

Assessing Learning Outcomes in CSCL Settings

Nancy Law

University of Hong Kong, Pokfulam
nlaw@hku.hk

Abstract. A variety of models and methodologies for assessing learning outcomes in CSCL settings have been reported in the literature, most of which were developed either within the framework of assessing levels of critical thinking or phases in problem solving. These generally assess outcomes at the individual level though the learning context was clearly a social collaborative one. Recent studies on the characteristics of productive online collaborative discourse have identified features at the group/community level that cannot be sufficiently described at the individual level. Building on the theory of knowledge building (Scardamalia & Bereiter, 2003) as a social intentional activity, this paper proposes a model of assessing learning in CSCL contexts as group/community outcomes with four inter-related but distinct dimensions: a social dynamic for sharing and open exploration, a progressive inquiry orientation, a socio-metacognitive orientation and a communal habit of mind. An application of the model is reported and the implication of the findings is discussed.

Keywords: assessment, online discourse, knowledge building, self-directed learning, critical thinking

INTRODUCTION

The use of CSCL in the formal curriculum has been gaining in popularity and importance. The increasing use of online discussions as a means of supporting collaborative learning has also raised the concern and interest of both researchers and practitioners on the issue of how to assess learning outcomes in such contexts. The assessment of learning outcomes have traditionally focused on the learner's mastery of knowledge, skills and understanding in specific subject areas. However, CSCL has often been adopted by educators who value the capacity of the learner to undertake autonomous learning and to problem solve as important outcomes to target. It is thus often the case that conventional methods of assessing learning outcomes are considered as inadequate for use in CSCL contexts. Further, it is often the assumption that social interactions and/or collaboration play an important role in the learning process and influence the quality of the outcome.

It is not surprising to note that much of the literature on assessing learning in CSCL contexts have originated from research in the adult learning area, which has been very much concerned with the concepts of critical thinking and self-directed learning. Another orientation in the assessment of learning outcomes was that of evaluating the quality of argumentation. Different rubrics have been developed on the basis of these conceptualizations of learning to analyze protocols/online discourse collected in computer conferencing systems. Reports on such research have consistently argued for the critical importance of social interaction to the learning process from a theoretical perspective. However, the actual rubrics were designed to assess the quality of the messages posted by individuals. Such assessment can only reveal the quality of individual learning. The contribution of the computer-mediated communication process to the learning outcomes, or indeed the nature of the collaboration and its relationship to learning is not clear.

Analyses of participation and social interaction form another strand of research in CSCL, contributing to our understanding of the social milieu of the learning contexts concerned. However, the educational link between the social interactions and the learning outcomes are not clear. For example, what kind of social dynamic would facilitate learning? Does discussion necessarily lead to enhanced learning? (Gunawardena, Lowe, & Anderson, 1997) reported on an analysis of a discussion forum transcript and concluded that "... the forum, which was perceived as a very valuable learning experience by the participants, was not unlike the type of informal interaction that takes place at breaks or during social activities at face-to-face conferences or professional activities." (p. 427). It is tempting, and yet not valid, to assume that when a group of learners communicates on an electronic platform about the object of their learning, collaborative learning takes place. In other words, there is a need for research to establish a better understanding of the criteria/conditions for learning contexts supported by computer-mediated communication platforms to qualify as CSCL contexts.

This paper argues for the need for assessment tools that can assess learning as group/community level outcomes and that such tools will in turn contribute to a better understanding of CSCL. It then proposes a

framework for such an assessment tool based on earlier work by Law & Wong (2003) that built on Scardamalia & Bereiter's (2003) theory that collaborative knowledge building is a social intentional activity with distinctive characteristics.

ASSESSING SELF-DIRECTED LEARNING AS OUTCOME

As mentioned earlier, many of the assessment rubrics developed for analyzing self-directed learning outcomes have been developed on the basis of literature in the area of critical thinking. For example, Henri's (1992) model for analyzing cognitive learning outcomes was a modification based on Ennis's (1986) taxonomy of 12 cognitive skills related to critical reasoning and consisted of five categories within the cognitive dimension: elementary clarification, in-depth clarification, inference, judgment and strategies. This model was designed for use in analyzing computer conferencing protocol. However, this could equally be used to assess critical reasoning as encapsulated in individual pieces of work. Indeed, it was designed to assess the quality of individual messages in the conference and thus provide information about the learning outcome of individual learners. It does not highlight the social milieu and its significance in relation to the learning outcome. Mason (1992) proposed that the content analysis should illuminate on how the discourse content builds on the contributions from other learners as well as from external sources. For example, has the message content under review built on previous messages? Has it drawn on the author's own experience? Has it referred to relevant materials within or outside the course?

