Examining Regulation of Knowledge Advancement Using Portfolio Assessment

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Abstract: This paper examined students' knowledge building and literacy in Knowledge Forum®, and specifically investigated students' collective regulation on knowledge advancement through portfolio assessment. Participants were 40 grade-nine students studying the classical Chinese novel *Romance of the Three Kingdoms*. They asked questions, developed explanation, and deepening their inquiry using portfolio assessment with metacognitive prompts to reflect and monitor their own and the community's idea growth and knowledge advances. Pre- and post-tests of domain knowledge revealed significant improvement. Qualitative analyses of portfolio notes in Knowledge Forum® identified several patterns of self-regulation, co-regulation and collective regulation; portfolio notes were also analyzed for knowledge building principles. Correlation analysis showed that regulation moves were significantly related to posttest domain scores and high-level explanation. Hierarchical regression analysis showed that knowledge building principles and regulation contributed to domain scores over and above prior knowledge and explanation scores. Implications of examining social and collective regulation for knowledge building and knowledge advances are discussed.

Keywords: knowledge building, regulation of learning, CSCL discourse, portfolio assessment

Introduction

Knowledge building, an educational model in computer-supported collaborative learning (CSCL) and the learning sciences (Scardamalia & Bereiter, 2006), postulates collective cognitive responsibility and adding value to the community. In the last two decades, substantial research evidence has revealed positive effects of designed knowledge building environment on student' inquiry and knowledge advances (Chan, 2013; Chan & Lam, 2010; Hakkarainen, 2004; Lee, Chan & van Aalst, 2006; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2009). Though much research has demonstrated the importance of CSCL and knowledge building, merely "putting students together" is not sufficient for bringing about effective collaborative learning and knowledge building (Chan, 2012). The use of principles rather than procedures in pedagogical designs for knowledge building (Scardamalia, 2002) is familiar in the learning sciences, but there is still a need to examine how students regulate their knowledge building and knowledge advancement both at individual level and collaborative levels. Relationships between understanding of knowledge building principles and metacognition and regulation activities also need to be examined further. In addition, in many literature, task-based activity was the context for regulation of learning, and the various types of tasks were explored in investigating its effects on students' regulation strategies using (Janssen, Erkens, Kirschner, & Kanselaar, 2012; Malmbery, Järvelä & Kirschner, 2014). However, in the current study, the main focus is more on the regulation of knowledge advances in an idea-centered context. The purpose of this study was to examine a portfolio design intended to help students to reflect and regulate their understanding and knowledge advances in a knowledge building environment, and to investigate the relationships among the regulation of learning, understanding of knowledge-building principles and domain understanding.

Theoretical Perspective

Regulation of learning and computer-supported collaborative learning

In the last two decades, considerable research has been conducted on students' regulation of learning in computer-supported collaborative learning environments. Research has revealed positive effects of self-regulated learning (Azevedo & Hadwin, 2005) and of technology use on students' regulation of learning (Winne et al., 2006). According to Hadwin, Järvelä and Miller (2011), regulated learning is an indispensable skill for successful collaborative learning. And it is not only regulation of their own learning, students also need to regulate learning with group members at the group level (Järvelä & Hadwin, 2013). Recent, research on regulation of learning in CSCL environments has expanded from self-regulated learning to socially shared regulation. Järvelä and Hadwin (2013) postulated a framework and proposed that self-regulated learning (SRL), co-regulated learning (CoRL),

and socially shared regulated learning (SSRL) are three distinctive types of regulated learning. A learner will regulate his or her own learning; or he or she will help regulate learning of a group member; or learners also construct shared goals and comment on each other's ideas at a group level. Research studies have designed technological tools in a CSCL environment to support students' regulation of learning. For example, a software system called gStudy was designed to support students' regulation both at individual and collaborative levels by using various tools (Winne et al., 2006). Although increased attention has now been given to explore regulation of learning in CSCL environments, few studies have examined students' regulation of learning activities in a knowledge building environment (an exception: Cohen & Scardamalia, 1998). Cohen and Scardamalia (1998) demonstrated that Computer Supported Intentional Learning Environment (CSILE) could scaffold students to monitor and regulate others and groups ideas. How do students regulate their knowledge building efforts personally and collectively to advance the knowledge of their community are interesting questions to examine.

Knowledge building, collective regulation and assessment

Knowledge building was adopted as the research framework in the present study. Knowledge building emphasizes collective cognitive responsibility and communal efforts to advance a community's knowledge (Scardamalia, 2002), which is one of the significant distinctions between learning and knowledge building. This emphasis on advancement of community knowledge is one of the most important distinctions between learning and knowledge building (Bereiter, 2002). In knowledge building communities, ideas are viewed as conceptual artifacts which can be sustainable improved and the production of knowledge is regarded as a social product (Scardamalia, 2002). Knowledge Forum® (KF) is an online environment that is designed to support the discourse of knowledge building. Scaffolds, embedded in Knowledge Forum®, are used as a meta-cognitive prompts to help students to organize their notes in a knowledge building way, such as "I need to understand", "My theory", and "Putting our knowledge together". Over the years, empirical research has shown the effects of knowledge building environment on students' learning. For example, Chan and Lam (2010) examined the effects of knowledge building environment on students' epistemological beliefs and conceptual changes, and results indicated that students in the experimental group performed better than their counterparts. Hakkarainen (2004) carried out content analysis of computer notes written by 10-year-old students who were studying electricity, and showed that the young children could be engaged in epistemic agency and moved towards to explanation-seeking inquiry.

