# Measuring Critical Thinking in Online Discussion: Analysis Model

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**Abstract:** The ability to foster critical thinking among students has long been a priority among educators whether it takes place in a classroom or online. The advancement of technology nowadays is the reason why educators use online learning as a means to foster students' critical thinking using the written method. From literature studies, it can be seen that students' critical thinking can be fostered using text-based discussion (often called asynchronous online discussion). One of the methods utilized to analyse students' critical thinking in online discussion is that of content analysis. Several researchers have developed models and tools to facilitate the analysis data representing students' critical thinking. In this study, the researchers specifically gather several models in order to analyse students' critical thinking within online learning. In relation to further studies, the researchers proposed the use one of the models to analyse online discussion transcript.

**Keywords:** Analysis Model, Content Analysis, Critical Thinking, Online Discussion

## 1. INTRODUCTION

Nurturing critical thinking skills is crucial among higher education students and educators have continued to place emphasis on the development of students' critical thinking especially in the field higher education [1–6]. Additionally, the purpose of developing students' critical thinking skills in higher education is necessary to prepare them for the workforce as these skills number among the employability skills that are needed in the workplace whether one is self-employed or working with others [7,8]. As Clanchy and Ballard [9] stressed there are three main forms in employability skills. These comprise (1) thinking skills; (2) research skills; and (3) communication skills. Therefore, it is important to develop the thinking skills which involve elements of critical thinking among students as these skills will help them later to make critical and wise decisions in the workplace. According to Beyer [1], critical thinking means making clear, reasoned judgements. Thus, ideas should be reasoned and well-thought out or judged during the process of critical thinking.

Concurrent with the rapidly growing online technology existing nowadays, developing critical thinking skills of students can be done in online medium such as in the online forum in the Learning Management System (LMS), Content Management System (CMS) and recently through Social Networking Sites (SNS) as well. This is supported by Macknight [10] who claimed that critical thinking can be promoted through online discussions. Moreover, the issue of promoting students' critical thinking should be explored, regardless of whether the learning takes place in a formal online discussion platform or otherwise.

In the meantime, how can we measure the level of critical thinking in online discussion? And how can we ensure the quality of online discussion? A reliable method by which to measure or identify the means of online discussion is by using the content analysis method [11]. According to Krippendorf [12], content analysis is a systematic, replicable technique for compressing a bunch of words of text into certain categories based on clear rules of coding. However, it is best to code the text-based discussion transcript based on established models proposed by previous researchers instead of developing the new coding schemes [13,14].

However, in the online discussion environment, many researchers have modified the existing analysis model or developed a new analysis model. In the next section, we will discuss about 10 critical thinking analysis models that can be used as a guideline to code the online discussion transcript. For each analysis model, we will discuss the differentiation between one analysis model and another in terms of its dimensions in the next section.

## 2. CRITICAL THINKING ANALYSIS MODEL

Table 1 demonstrates that the 10 critical thinking analysis models can be chosen or referred to in order to code the online discussion transcript. It is up to the researchers whether they want to modify the existing analysis models or alternately develop new analysis models to measure the level of critical thinking appropriate with their research objectives. In this present paper, the researcher only discussed ten (10) existing critical thinking analysis models that can be referred to as guidelines for other researchers. The ten (10) analysis models comprise: Henri [11], Newmann, Webb, and Cochrane [15], Gunawardena, Lowe, and Anderson [16], Bullen [17], Hara, Bonk and Angeli [18], Garrison, Anderson, and Archer [19], McKlin et al. [20], Yang, Newby and Bill [21], Perkins and Murphy [22], and Yang et al. [23].