Garrison (1991) developed an interaction analysis model for analyzing online discourse that similarly focused on assessing critical thinking, but at the same time highlighted the social process of negotiation and knowledge co-construction. This model comprised five phases: sharing/comparing, dissonance, negotiation, co-construction, testing and application, which paralleled and built on a conceptualization of critical thinking as a five-stage sequential process: problem identification, problem definition, problem exploration, problem applicability and problem integration. Indicators were developed to assess the stage of critical thinking the learner was in. However, though one can rationally describe the general trajectory of development in problem solving (or inquiry), the processes involved are often cyclic rather than linear. This may be one of the reasons why there were reports on the difficulties in coding the stage of critical thinking (Newman et al., 1997).

As an alternative to developing indicators for each of the stages in critical thinking, Newman et al. (1997), following Henri's (1992) model of identifying surface/deep processing dichotomies, developed 20+ pairs of opposites as indicators for all of the various stages of critical thinking. For example, one pair of indicators for the problem exploration phase was "*welcome new ideas*" and "*squashing, putting down ideas*". These indicators were grouped under 10 headings: relevance, importance, novelty, outside knowledge/experience, treatment of ambiguities, linking ideas, justification, critical assessment, practical utility and width of understanding.

UNDERSTANDING CSCL AT THE LEVEL OF TEAMS

It is evident from the above review that the various assessment methods were underpinned by theories of learning which assume the role of social interactions to be important to the learning process. On the other hand, the exact role played by social interactions in supporting learning has not been addressed adequately in these theories. Gunawardena et al. (1997) highlighted the need to recognize that there are two kinds of knowledge creation taking place, one taking place at the individual level and the other at the group level. They used a patchwork quilt metaphor comprising five phases of negotiation and co-construction (sharing/comparing, dissonance, negotiation/co-construction, testing tentative constructions and application of newly-constructed knowledge) to describe their understanding of the interdependence and interaction between the individual and the social construction of knowledge. According to this conceptualization, each phase represents a higher level of mental functioning and the online discourse can be coded using this model to indicate the level of knowledge co-construction in the message. The co-construction of knowledge is the pattern produced by the *totality of the discourse*. Analyses of online discourse using this model gave support for the argument that collaborative advancement of knowledge is not a "natural" outcome of people working or interacting together. Social knowledge construction perceived as a very valuable learning experience by the participants may be predominantly within the phase of sharing information (e.g. de Laat, 2002). Further, a debate format of online discussion hindered the desire of participants to reach a compromise or synthesis and thus the group's ability to move beyond phase III (Gunawardena et al., *ibid.*).

The five key characteristics summarized in the Collaborative Learning Model developed by Soller et al. (1998, quoted in Soller 2001) to characterize effective collaborative learning interaction also focused on the characteristics of teams rather than individuals: participation, social grounding, active learning conversation skills, performance analysis and group processing, and promotive interaction.

ASSESSING KNOWLEDGE BUILDING OUTCOMES: A FOUR DIMENSIONAL MODEL

Scardamalia & Bereiter (1991) put forward a notion of collaborative knowledge building as a useful paradigm for conceptualizing learning as social practice which resembles the way of life for those on the leading edge of scientific research. Central to this theory is the concept of collective cognitive responsibility for the advancement of knowledge (Scardamalia, 2002). This concept goes beyond the simple sharing of responsibility across members in terms of overt tasks, and places a particular emphasis on the cognitive dimension of the collaboration: “*they will also take responsibility for knowing what needs to be known and for insuring that others know what needs to be known*” (p. 68). Scardamalia (ibid.) observed that cognitive responsibility is harder to maintain than responsibility for tangible outcomes and put together a list of 12 distinctive characteristics that sets off a knowledge building community from other kinds of communities. These 12 characteristic socio-cognitive dynamics are generally referred to as the 12 *Knowledge Building Principles*. Knowledge building is a social intentional activity of a community which by definition cannot be achieved by individuals in isolation. Knowledge building discourse is thus by nature different from ordinary social discourse and demands distinctive characteristics of the technology for its support.

