induction and deduction, but generalizing as well. Finally, strategies are not tactics such as the use of algorithms or models, but practical proposals for dealing with the original issue. This approach to strategies fits well with the type of critical thinking that might be expected in an education course. If the model had been designed for an OAD in an area, such as mathematics or computer science, which are quite different from education, other types of strategies would have been chosen.

Clearly, this model leaves out much of the wealth of knowledge of critical thinking. However, proper selection of the knowledge most relevant to the task at hand is essential to its successful completion. A model which identified critical thinking processes in more detail would be less suited to the task of providing a comparatively simple way to assess critical thinking of individuals in an OAD used as part of a course. It is now necessary to add material to the model. This is not the same thing as attempting to include every nuance and aspect of critical thinking that might be found in a variety of settings. Rather, the next steps in this study are intended to increase the clarity with which a potential user understands exactly what the model represents without increasing the model's complexity. The first step involved the researcher writing brief descriptions of each process. These help define the processes for a reader or user of the model, and also help guide the selection, writing and editing of the indicators. The descriptions can be used to eliminate possible indicators that are outside the scope of the study because they are unlikely to be found in an OAD designed for use with a course.

4.7 Indicators Associated with Critical Thinking Processes

In order to move from a critical thinking model to the analysis of a transcript, further delineation of the model is necessary. Following the addition of a descriptions for each critical thinking process, this delineation may be provided by lists of indicators associated with the critical thinking processes. Indicators are sometimes referred to by other names; for example, Norris and Ennis (1989) write about 'topics'. Whatever term is used, indicators provide further insight into the different critical thinking processes. They help clarify in the

minds of the users of the model which types of thinking belong in each critical thinking category. The list of indicators that were added to this model is illustrative, not exhaustive. Critical thinking processes are broad enough that a very long list of indicators could be written to represent each of them. It is necessary to provide a list of indicators that is long and complete enough to capture the essence of the particular critical thinking process in question without being excessively long and complicated to use when applying the model to the analysis of a transcript of an OAD.

The way in which the indicators were selected and created is illustrated with the following example. One of the critical thinking processes is clarification: seeking and expressing understanding of the topic in question. Clearly, clarification includes a wide range of actions. One of the most basic aspects of clarification is identifying or stating what the issue is. A first step in choosing an indicator is to examine previous work to determine what approaches have already been used to create an indicator for this aspect of clarification. Table 4.7.1 provides the results of this examination for this example.

Table 4.7.1
An Example of Choosing and Writing Critical Thinking Indicators

Study	**Indicator**
Norris & Ennis (1989)	Seek a statement of the thesis or question
Henri (1992)	Identifying relevant elements
Garrison, Anderson & Archer (2001)	Recognizing the problem
Newman, Webb & Cochrane (1995)	Course related problems brought in.
Bullen (1997)	1. Focusing on a question a) Identifying or formulating a question
Current Study	Proposes an issue for debate.

Deciding on the exact wording of an indicator is influenced by the context in which it will be used. For example, this study focuses on a course in which issues, many of them identified by the students, are to be discussed. 'Seek' (Norris & Ennis, 1989) is too broad in this context. 'Identifying' (Henri, 1992) and 'recognizing'(Garrison, Anderson & Archer (2001)) are not appropriate for an OAD in a course, for which participants are expected to suggest topics for debate. Newman, Webb and Cochrane's (1995) is close, but they add other indicators to cover the possibility that the topic of discussion or problem may arise outside the course. In addition, their approach to critical thinking is different from that adopted by this study. Bullen's (1997) version is rather lengthy, particularly as only part of it is cited here. The entire indicator refers to identifying and formulating both questions and criteria for possible answers. Each indicator, under the approach used in this study, should be distinct; not containing two or more overlapping concepts. After examining the relevant indicators from the literature, it was decided to write a new, short and clear indicator for this study. 'Proposes' was chosen as the appropriate verb. It includes both the idea of identifying or seeking a topic, as used by other researchers, but also includes the idea that the topic is to be presented to a group for discussion. This makes 'proposes' a suitable choice for a model intended for use with an OAD. 'Problems', as used in some of the examples from the literature, was avoided in favour of 'issues' because 'problems' might imply that problem solving was being identified and measured. The other indicators were added following the same procedure.

Table 4.7.2
The Preliminary Model

Process	Description	Indicators
Clarification	All aspects of stating, clarifying, describing (but not explaining) or defining the issue being discussed.	Proposes an issue for debate.
		Analyses, negotiates or discusses the meaning of the question or assignment.
		Defines or criticizes the definition of terms.
Assessment	Evaluating some aspect of the debate; making judgements on a situation, proposed evidence, argument or links among the issues	Provides or asks for reasons that proffered evidence is valid and relevant in the context of the discussion.
		Provides or asks for reasonable supporting evidence before accepting observations as evidence (e.g. reliable, unbiased observer)
Inference	Showing connections among ideas; drawing appropriate conclusions by deduction or induction, generalizing, explaining (but not describing), and hypothesizing.	Makes appropriate deductions.
		Makes appropriate inferences.
		Proposes a hypothesis.
Strategies	Proposing, discussing, or evaluating possible actions.	Critiques others' solutions.
		Proposes a solution.
		Compares proposed actions.

4.8 Summary

This chapter described the development of a critical thinking model and its use in identifying and measuring critical thinking in online asynchronous discussions. The chapter began with a discussion of definitions of critical thinking, the selection of a definition for this study, and the reasons for that selection.

Chapter Four continued with an examination of some concepts which are closely related to critical thinking, including problem solving and higher order thinking skills. This section examined at the similarities and differences among these concepts, and clarified the critical thinking construct that is used in this study. The next section discussed approaches that had been used to measure critical thinking. This part of the chapter included the reasoning behind the decision to develop a method for measuring critical thinking in the context of a particular task (related to the aims of a course), rather than as an isolated construct. The following section reported on the different thinking processes that had been identified as part of the critical thinking construct. This section focusses on those thinking processes represented in the literature on critical thinking in online asynchronous discussions.

To this point, the chapter had presented the broad underlying concepts that are either part of the critical thinking construct, or the closely-related concepts which can assist in understanding critical thinking. The rest of the chapter built on this work, beginning with the construction of a model of critical thinking. The model, and the various critical thinking processes identified in it, were used as the base for the selection and creation of indicators, which are short sentences or phrases describing actions and statements which can be used to indicate that certain critical thinking processes are occurring. Finally a description of the procedure used to test and refine the model was presented, followed by the preliminary version of the model.

Chapter Five – Application of the Model

5.1 Introduction

The purpose of this study is to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions (OADs). A preliminary version of a model was developed for this purpose. This chapter describes the results of the application of the model to the transcripts of eight individuals who participated in an OAD. The purpose of the application of the model was to determine whether the process would provide useful information on the critical thinking processes engaged in by individuals participating in an educational online asynchronous discussion, and to further improve and refine the model.

