Investigating Students' Epistemologies in CSCL Discourse through Reflective Judgment Model and Practical Epistemologies

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Abstract: Students' beliefs in knowledge and knowing has been studied from different theoretical underpinnings for decades; however, researchers still have difficulties in explaining students' epistemic dynamics in socio-constructivist discourse from epistemological perspectives, e.g. Why some students demonstrate high level epistemic dynamics more frequently than others? This study aims to investigate this phenomenon from two theoretically different perspectives in research on students' epistemology: reflective judgment model and practical epistemologies. Thirty-two grade 8 students' epistemology was measured with King & Kitchener's (2004) reflective judgment model; at the same time Chinn & Malhotra's (2002) "epistemic authenticity" framework was employed to analyze students' practical epistemologies in essays. Analysis was focused on possible relationship between students' epistemological beliefs and their practical epistemologies demonstrated through engagements in computer supported collaborative inquiries discourse. Preliminary findings show students operate at more advanced levels of personal epistemology might be more inclined to engage in CSCL discourse as a socio-constructivist one.

CSCL: Socio-constructivist Discourse for Learning

Computer Supported Collaborative Learning (CSCL), a branch of the learning sciences deeply rooted in socio-constructivist theories, concern with studying how people can learn together for the benefit of increased learning capacity and outcome with the help of computers. In the literature, different socio-constructivist learning theories discern unique forms of learner-discourse dynamics and possible outcome. For example Vygotsky's social learning theory focuses on enhancement of learner's potential with mediation of a more capable peer through language and thoughts within the zone of proximal development. Piagetian socio-cognitive conflict describes the importance of creating disequilibrium in the learner's mind from interactions with others towards accommodation or assimilation of concepts. Situated cognition, like cognitive apprenticeship in Communities of Practice (CoP) (Lave & Wanger, 1991) identifies a specific form of socio-constructivist socialization process where learning of tacit knowledge and social norms specific to a community can only be achieved through legitimate peripheral participation within the socio-cultural environment. Last but not least Collaborative Knowledge Building (KB) (Bereiter & Scardamalia, 2005) explains the social origin of new knowledge or progression of ideas and theories, through knowledge works that treat knowledge as semi-autonomous artifacts that could be worked on collaboratively like real artifacts. To summarize, different socio-constructivist theories outline different forms of socio-constructivist interactions and dynamics between learners and the discourse; hence, post different assumptions and expectations on the engagements from their participants. Suggested by Kanselaar (2002), individual's engagement in socio-constructivist learning environments involves at least three aspects of learners' epistemological beliefs, including 1) nature of knowledge, 2) beliefs about learning and cognition, and 3) pedagogical beliefs about the best way to support learning. Kanselaar (2002) argues that variations among these aspects of beliefs form a "loosely coupled system" that serves as the basis of learners' epistemic engagement and potential outcome in socio-constructivist learning.

Reflective Judgment and Socio-constructivist Dynamics in CSCL

Personal epistemology is the field of research that specializes in investigation of one's beliefs in knowledge and the knowing process, and characteristics of people's epistemic behavior. King & Kitchener's reflective judgment model (RJM) (2004) describes a complex network of developmental progression of epistemological assumptions that late adolescents and adults rely on for making judgments about ill-structured controversial issues that cannot be solved by formal logic alone from four epistemic dimensions, including nature of knowledge, concept of justification, role of authority, and role of evidence, which is suitable to be applied to investigate learner-discourse epistemic dynamics in socio-constructivist discourses. The reflective judgment model describes seven levels of increasing sophistication in reflective thinking reasoning styles, which, could be summarized into three broad categories: pre-reflective, quasi-reflective, and reflective thinking. In pre-reflective thinking (stage 1-3 of RJM), people believe knowledge is gained through authorities or firsthand observations; while they believe what they know is absolutely correct and certain, no justification is required. In quasi-reflective thinking (stage 4-5 of RJM), people reason with assumptions that knowledge claims contain elements of uncertainty, thus tend to view judgments as highly idiosyncratic. In reflective thinking (stage 6-7 of RJM), people accept that knowledge claims cannot be made with certainty, so any judgments could only be "most reasonable" and "reasonably certain" based on a variety of interpretive considerations. Conclusions thus are

defended as representing the most complete, plausible, or compelling understanding on the basis of available evidence, of which Zeidler et al. (2009) argue are consistent with nature of science (NOS) claims.