Law & Wong (2003) reported on a set of scoring rubrics to assess the learning outcomes for 43 groups of students from 8 classes that participated in a “Peer Tutoring Project”, which was an online collaborative learning project lasting for about 10 weeks and involving 250 students from five secondary schools in Hong Kong. The online platform used was Knowledge Forum®, which is a collaboration platform specifically designed to embody the technological dynamics necessary to support the emergence of the 12 knowledge building principles. Their analysis found that while in theory all the 12 knowledge building principles are expected to be interrelated and mutually supportive of each other in their development, the emergence of these characteristics as evidenced through the Knowledge Forum® discourse was rather uneven. Further, they found a consistent trajectory in the emergence of these 12 socio-cognitive dynamics. Building on the earlier findings, this paper proposes a four dimensional model of assessing knowledge building outcomes based on the 12 knowledge building principles, and discusses how this model relates to the theoretical discussions and empirical findings in the CSCL literature reviewed (see Table 1 for an overview).

The first dimension is the presence of a *social dynamic conducive to sharing and open exploration of ideas*. This dimension relates to whether the social dynamics as revealed through the message contents is one that welcomes new ideas or conversely a social climate that squashes or puts down ideas (Newman et al. 1997). It reveals the level of achievement broadly within the first two phases in Gunawardena et al.’s (1997) Interactional Analysis Model (the sharing/compared of information and the discovery and exploration of dissonance among ideas) or Soller et al.’s (1998) participation characteristic. The three knowledge building principles within this dimension (community knowledge, collective responsibility, democratizing knowledge and idea diversity) were found to be the earliest to emerge from data collected at an earlier study (Law & Wong, 2003). This can be interpreted as an affirmation of the importance of a conducive social dynamic as a pre-requisite for further knowledge building advances.

A second dimension of group outcome, *progressive inquiry orientation*, relates more closely to the critical exploration of ideas and progressive inquiry, involving the following four knowledge building principles : epistemic agency, knowledge building discourse, improvable ideas and constructive use of authoritative sources. There is a strong similarity between these principles with the characteristics found in phases of dissonance and co-construction of knowledge (Gunawardena et al., 1997) and with the indicators related to linking ideas, treatment of ambiguities, justification and critical assessment used by Newman et al. (1997). However, Scardamalia & Bereiter’s (1991) theory of knowledge building requires that the members of a knowledge building community to set the advancement of knowledge as their explicit goal. This dimension thus also emphasizes on the sense of “agency” or intentionality of the members, and is close to two of Soller et al.’s (1998) characteristics of effective collaborative teams, social grounding and active learning conversation skills. Earlier analysis by Law & Wong (2003) found characteristics within this dimension emerge somewhat later and less effectively compared to those in the first dimension.

The third dimension is the *socio-metacognitive orientation* of the team/community, involving three knowledge building principles, real ideas, authentic problems, rise above, embedded and transformative assessment. It specifies that effective collaboration requires that members engage metacognitively with the inquiry task at hand, transforming authentic problems into researchable questions, formulating more inclusive, higher level conceptualizations as well as engaging continuously in internal assessment as a sustained effort to work at the cutting edge of knowledge. This is very similar to the formulation of the characteristic “performance analysis and group processing” in Soller et al.’s model while also bearing resemblances to some indicators in the other models as presented in Table 1. Characteristics within this dimension are not readily achieved and some groups did not exhibit any of these within the project life-cycle as reported by Law & Wong (2003).

The fourth dimension, comprising the principles pervasive knowledge building and symmetric knowledge advancement, describe characteristics of a community that has already internalized knowledge building as a collective “habit of mind” in that it is not an activity confined to particular occasions or subjects. Stahl (2002) commented that “*Collaborative knowledge building may be a way of life on the leading edge of scientific research, but it has proven devilishly hard to foster in contemporary school classrooms.*” (p. 63). It is perhaps not surprising that in Law & Wong’s (2003) analysis, none of the groups exhibited characteristics indicative of these two principles. There are also no comparable indicators developed in other content analysis schemes in the CSCL literature.

Table 1. A categorization of Scardamalia’s (2002) Knowledge Building Principles, Gunawardena et al.’s (1997) phase of knowledge co-construction, Newman et al.’s (1997) indicators for critical thinking and Soller et al.’s (1998) characteristics of collaborative learning teams into four dimensions of communal learning outcomes in knowledge building.