The chapter begins by providing general information on the participants. This general information is followed by a description of the results of the application of the model to the transcript of each of the eight participants. Each of these descriptions begins with a table showing the critical thinking processes demonstrated by that particular participant, followed by an analysis of the results and some examples from the transcript.

5.2 Information About Participants

The volunteers were from two sections of a graduate education course. More participants volunteered from the more recent offering of the course than from the earlier one. There was some variation in the amount posted by the different participants, with P1 and P6 posting more messages than the others. One participant made only four postings, well below the minimum of one posting and one reply per module required by the instructor, and

did not post on the topics and in the format typical of the others. Since the aim was to examine critical thinking of typical students, the transcript of this participant was one of those eliminated from the study. The number of sentences is provided as a check on the comparative lengths of the transcripts, showing that they are all fairly typical in manifest content, such as length, unlike the transcript that was eliminated.

Table 5.2.1
Participant Information

ID Number	Section	Number of Messages	Number of Sentences
P1	S 2003	79	1963
P2	S 2003	27	845
P5	F 2002	27	766
P6	S 2003	87	1670
P7	S 2003	39	1394
P8	S 2003	49	1085
P9	S 2003	19	604
P10	F 2002	25	638

5.3 Results

In each case, the participant's transcript was imported into Ethnograph™, which had been set up with a code for each of the critical thinking processes. The text was then coded following the procedures described in the previous chapter, using the indicators to guide the classification of each example of critical thinking according to the appropriate critical thinking process. The following reports were prepared based on the reading of the transcripts, and the summaries listing all the coded sections of each transcript. The numbers of passages coded for each critical thinking process are listed in the tables in the next sections. A discussion and selected examples for each critical thinking process in turn follows the table.

5.3.1 Participant 1

Table 5.3.1.1
Participant 1 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	25	10	12	14

Participant 1 was one of the most prolific of all the volunteers for this study. Many of his initial contributions consisted of feedback on other students' web sites and discussions of practical issues related to computer use. His contributions on these two topics mainly included anecdotes and hints; however, in some cases, P1 supported his suggestions or opinions with evidence; providing examples of the "Assessment" process.

Like many participants, P1's most frequent contributions to the online asynchronous discussions were forms of clarification. In the following example, he analyses the influence of money on computer access, and identifies some relationships among the socioeconomic characteristics of the area served by the school, the students, and the school's equipment, and the unequal distribution of resources in the district. These – analysing the issue, describing the meaning of the issue (by identifying relationships among parts of) – match indicators which are associated with clarification.

> My school is located in a community with a wide range of socio-economic levels - old farmland being converted to new subdivisions. In any class I will have the children (sic) of farmers and fishermen sitting next to those of lawyers and doctors. Poorer children without a computer in the home tend to have technology skill levels far below those of their classmates. The more affluent students tend to complain about the computers in our school because they are vastly inferior to the machines they have at home. I visit other schools in our district and I sometimes look with envy at their technology resources. I have been inserviced on hardware and software that we do not

have, could not afford to buy, and could not use anyway because our computers are too old to run it. That almost covers it!!

P1 also uses other aspects of clarification and assessment in discussions. In a response to a comment or question on filtering software, P1 begins by first proposing filtering as an issue, then distinguishing it from a similar activity: "Filtering software was seen as a proactive measure, whereas simple monitoring could only ever be reactive" and infers "In the end though, we realized that something as broad and varied as the Internet simply could not be effectively censored and we decided it was better to teach the students (high school, by the way) to use their judgement." P1 continues by providing supporting evidence for his statement that using filtering software was not appropriate. "We could control their use inside the school, but, sooner or later, they would be exposed to all the things that we wanted to shelter them from. All they have then to protect them is the sense of right and wrong that we helped them to build."

This passage illustrates a difficulty that arises when trying to identify cognitive thinking processes in text. This passage was coded as 'clarification'; and it does in fact contain several of the appropriate indicators, such as describing, analysing and discussing the meaning of the issue. It might be argued that the passage also contains assessment, since it contains a value judgement about filtering software, as well as an implicit judgement on some material available on the World Wide Web. Moreover, there is an element of strategies, as P1 is clearly discussing two different strategies to deal with problems arising from students' access to the World Wide Web. In this particular case, clarification was chosen as the appropriate code since P1 was reporting a debate that had taken place in his school as a

way of discussing the meaning of an issue that had been raised online. He was not proposing these arguments in a current debate.

P1 also used critical thinking processes other than clarification. For example, he made a value judgement (assessment) on his co-workers in education, as opposed to those in other professions:

> It's one of the things that I like best about the teaching profession - that for the most part the people I work with are generous and willing to help their colleagues in any way they can. I've worked in other professions and been disappointed by the amount of competition and selfishness of others towards their colleagues.

P1 also uses inference. In the following example, he follows a discussion of the similarities and differences between classroom and online asynchronous discussions with the following conclusion:

> Discussion would be different because it would be less reflective, but more spontaneous. The discussion forum leads to more considered responses but a classroom environment is more conducive to activities like brainstorming and small group work...

P1 also provides information on strategies, often in the form of describing actions. In the following passage, he suggests strategies during a discussion on the issue of student access to the Internet – how to provide access without undue restrictions while both avoiding exposure to offensive or illegal content and without enabling the waste of valuable class time on irrelevant entertainment sites:

> I always do some work ahead of time and give them a specific list of sites to visit and find the required information. It works to prevent some of the "accidental" visits to inappropriate sites and it saves time since they don't have to wade through the gazillion matches returned by Google.com. Even when every student is doing research on a different topic they have chosen themselves, there is still a way to limit that type of accident. Before letting them go wild in Google, I get them to write their search string on a piece of

note paper and show it to me. It lets me see what they might see and gives me a chance to help refine their searching techniques.

5.3.2 Participant 2

Table 5.3.2.1
Participant 2 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	10	12	5	7

Participant 2 posted somewhat more material that was coded as clarification or assessment than as inference or strategies, but the differences were not as pronounced as they were in some of the other participants' postings. Like the others, P2 began his postings with a personal introduction and moved into clarification with his description of selected trends in technology and education. As the discussion continued, posts on the same topic moved from clarification to strategies and to assessment. For example, one of his selected issues was the difficulty students were having with a mathematics placement test. P2 begins with a basic description of the issue:

> High School graduates are faced with the dilemma of having to perform well in a Mathematics Placement Test before entrance into university to avoid remediation. Can computers be an effective tool to improve their basic skills, without consuming instructional time in classrooms.