Student's Practical Epistemologies in Socio-constructivist Discourse

Argued by many (e.g. Bereiter & Scardamalia, 2005; Sandoval, 2005; Zeidler et al., 2009), mature scientific inquiry works resemble socio-constructivist epistemic dynamics in many ways. Sandoval (2005) suggests investigating 'practical epistemologies' that students bring into situations of inquiries. Practical epistemologies are highly contextualized epistemological ideas that students develop from their practical experiences through attempts to make sense and explain the world they live in; thus these epistemological ideas would re-surface in students' subsequent scientific inquiries. Sandoval (2005) suggests students' practical epistemologies could be evaluated by the epistemological authenticity framework (Chinn et. al, 2001; 2002), which argues the underlying structure of authentic scientific inquiries are fundamentally different from scientifically unauthentic ones in terms of connections that link ideas and inquisitive acts together. In brief, Chinn et al. suggested four kinds of epistemic connections to be varied between authentic and un-authentic inquiries; they are causal, inductive, analogical, and contrastive connections. Chinn et al. (Chinn & Brewer, 2001; Chinn & Malhotra, 2002) illustrated that the kind and combination of epistemic connections involved in scientifically authentic and unauthentic inquiry tasks are very different.

Other than epistemic connections, some researchers approach argumentative discourse acts in socio-constructivist learning discourses from the perspective of informal reasoning, arguing informal reasoning are as important as formal logic towards scientific progression (Sadler, 2004; Zeidler et al., 2009). Law, Yuen, Wong & Leng (2011) have investigated students' use of argumentative and question discourse markers in collaborative knowledge building discourses, and found qualitative and quantitative differences in the usage of discourse markers between inquiry threads which has and has not achieved idea progressions.

Summary & Research Questions

To summarize, socio-constructivist learning theories explains how collaborative learning happens through outlining different forms of socio-constructivist interactions and discourse dynamics between learners and the cultural environment. Specific theories post specific assumptions and requirements on participants' beliefs on knowledge, learning process, and desirable epistemic dynamics. As a result, investigating CSCL participants' beliefs on knowledge and knowing, and whether their epistemic engagement match with those outlined in specific learning discourse would greatly inform researchers about the question why some students would demonstrate high level epistemic dynamics more frequent than others? This study proposes and investigates the possible relationship between students' epistemology and their epistemic engagements in a socio-constructivist learning discourse, i.e. whether students who have more advanced epistemological beliefs be more inclined to engage in the CSCL discourse as a socio-constructivist one.

Context of Study & Methodology

This study investigates 32 grade 8 students' epistemic engagements in a learning module of integrated humanities conducted over 15 weeks. The curriculum design of the module reflects the school's strong emphasis on developing students' epistemic developments through collaborative inquiry learning, like deepening of students' understanding on the tentative and improvable nature of knowledge, and inquiry as a theory building process. The activity of the learning module is "planning of building a new tourist attraction for Hong Kong", where four stages of on and offline activities were designed by the teacher and the researcher towards students' understanding on *idealism and materialism*, two theories that explain development of civilizations. In this learning module, Knowledge Forum (KF) was used as the online collaborative platform to facilitate discourse dynamics. Three sources of data have been collected and analyzed to investigate the possible relationship between students' epistemological beliefs and epistemic engagements in the online discourse.

First, students' level of personal epistemology was measured by a questionnaire instrument designed by the author, based on the reflective judgment model by King & Kitchener in a format similar to the Reasoning for Current Issues (RCI) test (King & Kitchener, 2004). Two tests with topics related to the module (ecological footprint and natural/cultural conservation) have been designed and both distributed as pre and post test. Individuals' levels of reflective judgment (RJ) as measured from pre and post tests were calculated from students' choices and ranks to the items.