**Table 1:** Critical Thinking Analysis Model

| Authors | Theme/ Topics | Unit of Analysis | Analysis Model |
|---|---|---|---|
| Henri [11] | Cognitive and metacognitive knowledge | Units of Meaning | Developing a five phase analytical model including participative, social, interactive, cognitive and metacognitive dimensions. |
| Newman, Webb, and Cochrane [15] | Critical thinking | Units of Meaning | By simplifying Henri's [11] model and combining with Garrison's [24] model. |
| Gunawardena, Lowe, and Anderson [16] | Knowledge construction and collaborative learning | Message | Developing a five phase evolution of negotiation leading to the co-construction of knowledge including: Sharing/ comparing information, Discovery and exploration of dissonance, Negotiation of meaning/co-construction of knowledge, Testing and modification of proposed synthesis, Phrasing of agreement, Statement and application of the newly constructed meaning. |
| Bullen [17] | Critical thinking | Message | A ratio of positive indicators (critical thinking) to negative indicators (uncritical thinking) to determine the level of critical thinking, comprising: Clarification; Assessing evidence; Making and judging inferences; Using appropriate strategies and tactics. |
| Hara, Bonk, and Angeli [18] | Cognitive and metacognitive process | Paragraph or idea | Using a transformed Henri [11] method. |
| Garrison, Anderson, and Archer [19] | Critical thinking and cognitive presence | Message | Developing an inquiry model focus on cognitive presence. |
| Authors | Theme/ Topics | Unit of Analysis | Analysis Model |
| McKlin et al. [20] | Cognitive Presence | Message | To generate a method for automatically categorizing messages into cognitive categories using neural network software. |
| Yang, Newby, and Bill [21] | Critical thinking | Message | Combined the model of Gunawardena, Lowe and Anderson [16] with Newman, Webb and Cochrane model [15]. |
| Perkins and Murphy [22] | Critical Thinking | Message | Developed from Norris & Ennis [25], Henri [11], Garrison, Anderson and Archer [19], Newmann, Webb and Cohcrane [15] and Bullen [26]; Clarification, Assessment, Inference and Strategies |
| Yang et al. [23] | Cognitive | Message | Using the revised Bloom's Taxonomy by Anderson and Krathwol [27] ; Remembering, Understanding, Applying, Analysing, Evaluating, Creating |

### 2.1 Unit of Analysis

Dewever [13] claimed that the unit of analysis determines how the complete discussion will turn into manageable items that later will be coded into the analysis categories. There are many forms of units of analysis when conducting content analysis. Theses include: using a message as the unit of analysis; a segment; a paragraph; as well as a sentence or meaning [28]. The majority of the analysis models referred to in the Table 1 used a complete "message" as the unit of analysis [16], [17], [19–23]. Henri [11] in addition to Newman, Webb and Cochrane [15] used "unit of meaning" (thematic analysis) as the unit of analysis. The study by Hara, Bonk and Angeli [18] used the concept of paragraph or idea as the unit of analysis. When deciding the unit of analysis, we must bear in mind that the selections may affect the accuracy of the coding and the extent portrays the factual content of the original transcript [29].

### 2.2 The Most Popular and Cited One Critical Thinking Analysis Model

It can be seen from the Table 1 that, the critical thinking analysis models which are the most popular and the most cited to use as a coding scheme are namely: Henri's [11] model; Newmann, Webb and Cochrane's [15] model;

Gunawardena, Lowe and Anderson's [16] model; and Garrison, Anderson and Archer's [19] model respectively [23]. The literature shows that the theoretical foundation of most of the existing analysis models as a coding scheme for content analysis came from Henri's Cognitive Framework [11] and Garrison's Critical Thinking Model [24].

Henri's Cognitive Framework [11] is considered as a pioneering work in the online collaborative learning environment to use as an instrument for content analysis. Henri develops five dimensions that access students' learning process among online learners, specifically: (1) participative, (2) social, (3) interactive, (4) cognitive and (5) metacognitive dimensions. Meanwhile, to assess students' cognitive dimensions, she proposed five categories, namely:

(1) elementary clarification; to observe and study a problem classifying its features and observing its relationship so as to achieve basic understanding, (2) in-depth clarification; to analyse and understand a problem highlighting the values, beliefs and assumptions behind the statement of the problem, (3) inference; induction and deduction, accepting or suggesting an idea on the basis of its relation with the suggestion which is accepted as being true, (4) judgement; making decisions, statements, appreciations and criticisms and (5) strategies; to propose appropriate actions for the implementation of a solution depending on the options available. In addition, Henri's model can be categorized according to surface level and in-depth level processing to measure the recognised skills. She distinguished the message between surface level and in-depth level by identifying the repeating message with no added on new information and statements without justifications and elaborations categorized as surface level. Meanwhile, messages with reasons and explanations, together with added new information were considered as in-depth level. However, other researchers have detected weaknesses in Henri's model, specifically lack of impression on social co-construction of knowledge by a group or individuals as a group in a discussion [30].

Newman, Webb and Cochrane's [15] model focuses on group learning, deep learning and critical thinking respectively. The model was developed by simplifying the Henri's [11] model and combining it with Garrison's [24] critical thinking model. Garrison's model consists of five stages of problem solving, namely: (1) Problem identification; (2) Problem definition; (3) Problem exploration; (4) Problem evaluation/applicability; and (5) Problem integration skill. Basically, Garrison's model closely resembled that of Henri. In the work of Newman, Web and Cochrane, ten categories were identified (1) Relevance; (2) Importance; (3) Novelty, new info, ideas and solutions; (4) Bringing outside knowledge; (5) Ambiguities; (6) Linking ideas; (7) Justification; (8) Critical assessment; (9) Practical utility; and (10) Width of understanding. For each category, numbers of positive and negative indicators were formulated and chosen in fairly obvious opposites [15]. The ratio of critical thinking is calculated using the totals for each positive or negative indicator, with a minimum of -1 (all uncritical thinking, all surface-level learning) and a maximum of +1 (all critical thinking, all deep learning) [15]. However, the main challenge involved in replicating the Newman, Web and Cochrane's model is that the list of categories is too long and it would be quiet complicated to analyse it.

Gunawardena, Lowe, and Anderson [16] have developed five phases of an Interaction Analysis Model (IAM) to examine social construction of the knowledge and collaborative learning process. The five phases comprise: (1) Sharing/ Comparing knowledge; (2) Discovering/ Exploring disagreements; (3) Synthesis via negotiation meaning; (4) Testing/Modifying proposed synthesis vs. schemes, theory, facts, beliefs and (5) Proofs of reaching agreements or meta-cognitive data admitting change of knowledge. The IAM provides an assessment of the process and learner' participation (the exchange of the dialogue), as well as and knowledge construction. Reviews from other researchers have revealed that the IAM is lacking in focus on student-to-content interaction [31]; however, it has more focus on social interaction (student-student and student-instructor) and knowledge construction [23]. The student-content interaction is important in order to show one's prior

knowledge about the content which often in the lower level of cognitive skills [32].

Garrison, Anderson and Archer [19] examine a practical approach by which to assess the nature and quality of critical discourse and thinking in a computer conference. They have developed an inquiry model which focuses on cognitive presence (i.e., critical and practical inquiry). The inquiry model used the conceptual framework for a community of inquiry as described in Garrison, Anderson and Archer [33]. They also used Garrison's [24] critical thinking model as the basis for them to develop the inquiry model. There are four phases in an inquiry model which are (1) Evocative; (2) Inquisitive; (3) Tentative; and (4) Committed. Garrison, Anderson and Archer [19] emphasized the importance of identifying the cognitive presence among students since this represents their higher order thinking processes and individual learning outcomes.

## 2.3 Other Existing Critical Thinking Analysis Model

Besides the most cited critical thinking analysis model, other analysis models also can be used to measure critical thinking in online discussion [17], [18], [20–23].

Bullen's [17] model places an emphasis on critical thinking. The theories underpinning Bullen's model are based on Dewey [34], Ennis [35] and Garrison [24]. Bullen's model assesses critical thinking skills by using a ratio of positive indicators (critical thinking) to negative indicators (uncritical thinking). There are five dimensions in this model, specifically: (1) Clarification; (2) Assessing evidence; (3) Making and judging inferences; (4) Using appropriate strategies; and (5) Tactics.