Describing or defining an issue for discussion is an indicator of clarification; therefore, this passage is coded as clarification. On the same issue, P2 demonstrates assessment by briefly evaluating the results of an attempt to solve the problem by administering a mathematics skills test in school: "However preliminary findings have shown little increase in their skills after the MST" and then suggests a strategy: "I am looking

towards interactive computer software that students could use outside of class time". At a different point in the transcript, P2 shows an analysis of a situation, evaluation of previous solutions, and another proposed solution.

There are also examples of inference in P2's transcript. The following passage has some evidence of assessment, but is coded as inference, showing the connections between the Universities' assessment of constructivism in mathematics instruction, and teachers' classroom practices, particularly those involving the use of technology in mathematics instruction.

> In a few years time when the universities claim that the constructivism approach to mathematics was a failure - they are saying that now before the students even get there (Atlantic Provinces Council on the Sciences, 2002)- they will be right. Especially if something is not done to encourage math teachers to use technology so that students can construct their own meaning of the concepts.

5.3.3 Participant 5

Table 5.3.3.1
Participant 5 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	13	11	3	1

Participant 5 posted less than some of the other participants, and, like several others, tended to post material that was coded as clarification or assessment. P5 also began with a listing and description of trends which he proposed for review, but unlike some of the others began with a summary of the points from an article on one of the issues he had identified (plagiarism and the Internet).

P5 begins his discussion of plagiarism with a brief clarification of exactly what he intends to discuss: "The Internet and its ability to both promote, and to identify and deter student plagiarism." At the beginning of a lengthy posting summarizing the points in an article on plagiarism, P5 assesses the article: "This article is a great discussion of the problem of students' use of the Internet to plagiarize homework assignments.

The following example of P5's posts, on another topic, shows how he presents a conclusion along with supporting arguments. Presenting a conclusion and the reasoning behind it is an indicator associated with Inference.

> First of all, I think that collaboration is necessary because we can all learn from each other. Nobody has all of the answers, and nobody can possibly find them on their own. Even with tremendous dedication of time, and effort, we can only come up with so much on our own, and what we do learn throughout the solitary process will be influenced by our earliest exposure to topics, as well as our own limitations of preference, and ability. Collaboration allows us a process to circumvent these limitations.

The last critical thinking process, strategies, was not one P5 used a great deal, but he did suggest one strategy connected with digital repositories:

> Why don't we create our own digital repository. (sic) If anyone in the class has resources that they have gathered or created, and posted to their own web sites, please send me the URL, and a short description of the subject areas to which they apply.

5.3.4 Participant 6

Table 5.3.4.1
Participant 6 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	32	6	10	15

Participant 6 posted the most messages of all the volunteers in this study. Only P1 posted a similar quantity of text. There were other similarities between P1 and P6. Like P1, P6 offers advice and feedback on technical issues to other class members, although she does so somewhat less frequently. P6 and P1 also both had more comments coded as clarification than as any other process. This was either not the case, or less obviously the case for the other participants. P6's first coded passages, like those of other participants, are classified as clarification, and consist of P6's descriptions of the issues she proposed for discussion by the class. When discussing the issue of inservice in technology for teachers, she clarifies the sort of thing she is talking about:

> British Columbia recognized that two years ago with the ICT mentorship program. (now defunct) Technology leaders in schools were identified, given release time for some background training and sent back to their schools with the mandate of being a mentor.

P6 uses assessment less than other critical thinking processes, but she does show some use of it. For example, when evaluating the mentorship program mentioned above, she writes that she "...found it beyond worthwhile."

P6 uses inference and strategies more frequently. She concludes based on her experiences, that "Dumping a computer in a teacher's room with a mandate to integrate technology simply doesn't cut it" when it comes to training teachers for technology integration". Another example of S6 reaching a conclusion is: "After researching and completing the trend of integration of computers in classrooms, my only conclusion is that the majority of barriers could be eliminated with an influx of money." This particular example also indicates that her conclusions are based on certain evidence, that she obtained

from the research leading to the completion of the study of the trend of integrating computers in the classroom.

Finally, P6 had an usually high number of passages coded as strategies – in other words, describing, proposing or evaluating possible outcomes or actions. She wrote, for example, an extensive description of ways in which a class web site can be used to address numerous educational problems such as forgotten texts, homework, or handouts, access to missed work for sick or failing students, and access to an email link for students who are away from class and need to submit work.

5.3.5 Participant 7

Table 5.3.5.1
Participant 7 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	14	18	11	10

Participant 7 had a similar number of codes in all four categories, although she had somewhat more examples coded as assessment than as the other critical thinking processes. In the following example, P7 engages in clarification. She begins by defining some issues that are related to the question she wishes to discuss:

> Some teachers wonder, however, if we should be taking on the responsibility of posting homework rather than making the students accountable for writing it in their agenda. In terms of email, some teachers feel pressure (sic) to respond immediately, even during evenings and weekends.

She continues in her use of clarification by proposing a topic for discussion, based on the issues she has just identified. "Is the use of technology in our schools changing the relationship among teachers, students and parents?"

As noted previously, P7 frequently uses assessment. One of her more lengthy examples was:

> I also wonder what we mean when we say 'value'. In my school, each teacher has a networked computer on the desk. All teachers use it for attendance, and most of us use it for email and preparing classroom materials such as tests and worksheets. I think we now value computer technology for these uses. However, if I asked my colleagues how many of them used these computers with their students, I suspect the answer would be in line with the results of a 1999 NCES study which found that only about 50% of teachers use computers for classroom instruction (Smerdon et al., 2000). Is this also an issue of 'value'?

In this passage, P7 makes a judgement about the usefulness of computer technology for attendance, email, and word processing. She then goes further – she questions the use of the term 'value' – is it enough to value technology for administrative purposes, or is it only really of value in education if it is used for student instruction? She does not answer her own question, but by posing it in this context, she is adding an extra layer of meaning to her judgement on computer technology in the schools.

In the following example, P7 takes an observation (longer threads) and a theoretical assumption about the nature of knowledge (higher-order posts). From these, she draws a conclusion about the design of online asynchronous discussions.

> ...I noticed that the longer threads seemed to be where most of the higher-order posts occurred. If it is through this negotiation that we construct our knowledge, then we need to build negotiation into the process.

In the last category, strategies, P7 posted descriptions of teaching strategies she had experienced or used as either a graduate student or a junior high school teacher. She also

suggested the use of a strategy she first learned about in the course for which the OAD was produced:

> I wasn't aware of them either, but now I am going to use LOs every chance that I get! I was so excited to discover some of these objects they fulfilled needs that I haven't been able to cover due to cost or other factors such as safety. Some of them just present similar information but in different ways, so they will help me cater to various learning styles.

5.3.6 Participant 8

Table 5.3.6.1
Participant 8 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	10	20	3	2

Participant 8, like the others, used clarification frequently when describing an issue. For example, she proposes a debate on grading online asynchronous discussions, and introduces her topic this way:

> One point I wanted to raise about online discussion is the motivation when marks are involved. I once participated in a web-based course where there was a mark assigned to participating in the online discussions. Some people posted almost every day, and often just posted summaries of what they had read in the textbook or in the assigned readings, i.e., it seemed as if they were motivated to post just to get their mark. Sure, assigning a grade encourages students to post, but to what end? I would like to know how others feel about the assignment of marks to online discussion participation.