Qualitative analyses have been conducted on logs of Knowledge Forum® discussions to investigate students' usage of argumentative and questioning speech acts (Law, Yuen, Wong & Leng, 2011). The speech acts and related specific discourse markers used in the analysis are:

Category	Speech act	Discourse markers coded
Argumentative	Claim	I think, I agree, we should
	Disagreement	I don't think, I didn't think, I do not think, I don't agree, …
	Reason	because, since
	Elaboration	moreover, such as
	Condition	if
	Contrast	but, though, although, however, even, otherwise
	Consequence	then, thus, so, therefore
Question	Explanatory	how, why
	Factual	what, is there, are there, where, who, whom

By the end of the learning module students have to hand in individual essay on their view towards idealism and materialism. The teacher has introduced a writing framework for the essay. This essay is a class work, and students have 2 one-hour lessons to finish it. Students' usages of epistemic connections in the essay, e.g. causal, inductive, analogical, and contrastive (Chinn & Malhotra, 2002) have been analyzed and coded:

Analysis & Results

Figure 1 presents one possible interpretation of data collected. In the figures, students are sorted by their measured level of reflective judgment from post test, from low to high.

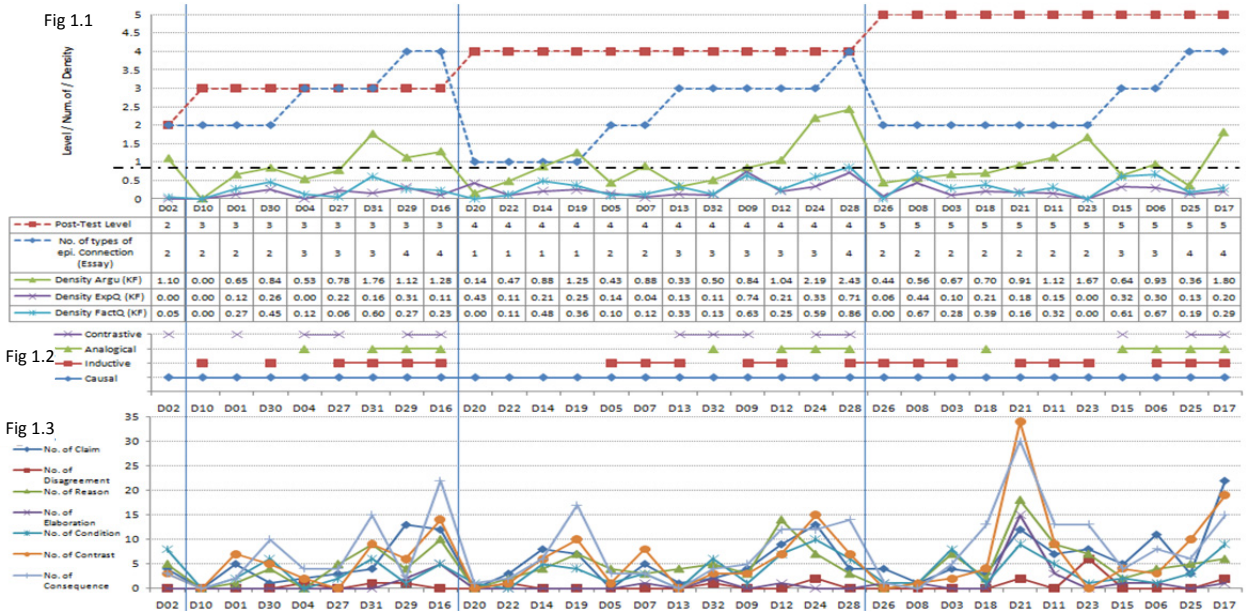

Figure 1.1. Measured level of reflective judgment from post test; Number of types of epistemic connection used in students' final essay, & Densities of argumentative and question discourse markers; Figure 1.2. Types of epistemic connection used in students' final essay; Figure 1.3. Breakdowns of individual's usage of argumentative and question markers in numbers.