Other analysis models such as that of Hara, Bonk, and Angeli's [18] focus on the cognitive and metacognitive processes. They use a transformed version of Henri's model for content analysis so as to analyse the discourse. They include five dimensions to assess the students' cognitive and metacognitive processes which are: (1) student participation rates; (2) electronic interaction patterns; (3) social cues within social message; (4) cognitive and metacognitive components of students' message; (5) depth of processing message posting. They investigate the discussion in online learning environment that promotes class discussion in a psychology course using an instructional approach called the "starter-wrapper technique". Results have revealed that students posted messages which were detailed, cognitively deep, as well as having peer references inserted. The study also shows that students were using a high level of cognitive process inferences, judgments and metacognitive strategies to reflect on their self-awareness and experience.

Yang, Newby and Bill's [21] model developed a modified coding scheme by combining the model of Gunawardena, Lowe and Anderson [16] with that of Newman, Webb and Cochrane [15]. They investigated the effects of using a Socratic questioning technique to enhance students' critical thinking skills in asynchronous discussion forums in university-level distance learning courses. The results revealed that teaching and modeling of Socratic questioning helped students demonstrate a higher level of critical thinking skills. In addition, the students maintained their critical thinking skills after exposure to and modeling of Socratic questioning in the asynchronous discussion forum.

Perkins and Murphy [22] developed a model to assess individual engagement in critical thinking in an online discussion. The difference between the Perkins and Murphy [22] model from all the models previously discussed is that

it focuses on evaluation of the individual critical thinking engagement in online discussion forums. This is contrast to other models which calculated the average groups' level of critical thinking and were not specific to particular individuals. They developed this model by reviewing the literature; the critical thinking models that influenced them were Norris and Ennis [25], Henri [11], Garrison, Anderson and Archer [19], Newmann, Webb and Cohcrane [15] and Bullen [26] respectively. After examining the relevant indicator from the literature, they came up with four categories by which to identify engagement in critical thinking which are (1) Clarification; (2) Assessment; (3) Inference; and (4) Strategies. The result from the application of the model showed that it could be used to obtain insight into the critical thinking processes used by students in online discussions. In addition, this model is not very complicated and hence it is easy to assess online discussion transcripts compared to longer version models which have many categories and complex analysis. One example of these types of models is that of Newman, Webb and Cochrane's [15] model, which is hard to replicate and understand the analysis process.

A recent model has been developed by Yang et al. [23] using the revised Bloom's Taxonomy by Anderson and Krathwol [27]. The revised Bloom's Taxonomy has a two-dimensional structure with knowledge separated from cognitive process (skills) in the cognitive domain. The knowledge domain comprises of Factual, Conceptual, Procedural, and Meta –Cognitive knowledge respectively. The cognitive domain comprises of six levels of cognitive phases, specifically: (1) Remembering; (2) Understanding; (3) Applying; (4) Analysing; (5) Evaluating; and (5) Creating. The new model developed by Yang et al. [23] examines the cognitive aspects of students in an online discussion forum. They highlighted that their study contributes to practice by providing a more complete content analysis model compared to other models. Furthermore, this model also has a reliable and valid available content analysis in terms of the score it generates.

## 3. CONCLUSION

In summary, most of the analyis models have the same theoretical underpinning behind them so as to assess the critical thinking skills in online discussions. Besides that, in relation to further research, the researchers decided to use the "unit of meaning" as the unit of analysis following the Henri's [11] in addition to Newman, Webb and Cochrane [15]. Moreover, the researchers adopted the established model available in order to measure the level of critical thinking in online discussion. They deduced that this depends on the research objectives and research purpose. The researchers proposed to adopt Perkins and Murphy [22] as an instrument by which to examine students' critical thinking engagement. The reason for their decision was that the model by Perkins and Murphy [22] was developed specifically in order to measure individual critical thinking engagement compared to other available models which calculate the aggregate measures of group engagement. Hence it is relatively easy to assess the online discussion transcript.

## ACKNOWLEDGMENT

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