Participant 8 also uses assessment, as in the next example, when she makes a judgement on the value of online asynchronous discussion compared to that of a classroom discussion:

> During the past three years I have taken several Distance courses, many of which have involved an on-line discussion board. For me, this mode of

discussion and expression of views appears to have many benefits over classroom discussion.

Participant 8 had fewer passages rated as inference, compared to the other processes. She did make some use of this critical thinking process. She claims a connection between use of technology and basic skills in this passage: "I agree that the way in which technology is being used can be responsible for the loss of certain basic skills." Finally, few examples of strategies were noted. She did suggest, as a solution to the problem of the lack of teacher training in technology, that "perhaps a web site which combines tutorials with a technology question forum as you have suggested might be a welcome addition."

5.3.7 Participant 9

Table 5.3.7.1
Participant 9 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	7	1	9	2

Participant 9 posted the fewest messages of all the participants. He usually used clarification and inference, with very little text being classified in the other two categories. His use of clarification is shown in the following passage in which P9 explains the issue of access to computers for the disabled:

> My interest in online learning accessibility arises from my general concern for the inclusion of disabled students in computer learning opportunities. I once worked at a school where some disabled students were excluded entirely from computer-lab activities. Even though these students fully participated in most class activities, a lack of assistive devices in the lab prevented them from working on the computers with their peers. As I expect to become involved in designing online learning in the near future, I would like to learn

how to make online content accessible to all individuals, including those with disabilities.

P9's assessment passage refers to sharing in the workplace: "Personally I have found sharing to be very easy in my work, perhaps because I have only had positive sharing experiences." He continues on with a passage coded clarification in which he expands on sharing among teachers. Later in the transcript, P9 provided some generalizations (coded as inference) on the effect of sharing in the school: "Sharing with others also promotes positive relations in the school community, which can help make the school a more comfortable and 'easier' place to be. This example shows how a lengthy discussion of the same topic can contain several critical thinking processes.

Finally, P9 used strategies as well, when he suggested a method for handling group work:

> A variation on these is a 'jigsaw' approach. Learning content is divided into parts (like pieces of a puzzle), and each part is assigned to a different individual group. These learners become 'experts' who must teach their 'piece' of the 'puzzle' to the whole group. Online students could use the discussion forum to respond to the 'expert' products. To promote interactive discussion, respondents could be required to make one original criticism (in addition to any original praise).

5.3.8 Participant 10

Table 5.3.8.1
Participant 10 – Critical Thinking Processes

Process	Clarification	Assessment	Inference	Strategies
Number of Passages	10	10	5	2

Participant 10 used mostly clarification and assessment, but also used the other two processes. In the following passage, she expands the definition of 'plagiarism' to include other forms of dishonesty: "As to Internet Plagiarism, I think it's not only found in Educational field and it should not only point to students. As far as I know, some educators or teachers they do the same thing when seeking promotion or other stuff." P10 offers the following assessment at the end of a lengthy post describing the activities her group engaged in while participating in an online collaboration: "All these were running well via the medium of web, which I think offer a good opportunity for us to share work and exchange ideas anytime anywhere. I really enjoy this kind of teaching and learning."

P10 also showed the connections between knowledge and information in the following excerpt from her transcript:

> As to the difference, I think information is more like a carrier for knowledge. It contributes to the construction of knowledge. Information could be any piece of mental or mental-based visual, audial (sic) existence or abstract thoughts. While knowledge would be a systematic information collection. We collect and digest information and then construct our own knowledge.

Finally, P10 gave some examples of strategies her group had used in a group project: "We did use Chatroom and Email a lot. Synchronous communication chat makes the discussion proceed like face to face. Meanwhile through asynchronous communication Email, we worked collaboratively (sic) on this assigned work." These were coded as strategies.

5.4 Summary

Chapter Five began with a general description of the participants in the study. This description was followed by a summary of the results of the application of the model to the

transcript of each of the eight participants. Each of these descriptions of the results began with a table showing the number of examples of each critical thinking process found when the model was applied to the transcript of each participant. This table was followed by a summary and an analysis of each participant's results. In addition, at least one example was provided of each critical thinking process for each participant. By presenting this information, this chapter has provided a description of the overall pattern of the critical thinking processes found in the transcripts for each participant. All participants used a range of critical thinking processes, although the proportion of each varied according to the individual. For example, in general, participants used Clarification and Assessment the most, and Inference and Strategies the least. However, although P1 and P6 used Clarification frequently, they also used Strategies quite frequently. P5, in contrast, used Strategies only once, and also used Inference infrequently. P7 showed less variation among the processes used than most participants. These differences illustrate the way that different individuals in the same OAD engage in critical thinking in different ways.

Chapter Six – Discussion and Future Directions

6.1 Introduction

The purpose of this study is to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions. This chapter begins with an analysis of the process of moving from the preliminary to the final model, focussing on the selection and revision of the indicators. The following section of the chapter presents the final version of the model developed in this study, including all the modifications and revisions made as a result of applying it to the content analysis of OAD transcripts. The content analysis process is analysed in the next section of the chapter. This section is followed by conclusions about the procedure that was used to develop the model and then apply it to the content analysis of the transcripts. The chapter ends with a discussion of the implications for practice and future research.

6.2 From a Preliminary to a Final Model

The purpose of this study is to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions. Identifying and describing the essential critical thinking processes at the core of the model required an understanding of the concept and the literature. Specifying exactly what was included in each critical thinking process to the level of detail needed to enable the reliable and valid use of the model to support content analysis of OAD transcripts was a much more complex task. This task was especially difficult because part of the aim of the study was to produce a model that could be used by non-researchers, and that was targeted at a specific setting (OADs);

therefore, the final model needed to be fairly simple and easy to use. The next step, that of providing indicators, was one of the most important in the development process. The importance of this step is supported by the work of other researchers (Fahy, n.d.).

The initial list of indicators for the various critical thinking processes were obtained from a variety of sources. Some were adopted from the literature; others were written by the researcher after analysis of the critical thinking construct. After they had been identified and included in the model (see Chapter Three), these indicators underwent numerous revisions after being applied to guide the content analysis of the participants' transcripts. This refinement process was an essential part of tailoring the model for the OAD context, necessary in order to confirm that the indicators were clear and accurately reflected critical thinking. Testing and revising indicators in this way improved the validity of the entire model. The guiding principles for this part of the process, also derived from the literature, were comprehensiveness and uniqueness. In other words, the indicators had to cover an appropriate range of the behaviours associated with critical thinking processes (i.e, to increase validity) and had to clearly represent separate and distinct aspects of the critical thinking processes (i.e., to increase reliability).