Students' Epistemology Approached as Separated Perspectives

Figure 1.1 presents data of individual students from all three sources of data collected. The first is the level of reflective judgment from post test (red dashed line with squares). Cronbach alpha of pre and post test of questionnaire instrument is 0.784. The second is the number of types of epistemic connections used in student's module essay (blue dashed line with diamonds), which informs epistemic authenticity of students' inquiry in their essay. From figure 1.1, only 5 students (D16, D17, D25, D28, & D29) have used all four types of epistemic connections in their essay. Figure 1.2 present breakdowns of types of epistemic connection found in individual student's essay. From the plot, causal is the most common type of connections found in students' essays.

The third group of data presented in figure 1.1, densities of argumentative and question discourse markers used by individual students in his/her notes on the KF, are conceived as indicative of students' informal reasoning at inquiry and engagement in the CSCL discourse. In general, students' densities of argumentative markers (green line with triangles) are higher than densities of both question markers (light blue & purple lines).

Table 1: Mean densities of markers by students' measured post test levels.

Post Test Level	No. of students	Mean den. of Argu markers	Mean den. of Expl Q markers	Mean den. of Fact Q markers
Pre-reflective (2-3)	9	0.89	0.13	0.23
Quasi-reflective (4-5)	23	0.92	0.24	0.33
Class Median	32	0.84	0.17	0.27

Interestingly, students who operated at quasi-reflective thinking in post test (level 4-5) have higher mean density of argumentative and question markers in their KF postings than students at pre-reflective levels

(level 2-3) (table 1). At the same time, in general students who have used more types of epistemic connections also have higher densities of argumentative or question markers, e.g. student D31, D24, D28, D17. In general, positive relationship exists between mean densities of argumentative markers used on KF and number of epistemic connection used in students' essay (table 2).

Table 2: Summary of mean densities of three categories of discourse markers.

No. of types of epistemic connection used in essay	1	2	3	4
No. of students	4	13	10	5
Mean density of Argu markers used in KF	0.69	0.77	0.95	1.4
Mean density of ExplQ markers used in KF	0.25	0.13	0.25	0.29
Mean density of FactQ markers used in KF	0.24	0.22	0.40	0.37

Figure 1.3 offers an expanded view on the number of each kind of argumentative speech acts identified from individual student's postings on the KF. From the chart, no student's usage and pattern of argumentative speech act is similar to each other. In general, students who have higher than class median density of argumentative markers (figure 1.1 black dash dotted line) tend to use more number of claims, contrast and consequence speech acts, while patterns could hardly be perceived among students who have lower than class median density of argumentative marker.

Students' Epistemic Dynamics in CSCL Discourse and Individual Essays

The three vertically aligned charts (figure 1.1-1.3) afford to be read vertically for profile view of individual student's epistemology from the three sources of data. Table 3 summaries and put them in groups according to three criteria: 1) Density of argumentative markers in students' postings on KF, 2) Pre and post test difference in level of reflective judgment, 3) Number of types of epistemic connection used in final essay.

First of all, there are certain degrees of similarities among students who have used all four types of epistemic connections in their essay. Five students, D29, D16, D28, D25, & D17 belong to this category. In terms of measured level of reflective judgment between pre and post tests, results show two out of the five students have increased level of reflective judgment, two decreased and one held constant (table 3); still, all of them have operated at level 4 (quasi-reflective) or above in either pre or post test. Also, except student D25, they all have higher than class median (0.84, black dash dotted line, figure 1.1) density of argumentative markers in KF discussions. Furthermore, breakdowns of their usage of argumentative markers are quite similar (*claims*, *contrast* or *consequence)* upon close examination (figure 1.3).

Table 3: Relationship between measured RJ and density of markers.