Dimension of community development	Scardamalia’s (2002) Knowledge Building Principles	Gunawardena et al.’s (1997) phase of knowledge co-construction	Newman et al.’s (1997) indicators for critical thinking	Soller et al.’s (1998) Collaborative Learning Model characteristics
Social dynamic conducive to sharing and open exploration of ideas	<ul style="list-style-type: none"> Community knowledge, collective responsibility Democratizing knowledge Idea diversity 	<ul style="list-style-type: none"> Sharing/comparing of information 	<ul style="list-style-type: none"> Novelty Relevance Outside knowledge/experience Importance 	<ul style="list-style-type: none"> participation promotive interaction
Progressive inquiry orientation	<ul style="list-style-type: none"> Epistemic agency Knowledge building discourse Improvable ideas Constructive use of authoritative sources 	<ul style="list-style-type: none"> Discovery and exploration of dissonance or inconsistency of ideas Negotiation/co-construction of knowledge Testing/modification of proposed co-constructed synthesis 	<ul style="list-style-type: none"> linking ideas treatment of ambiguities justification critical assessment 	<ul style="list-style-type: none"> social grounding active learning conversation skills
Socio-metacognitive orientation	<ul style="list-style-type: none"> Real ideas, authentic problems Rise above Embedded and transformative assessment 	<ul style="list-style-type: none"> Co-construction of knowledge/application of newly constructed meaning 	<ul style="list-style-type: none"> practical utility width of understanding 	<ul style="list-style-type: none"> performance analysis and group processing
A communal “habit of mind”	<ul style="list-style-type: none"> Pervasive knowledge building Symmetric knowledge advancement 			

Table 2. Scores for the mean group score¹ for each of the participating classes on the 4 dimensions of knowledge building learning outcomes based on a re-analysis of data presented in Law & Wong (2003).

Dimension of knowledge building outcomes	Class A (43, 7) ²	Class B (42, 7)	Class C (42, 7)	Class D (45, 8)	Class E (34, 3)	Class F (34, 6)	Class G (19, 4)	Class H (4, 1)	Overall Mean
Social dynamic conducive to sharing and open exploration of ideas	2.05 ³	1.72	1.90	2.10	1.90	1.56	1.67	2.67	1.88 ⁴
Progressive inquiry orientation	1.21	0.93	1.18	1.38	1.50	0.71	1.50	1.50	1.17
Socio-metacognitive orientation	0.62	0.43	0.24	1.17	1.13	0.17	1.33	1.00	0.68
A communal “habit of mind”	0	0	0	0	0	0	0	0	0

¹ The maximum score for each principle is 3.

² The first number inside brackets indicates the total number of students in the class, and the second number indicates the number of groups in the class. The total number of groups participating in the project was 43.

³ The contributions from each group was given a score for each principle, and the class mean score for each dimension was the mean score per principle within the dimension averaged for all groups within each class.

⁴ The overall mean of each dimension is generated from the sum of means of the 43 groups divided by the total number of groups (43).

CSCL discussions are often used to support learning activities that are extended over periods of weeks or months, and it would be very useful if there can be simple tools for formative assessment of online discussions to help teachers in monitoring class progress and implementing suitable facilitation measures. Well designed assessment feedback to learners can provide a better understanding of what makes up a productive online discussion and scaffold collaborative learning. In our earlier work (Law & Wong, 1998), we observed a pattern in the trajectory of emergence of the knowledge building principles in the online discourse of around 250 students in 5 schools. Table 2 presents the re-analysis of that data into the four dimensions described above. The trajectory becomes even more distinctive and consistent.

CONCLUSION

This paper introduced a four dimensional model for the assessment of collaborative learning outcomes at the group/community level based on Scardamalia & Bereiter's (1991) theory of knowledge building built around a central concept of collective cognitive responsibility, compared the similarities of the model with several other models that describe outcomes or characteristics of collaborative teams based on learners' online discourse. It also reported on the findings from an application of the model to a large set of online discourse data which indicates that collaborative teams need to develop a social dynamic conducive to sharing and open exploration before significant progressive inquiry can take place. The findings also indicate that a collaborative team needs to develop a social-metacognitive orientation for knowledge co-construction and a communal habit of mind to advance in its knowledge building capacity. This model needs to be further tested against more extensive data of online knowledge building. It is also hoped that this model will provide a useful framework for assessment knowledge building outcomes at a team level as well as for the development of effective facilitation support to learners engaged in collaborative inquiry.

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