6.3 A Final Model to Measure Critical Thinking

After the preliminary model was applied to excerpts from the eight participants' transcripts, a number of changes were made. A number of indicators were changed, and some were added. For each critical thinking process, further indicators were added to better represent the process. In the case of clarification, for example, 'identifying underlying assumptions' was added, to indicate that the participant was going beyond a surface level.

'Identifies relationships' was deemed to be sufficiently important to warrant a separate indicator. Two very similar indicators, one from Clarification and one from Inference were put in and re-worded to try to clarify the different processes they refer to. Similar additions, deletions and editing was carried out in all four processes.

In addition, examples are added to the model to provide more guidance to the user of the model. These examples are adapted from the transcripts during the revision of the preliminary model, and are intended to provide further guidance to potential users of the model. Because of space needed by the additional material, the model has been divided among four tables; one for each critical thinking process.

Table 6.3.1
The Final Model: Clarification

Process	Indicators	Examples
Clarification All aspects of stating, clarifying, describing (but not explaining) or defining the issue being discussed.	Proposes an issue for debate.	Can computers be an effective tool to improve basic skills?
	Analyses, negotiates or discusses the meaning of the issue.	I think 'basic skills' include algebra as well as arithmetic.
	Identifies one or more underlying assumptions in a statement in the discussion.	You can't assume that good students don't need practice in math skills.
	Identifies relationships among the statements or assumptions.	What is the connection between being a 'good' student and knowing basic math? Good students can have their strengths in other subjects!
	Defines or criticizes the definition of relevant terms.	'Basic skills' covers material before Level I.

Table 6.3.2
The Final Model: Assessment

Process	Indicators	Examples
Assessment Evaluating some aspect of the debate; making judgements on a situation, proposed evidence, argument or links among the issues	Provides or asks for reasons that proffered evidence is valid.	I began getting into online collaboration as a university student (citing personal experience)
	Provides or asks for reasons that proffered evidence is relevant.	Can you say that poor students do well with collaborative learning, when the program you describe is restricted to academic students?
	Specifies assessment criteria, such as the credibility of the source.	Many researchers on collaborative learning are not classroom teachers. I would like to hear from someone who has used these methods in a class like mine.
	Makes a value judgement on the assessment criteria or a situation or topic.	Using public exam marks to measure achievement isn't valid for an education program using these new methods. We need new evaluation methods too!
	Gives evidence for choice of assessment criteria.	I think we can use public exams because the questions and the course objectives are a good match, as is shown in the reports...

Table 6.3.3
The Final Model: Inference

Process	Indicators	Examples
Inference Showing connections among ideas; drawing appropriate conclusions by deduction or induction, generalizing, explaining (but not describing), and hypothesizing.	Makes appropriate deductions.	After reading what A and B had to say, I have to conclude that OADs are an effective educational setting.
	Makes appropriate inferences.	Disabled students cannot use computers; I think this is because the software is not set up properly to accommodate them.
	Arrives at a conclusion.	Collaborative group learning is a useful educational approach.
	Makes generalizations.	"Talkers" prefer chat while "Writers" prefer OADs.
	Deduces relationships among ideas	Your comment about group work and mine about scaffolding can be used together to explain how collaborative learning in groups works

Table 6.3.4
The Final Model: Strategies

Process	Indicators	Examples
Strategies Proposing, discussing, or evaluating possible actions.	Takes action.	Our board will use computer software to try to increase basic skills in ...
	Describes possible actions.	We tried gluing the mouse shut, and using a checklist to deal with mouse ball theft.
	Evaluates possible actions.	If you cannot remove the mouseball for cleaning, the mouse will become useless anyway.
	Predicts outcomes of proposed actions	Having all teachers do checklists at the beginning of each class will help prevent theft.

As can be observed by comparing Tables 6.3.1 to 6.3.4 to Table 4.6.1, the process of refinement and testing resulted in a more detailed model, which should, as described in the literature, result in improved validity and reliability when applied to the transcripts.

6.3 Content Analysis: Discussion of Results

The results of the content analysis were presented in two parts: first, a very brief numerical summary, and second, a brief analysis of the passages coded for each critical thinking process. These parts were presented for each individual transcript.

The numerical summary is not intended as an accurate count of the number of incidents of, for example, inference. Such an interpretation would be quite out of keeping with the idea of providing a broad assessment of the thinking patterns, and imply almost a one-to-one relationship between a critical thought and a word or phrase. In this study, critical

thinking is understood as a process, far more complex and less atomistic than something that can be pinned down to an exact number. The counts are presented in addition to the more specific discussion of examples because they are potentially very useful even though they do not represent incidents which are clearly countable in the usual sense. The purpose of presenting the numbers is not to imply that, for example, Participant 6 used assessment 6 and only 6 times. She clearly used assessment 6 times. She may have made more use of assessment. There may have been some passages in which she appeared to use some assessment, but which showed stronger evidence of clarification, and which were coded as clarification. In spite of this limitation, the numbers of passages coded for specific critical thinking skills do provide useful information.

Initially, and most basically, the numbers indicate that these students are engaging in critical thinking, and that they are using all four critical thinking processes, usually in different proportions. Such information would be useful to an instructor interested in his or her students' use of critical thinking in an online asynchronous discussion. It indicates that some critical thinking is occurring and that there are variations among the students as to both level and type of critical thinking being used. In addition, the information reveals that the students are not invariably using one of the simpler processes like clarification, since there are coded passages for all four critical thinking processes for all participants. Therefore, the numbers produced by the use of the content analysis can be used, along with the other results, to indicate the relative use of the four critical thinking processes as well as the actual presence of critical thinking in an OAD.

Other useful insights can be derived from these results. There were clear differences in the proportions among the critical thinking processes for the different students. Since all

students were in the same course, and most of them in the same OAD, the differences in the critical thinking processes in which they engaged may reflect differences in the processes that the student is comfortable with, or even capable of, using. Knowing this, the instructor may decide to revise the course to encourage a broader range of processes, or provide feedback to students who appear to be uncomfortable with or unable to engage in a particular critical thinking process. Students who are asked to perform some self-assessment can also find this sort of analysis of their thinking useful for self-improvement.

This study has provided further evidence of the usefulness of content analysis as a method for studying cognitive processes in OADs. Content analysis can provide useful information at the individual level to students and instructors, especially when guided by an appropriate model, such as the one developed in this study.

6.4 Conclusions and Implications for Practice and Research

The purpose of this study was to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions. A model was created, based on the literature, adapted to an OAD by the selection and focus on specific aspects of the critical thinking construct. This model was tested with eight individual participants' transcripts. The results of the testing showed that the model could be used to obtain insight into the critical thinking processes used by participants in an OAD.