Density of Argu Markers	Pre & post tests diff. in levels of RJ	No. of epistemic connection used 1	2	3	4	Total
Above or equal to class median 0.84	Increase	1	2	2	1	6
	Constant	-	3	1	1	5
	Decrease	1	1	2	2	6
Below class median 0.84	Increase	2	2	-	1	5
	Constant	-	3	2	-	5
	Decrease	-	2	3	-	5
	Total	4	13	10	5	32

On the other hand a group of four students have used "causal" connection only to connect ideas in their final essay, including students D20, D22, D14 & D19. Although all of their measured level of reflective judgment are at level 4 (quasi-reflective) from the post test, in fact three students have increased and one has decreased from their previous levels (table 3). In details, their engagements on the KF are quite different among themselves. Student D14 & D19's densities of argumentative and question markers are above class medians, while for D20 & D22 the relevant densities are all below class medians. Usages of argumentative markers also distinguish the two pairs from each other. For student D14 & D19, *claim*, *consequence* and *contrast* are the top three most used markers. On the contrary, there are barely any argumentative markers used by student D20 & D22 in the KF discourse.

For students who have used 2-3 types of epistemic connections in essay, there are almost equal numbers of students who have higher (11 students) or lower (12 students) than class median density of argumentative markers on KF (table 3). Students who have higher than class median density of argumentative markers in 2-3 connection-types groups (e.g. student D31, D12, D24, D06) tend to have used larger number of *claim*, *contrast*, *reason* and *consequence* markers, similar to students who have high argumentative markers density in the 4-types group. Furthermore, usage of kind and number of argumentative markers are very different between them (figure 1.3).

Discussions

In this exploratory study possible relationship between students' epistemic beliefs and practical epistemologies brought into socio-constructivist discourse and essays have been studied from 1) Measured changes in level of reflective judgment, 2) Densities, number and types of argumentative markers used in KF, and 3) Numbers and types of epistemic connections used in final essay.

First of all, the assumption of a possible relationship between students' level of reflective judgment and epistemic dynamics in socio-constructivist discourse was shown to be positive at preliminary level. In this exploratory study, data from questionnaire and KF suggest that students who operate at quasi-reflective thinking levels (4-5) of reflective judgment have higher mean densities of argumentative and questions markers (table 1) than students who operate at pre-reflective thinking levels (2-3). To explain the differences, King and Kitchener's reflective judgment model suggest that people who operates at pre-reflective thinking believe what they know and think are absolutely correct and certain hence no justification is required, while people at quasi-reflective thinking levels hold the beliefs that knowledge claims contains elements of uncertainty and idiosyncrasy. As a result, students at quasi-reflective levels see greater needs in making sense out of uncertainties in others' claims and ideas on the CSCL discourse, while students at levels 2-3 do not treat such sense-making acts as their primary concern in the collaborative learning discourse.

On the other hand students' uses of argumentative markers as process indicators also show its functions in the investigation of student epistemology in socio-constructivist discourses. Argued by Chinn et al. (2001; 2002), the more scientifically authentic an inquiry task is, the more kinds of epistemic connections could be found to connect or link ideas, procedures and experimental conditions together that meets scientific standards. In this study individual students who have used more types of connections in essay were found using a higher density of argumentative markers in KF (table 2 & figure 1.1), suggesting students may see the CSCL discourse as venue for epistemic engagements towards a progressive discourse somewhat similar to scientific inquiry. The findings also inform Sadler's (2004) argument for the importance of informal reasoning in collaborative discourses to scientific inquiry progresses.

To summarize, preliminary findings of this study show that students who operate at more advanced levels of personal epistemology in the reflective judgment test instrument and personal essay might be more inclined to perceive and engage in the online CSCL discourse as a socio-constructivist one, as reflected from usages of discourse markers. However, these findings are far from conclusive towards the question posted at the beginning. The methodology applied is inadequate in terms of breath of indicators and depth of analysis to obtain a fuller picture of individual's network of reflective judgment beliefs from complex stage theory (King & Kitchener, 2004) point of view. Further, there are possibilities students hold context specific epistemological beliefs that lead to different epistemic behaviors in different learning discourses. Last but not least, the coding scheme on types of epistemic connections applied to students' essays could be further enriched to capture more specific usage of words or argumentative markers. Certainly more in depth research on these are required.

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