The process for developing a model was successful. This process could be applied to other thinking skills, such as problem solving and knowledge construction. The basic approach of creating a model for an underlying construct and then applying it would be the same. The need for such work has been identified in the literature (Rourke, Anderson,

Garrison and Archer, 2001; Zhu, 1996; Henri, 1992). The greatest challenge in any study using the approach of this one is undoubtedly creating and selecting indicators, which are essential to the validity and reliability of the entire process. Some difficulty was experienced in applying the model, especially when participants' text could be interpreted in more than one way. Of course, this may be partly due to the fact that this was an experimental model; and further use of the model and refinement of the indicators might reduce this problem.

Both instructors and students could benefit from using the model developed in this study. Instructors who have designed their OAD to encourage the use of critical thinking processes can rate their students' transcripts using the model in order to assess the success of their efforts to encourage critical thinking. They can also focus on developing teaching strategies to encourage specific types of critical thinking processes if, for example, they want the students to use inference more often, and clarification less often. Applying the model to their students' transcripts will reveal which critical thinking processes are most frequently used. This is information that instructors need before deciding which specific skills to encourage or before determining how successful their efforts were to support particular skills.

The model could also be used as the basis of a student evaluation tool. It would also be relatively simple to modify the model into a rubric by assigning marks to each critical thinking process and adjusting the rating system somewhat. In other words, it would be necessary to rework the model from one intending to provide feedback on a personal level to one specifically designed to compare and rate students' performances.

Students could also use this model, in their case, for self-assessment. Self-assessment might be required by the instructor as part of the course work or course evaluation. Some students may wish to use it for their own personal benefit, to enhance their understanding of

the cognitive processes involved in critical thinking, or to monitor and enhance their own contributions to an OAD.

There are many possibilities for further research based on this study. For example, the reliability of the procedure could be measured by having the same transcripts rated by independent raters. The inter-rater reliability could then be determined. If the reliability were too low, the indicators would be revised and the model then retested until it was proven to be more reliable. Of course, the additional testing might reveal that the model is already reasonably reliable.

Another area for further research would be to apply the same model to OADs from other courses, including courses in other subject areas. While the model was specifically designed for OADs in graduate-level education courses, this study did not determine if it would be effective in courses other than the one in which it was tested. Possibly, the proportions of the critical thinking processes observed are affected by the requirements of the course as well as the personal variations among the students. This is only one hypothesis that could be tested by expanding the application of the model into a wider range of OADs from different courses. Such expanded application could also be used to find evidence as to whether there are subject-specific critical thinking processes, and if there are, what processes and indicators should be added to the model. Some research in this area would include measuring uncritical, as well as critical thinking, in order to give a better and more balanced picture of an individual's thinking. Adding this dimension to the model and testing it would be another avenue for further research.

6.6 Summary

The purpose of this study was to develop a model to identify and measure students' engagement in critical thinking processes in online asynchronous discussions. This chapter began with an analysis of the process of moving from the preliminary to the final model. This procedure began with the identification and description of critical thinking processes, and continued through the creation and testing of indicators describing the various aspects of critical thinking processes. The results of applying the final model to the content analysis of the transcripts was discussed next, tying together the results of the individual analysis presented in the previous chapter and stating what can be learned from the use of the model, and the main difficulty encountered in applying it to content analysis. This discussion was followed by conclusions about the entire process that was used to develop the model and then apply it to the content analysis of the transcripts. The chapter ended with a discussion of the implications for practice and future research.

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Appendix 1: Discussion Guidelines for the Course, Fall, 2003

Discussion guidelines

To keep the discussion running smoothly and to ensure its effectiveness you are asked to take note of the following guidelines:

1. Consult the rubric for evaluation of the discussion before beginning.

2. Be careful to post in the right area. Do not post in the main and notes' topics.

3. Use the subject line to reference the content of your posting.

4. Keep your messages short and to the point. DO NOT WRITE MORE THAN 100 WORDS PER POSTING.

5. Decide before you post whether or not you should post to the entire group or just to an individual. For example, if you only want to say something such as "Great posting" or "I agree with your posting", send that as an email to the individual rather than cluttering up the discussion forum.

6. Do not dominate the forum. Do not make anymore than two postings per day.

7. Beware of "topic drift"! Aim not to digress from the topic at hand.

8. WebCT does not allow you to delete or modify an entry once it is posted so be sure to check your message carefully before you post it.

9. Avoid flaming and Ad Hominem attacks. Focus on the argument and not on the person.

10. Use the water cooler for informal discussion not directly related to the modules.

11. If you are making reference to a comment posted by someone else, quote a small snippet or the relevant aspect of the original posting (you can use the "quote" function in WebCT for this). Avoid requoting the entire message and as well avoid not quoting since participants may not necessarily remember or have read the previous posting.

12. Check your message before you send it. Pay attention to your spelling and grammar, and be sure your message expresses the points you want to make in a clear and concise way.

13. Respect others' ideas and opinions. Feel free to disagree, but express your disagreement in a respectful manner.

14. Avoid writing in ALL CAPS as it usually represents SHOUTING!

15. Feel free to use emoticons. Here are some examples:
http://www.pb.org/emoticon.htmlor
http://www.computeruser.com/resources/dictionary/emoticons.html

16. Explore the various discussion forum tools such as select all, search and compile.

17. A reminder that, for grading purposes, you must make one posting and one reply per module. See below re evaluation. You play an important role in the evaluation of your discussion postings.

Appendix 2: Evaluation of the Course Discussion, Fall, 2003

Discussion

This course is not designed on the principle of knowledge transmission from teacher to students. The direction of interaction in the course is meant to be more lateral or from student (s) to student(s). The discussion forum is designed to promote knowledge sharing and construction and interaction between students.

The role of the instructor in this case is that of the facilitator or moderator. In this role, the instructor contributes no more than 20-30% of the discussion postings. He/she sets up the structure of the discussion in the beginning, intervenes to keep it on track

Discussion guidelines

To keep the discussion running smoothly and to ensure its effectiveness you are asked to take note of the following guidelines:

1. Consult the rubric for evaluation of the discussion before beginning.

2. Be careful to post in the right area. Do not post in the main and notes' topics.

3. Use the subject line to reference the content of your posting.

4. Keep your messages short and to the point. DO NOT WRITE MORE THAN 100 WORDS PER POSTING.

5. Decide before you post whether or not you should post to the entire group or just to an individual. For example, if you only want to say something such as "Great posting" or "I agree with your posting", send that as an email to the individual rather than cluttering up the discussion forum.

6. Do not dominate the forum. Do not make anymore than two postings per day.

7. Beware of "topic drift"! Aim not to digress from the topic at hand.

8. WebCT does not allow you to delete or modify an entry once it is posted so be sure to check your message carefully before you post it.

9. Avoid flaming and Ad Hominem attacks. Focus on the argument and not on the person.

10. Use the water cooler for informal discussion not directly related to the modules.

11. If you are making reference to a comment posted by someone else, quote a small snippet or the relevant aspect of the original posting (you can use the "quote" function in WebCT for this). Avoid requoting the entire message and as well avoid not

quoting since participants may not necessarily remember or have read the previous posting.

12. Check your message before you send it. Pay attention to your spelling and grammar, and be sure your message expresses the points you want to make in a clear and concise way.

13. Respect others' ideas and opinions. Feel free to disagree, but express your disagreement in a respectful manner.

14. Avoid writing in ALL CAPS as it usually represents SHOUTING!

15. Feel free to use emoticons. Here are some examples:
* http://www.pb.org/emoticon.html or
* http://www.computeruser.com/resources/dictionary/emoticons.html

16. Explore the various discussion forum tools such as select all, search and compile.

17. A reminder that, for grading purposes, you must make one posting and one reply per module. See below re evaluation. You play an important role in the evaluation of your discussion postings.

Visualizing your thinking

As a means to facilitate knowledge construction and metacognition you are encouraged to add a short sentence at the beginning of your post to indicate the type of post you are making.

e.g. "In this posting I would like to relate an anecdote in support of John's claim that administrators are not always supportive of technology use." Below are some ways in which you can categorize or describe your postings: Here are some of types or categories of postings:

1. A CLAIM is the point or argument you are trying to make:

Example: "You should send a birthday card to Mimi, because she sent you one on your birthday."

or

"I drove last time, so this time it is your turn to drive."

There are three basic types of claims:

1. Fact: claims which focus on empirically verifiable phenomena

2. Judgement/value: claims involving opinions, attitudes, and subjective evaluations of things
3. Policy: claims advocating courses of action that should be undertaken

2. GROUNDS refers to the proof or evidence an arguer offers.

Grounds answers the questions, "What is your proof?" or "How come?" or "Why?"

Grounds can consist of statistics, quotations, reports, findings, physical evidence, or various forms of reasoning.

example: "It looks like rain. The barometer is falling."

example: "The other Howard Johnson's restaurants I've been in had clean restrooms, so I'll bet this one has clean restrooms too."

grounds can be based on:

Evidence: facts, statistics, reports, or physical proof,

Source credibility: authorities, experts, celebrity endorsers, a close friend, or someone's say-so

Analysis and reasoning: reasons may be offered as proof

Grading

Your participation in the discussion counts for 20%. The rubric which is listed below provides the criteria with which to evaluate discussion contributions. The rubric also serves as a guide to participants to assist them in formulating postings.

In the final week of the course, you must send an email to your instructor in which you present an analysis of your discussion contributions for modules 1-4 in relation to the rubric. You must refer to the rubric to evaluate your contributions to the discussion and to provide a mark out of ten with a rationale for why you feel you should have received the mark you did. You must use the evaluation criteria in the rubric as your guide. Thus you will quote directly from your postings to illustrate how you met the criteria in the rubric.

The instructor will make a decision on your mark based on the strength of your rationale. The strength of your rationale depends on how well you are able to relate your postings to the rubric.

You must also provide a numerical summary of the number of postings you made per module.

You must also refer to the discussion guidelines and indicate if there were any instances in which you did not adhere to the guidelines.

RUBRIC FOR THE EVALUATION OF THE DISCUSSION

18-20: Postings reflect a superior level of insight, originality, analysis and critical thinking. Articulation is at the superior level.

15-17: Postings offer a critical analysis of existing posted ideas and introduce a different interpretation to an existing idea. Asks provocative questions or makes insightful, critical, evaluative comments. Contributes new information. Expresses ideas very clearly and coherently.

12-14 Agrees or disagrees with existing discussion and provides some justification/explanation but not a critical analysis. Exhibits some good insights and understanding. Expresses ideas clearly and coherently for the most part.

9-11: Agrees or disagrees with existing discussion but provides a limited justification/explanation and no critical analysis. Reveals an adequate understanding of the topic. Asks points of information but does not add new information. Ideas not always expressed clearly and coherently.

6-8: Agrees or disagrees with existing discussion but provides no justification/explanation. Reveals a restricted understanding of the topic. Ideas not expressed clearly and coherently.

0-5 Provides no evidence of agreement or disagreement with existing discussion. Postings are unrelated to discussion

Appendix 3: Evaluation of the Course Discussion, Spring, 2003

Conclusion

The course conclusion is designed to provide you with an opportunity to draw some conclusions related to your learning in this course. You will engage in two activities as part of the course conclusion. These are discussion activities and a presentation activity.

Discussion activities

Week 12: Recall and reflection activity
What are some important things you have learned in this course related to issues and trends in educational computing?

Week 13: Projecting activity
What are some questions or issues or things about which you would like to find out more related to issues and trends in educational computing?

Presentation activity

For this activity, you will complete an analysis of your contribution to the discussion forum. Your analysis will be somewhat similar to what you did in Module 3 when you analysed the contribution of all participants to the discussion forum. Your aim will be to complete an objective, rigorous and systematic assessment of your contribution as if you were analysing someone else's postings. Follow these steps to complete your analysis.

1. Use the search feature to locate all your postings.

2. After you have located all of your postings, select your postings from weeks 2-11 inclusive. Then use the compile feature of the WebCT discussion forum to compile all of your postings into one text file which you can then save to your computer and from which you can cut and paste.

3. Determine how many postings you made and how they were distributed over the modules i.e. how many were for module 2, how many were for module 4 etc.

4. Do a word count using the wordcount features in your word processor to determine the average length of your postings. Also determine what the shortest posting was that you made and what the longest one was that you made.

5. (This is the main analysis you will perform).In relation to the content of your postings, determine how many claims you made and of what type they were and what type of grounds you provided for your claims. A CLAIM is the point or argument you are trying to make such as: "Professional development programs do not always show how best to integrate technology". There are three basic types of claims:
   1. Fact: claims which focus on empirically verifiable phenomena

2. Judgement/value: claims involving opinions, attitudes, and subjective evaluations of things
3. Policy: claims advocating courses of action that should be undertaken

GROUNDS refers to the proof or evidence an arguer offers. Grounds answers the questions, "What is your proof?" or "How come?" or "Why?"

Grounds can consist of statistics, quotations, reports, findings, physical evidence, various forms of reasoning or anecdotal evidence.

6. Once you have determined all of the above, use a spreadsheet program such as MSExcel to present your analysis in pie charts or bar graphs.

7. Include these charts and or graphs to describe your participation in the forum. Then go a step further and evaluate to what degree you did or did not advance the discussion and promote knowledge building in the discussion. Provide some specific examples with quotes and refer as well to your charts and graphs.

8. Describe how you might have improved your participation in order to promote more sharing and construction of knowledge.

9. Present all of the above in an essay.

10. Upload your essay to your webpage.

Grading

Your presentation will be graded according to the following criteria.

* Rigorous analysis
* Systematic analysis
* Clarity of presentation
* Explanation of approach
* Coherence and logic
* Depth of analysis and reflection
* Insight and originality
* Precise, scholarly and appropriate use of language
* Respectful of conventions of spelling and grammar

Appendix 4: Ethics

Memorial
University of Newfoundland

Office of Research

August 7, 2003

ICEHR No. 2002/03-096-BA
Ms. Cheryl Perkins
Faculty of Education
Memorial University of Newfoundland

Dear Ms. Perkins:

The Interdisciplinary Committee on Ethics in Human Research has examined the proposal for the research project entitled "*Identifying and measuring critical thinking in Online asynchronous discussions in graduate courses*" in which you were listed as the principal investigator.

The Committee has given its approval for the conduct of this research in accordance with the proposal submitted on the condition that the following minor modifications are incorporated:

1. Is there a likelihood that any of the students in the selected courses are being, or might be in future, taught by the researcher's supervisor? If so, then there is a possibility that such students may feel (however unrealistically) that they ought to participate or face the consequences in future courses. This raises concerns regarding the possibility of felt coercion, which must be remedied. This is particularly a concern, since this study can be seen to be making a contribution to the area of research undertaken by the supervisor herself. The simplest way to deal with this might be to exclude from the study, students in courses taught by the researcher's supervisor, and to ensure that the supervisor not have access to identifying information in respect to any of the postings.

2. The information for students and instructors should specify the means by which the researcher will actually obtain access to these postings. Does the professor or the participating student send them? If as it appears, the professor forwards the postings to the researcher, s/he must be clearly instructed not to give you access to the postings of anyone who has not consented to participate in the study, or to provide you with any otherwise identifying information about those non-participating students.

3. Please provide for written documentation of consent to participate. We suggest that you use an online form that can be printed by prospective participants and then mailed to you.

4. As part of the informed consent process, the information and consent forms provided to participants require the addition of further information. These should also address:

   a) Purpose of the research - specify that this is a thesis.

St. John's, NL, Canada A1B 3X5 • Tel.: (709) 737-8251 • Fax: (709) 737-4612 • http://www.mun.ca/research

Instructor Information

I am a graduate student in the MEd(IT) programme, studying critical thinking in asynchronous online discussions for my thesis. Many benefits have been claimed for the use of online asynchronous discussions in education, but there is relatively little information about the extent to which these benefits are realized. I intend to examine transcripts of online asynchronous discussions in a search for indicators of critical thinking. By doing this, I will develop an instrument that can be used to measure critical thinking in other online asynchronous discussions, which will be useful in future explorations of the types of thinking processes that occur in such discussions. I would very much appreciate your assistance in allowing me to ask your students to volunteer as participants, and in releasing partial transcripts to me for analysis. At the end of the study, I will provide you with a copy of the instrument which you may use in your classes in the future.

Your participation would be very limited. I need your permission to send the attached call for volunteers to all members of your class by posting it in your discussion group and by email. In order to send out the email, I will need the email addresses of all class members. In addition, I am asking you to authorize release an electronic copy of the postings for the participating students only, without any identifying information on the non-participating students. Anonymity will be preserved as well as possible, considering the limitations imposed by class size. No classes or individuals will be identified in the report on the research. You are welcome to read the final report.

I am attaching a copy of the information sheet and consent form that will be sent to volunteers.

Please feel free to contact me or my supervisor if you have any questions about this research, and if you are interested in participating, you can reach me by email or telephone.

Cheryl Perkins
Tel: 777-6874 (W), 754-5201(H)
Email: cperkins@mun.ca

Supervisor:
Dr. Elizabeth Murphy
Tel: 737-7634 (W)
Email: emurphy@mun.ca

If you have any questions, you may also contact ICEHR, which has approved this project:
Interdisciplinary Committee on Ethics in Human Research (ICEHR)
Tel: 737-2528

Call for Volunteers

I am looking for people to participate in a research project in online asynchronous discussions. This research is being carried out as part of the requirements for my Master's thesis. You are invited to participate because, as part of your work in [name of course], you are participating or have recently participated in an online discussion.

The overall aim of the research is to gain insight into the use of online discussion forums in education. Many benefits have been claimed for the use of discussion forums for teaching and learning, but there is relatively little information about the extent to which these benefits are realized. I have chosen one of the reported benefits the use of critical thinking and am planning to identify and measure it. This information should increase understanding of teaching and learning using online asynchronous discussions and consequently help improve their use in education.

If you agree to participate, please send me an email at cperkins@mun.ca with your mailing address. I can then mail you a consent form to sign and return to me in the enclosed, stamped, self-addressed envelope. A copy of the consent form is at the end of this notice, so you can review it in advance.

None of your posts will be used unless you give me permission. Access to your posts will be gained with the assistance of your professor, who will provide me with transcripts of those students who have signed a consent form.

If you do volunteer to participate, and give me permission to use your posts, any excerpts from your work that are published in the final thesis will be anonymous. If you change your mind, and decide to withdraw from the study, you may do so without prejudice, and any information collected related to your participation in the discussion group will be excluded from the study.

The data collected will be analysed using content analysis, which involves classifying statements according to certain criteria in this case, criteria related to critical thinking. The original data, in electronic form, will be kept in my custody for a year after the publication of the thesis. The analysed data will be published in a thesis, and may also be published in academic papers.

Whether or not you agree to participate will have no effect on your grade in your course, and will not affect any connection you will have with the university in the future.

If you have further questions about this research, please contact any of the following:

Principal investigator	Supervisor
Cheryl Perkins	Dr. Elizabeth Murphy
754-5201	737-7634
cperkins@mun.ca	emurphy@mun.ca

The Interdisciplinary Committee on Ethics in Human Research (ICEHR) has approved the proposal for this study. The Committee may be contacted directly with any ethical concerns about the research at 737-8368 or icehr@mun.ca

Consent Form

1. By agreeing to participate in this study, I am providing consent to publication of my comments in anonymous format in part or in whole in subsequent research reports and papers that may be published in relation to the study.

2. I understand that because of the small class size and the specificity of the course material, the confidentiality of comments cannot be guaranteed. Nonetheless, every possible measure will be taken to disguise individuals' identities.

3. I will be given the opportunity to edit or exclude any direct quotes. Any of my quotes that will be published will be sent to me by email prior to their being included in any publications.

4. I will be provided with the results of the study upon my request.

5. My agreement or refusal to participate will not in any way affect my grades in this or in any class, nor my access to services from this University now or in the future.

I provide my consent to participate in the study

_____ _____

Signature Date

_____

Name (Printed)

Please mail in the enclosed stamped self-addressed envelope to:

Cheryl Perkins
39 Fleming Street
St. John's NL A1C 3A3