Collective cognitive responsibility and communal efforts are essential features of knowledge building: it emphasizes social and collective growth of learning. In addition, collective regulation of learning also focuses on shared tasks and shared goals and it includes group members' shared efforts and collective regulatory activities (Järvelä & Hadwin, 2013). Both knowledge building and shared regulation pays attention to the collective aspects of learning. Moreover, the metacognitive scaffolds, which are embedded in Knowledge Forum®, support reflective and collective aspects of regulation. For example, the scaffold "Putting our knowledge together" helps students to regulate their learning and understanding collectively and improve their awareness to make advancement for the whole community. Research in knowledge building has also elucidated the role of assessment designs in scaffolding students toward knowledge advances: When students wrote knowledge-building portfolios, they need to reflect on their personal and collective inquiry; consider what had been accomplished, and chart further questions to pursue (Chan & van Aalst, 2006). Portfolio included charting of knowledge-building trajectories and would be useful scaffolds and assessment tools for examining how students regulate their own and collective knowledge-building inquiry.

In many previous researches, questionnaire surveys, videotapes and interviews were often collected as the data sources in examining students' regulation strategies in the task-based activities (Kaplan, Lichtinger, & Margulis, 2011; Rogat & Linnenbrink-Garcia, 2011). However, in this study, the unit of analysis is students' portfolio notes on Knowledge Forum®. Accordingly, the goal of the present study was to characterize students' regulated learning strategies for knowledge-building inquiry and knowledge advancement through examining portfolio reflection, and to investigate the relations among knowledge building participation, collective regulation, knowledge building principles and domain understanding. Specifically, three research questions were addressed: (1) Did students change on their conceptual understanding, and specifically did they change from pretest to posttest domain scores, and did they improve on the quality and explanation of Knowledge Forum® notes? (2) What characterized the different patterns of regulation and how was self-regulation, co-regulation and collective regulation manifested in portfolio reflection? (3) What were the relationship among knowledge building principles, regulation strategies, Knowledge Forum participation, and domain understanding?

Methods

Participants and procedure

Forty Grade 9 students in a Chinese language and literature class in a Hong Kong public school participated in this study; the school's academic performance was average (Band 2 in a 3-band system). Students studied and engaged in a knowledge building environment and wrote notes on Knowledge Forum®. The teacher had five years of experience using knowledge-building in his teaching.

Design of a knowledge-building environment for regulation processes

The pedagogical design was adapted from previous studies that applying knowledge building pedagogy in Hong Kong schools (Chan, 2011). We aimed to provide a knowledge building environment to help students engage in a collaborative learning environment that treats their ideas as improvable, encourages advancement of community knowledge and helps students to regulate their learning and knowledge advances especially the collective regulation of learning. The specific designs are described below:

(1) *Developing a collaborative classroom culture*. Because of the different cultural background and the influence of Confucius, Asian students are familiar with the teacher-led lectures teaching. It is important to design a collaborative culture which can help students to be involved in the knowledge building environment making ideas visible for improvement and taking collective cognitive responsibility (van Aalst & Truong, 2011). Students took part in collaborative inquiry by asking questions and posing ideas on a knowledge building wall (KB Wall) that helped them to make their ideas become public. Knowledge building principles were also introduced into classroom discourse so students began to understand more about idea improvement and collective growths.

(2) *Scaffolding knowledge building inquiry in Knowledge Forum*®. Knowledge Forum® and its basic functions were introduced to students at the beginning of the study. Then students started to ask questions and generate ideas on Knowledge Forum®. As well, students continued to work together and discuss in groups. Metacognitive scaffolds, such as "I need to understand", "My idea", were provided in Knowledge Forum to help students increase their awareness of metacognitive thinking and to help them plan and monitor their idea improvement.

(3) *Deepening knowledge building discourse*. In order to help students to engage deeply in knowledge building discourse and knowledge advances, the teacher worked together with students to inquired into Knowledge Forum® discourse and identified areas that need deepening and further inquiry. After that, students continued to write notes on Knowledge Forum and revise their initial ideas. Knowledge building principles were also discussed by students. Students identified clusters of notes on Knowledge Forum® and analyzed them using the knowledge-building principles. These 'rise-above' inquiries can help students to monitor and to understand deeply of their notes based on principles.

(4) *Understanding knowledge building processes and regulation through portfolio assessment*. Students were asked to write learning portfolios to reflect their learning and progress; a portfolio assessment was designed to reflect students' regulation activities and knowledge building processes (Lee et al., 2006). Students were required to select some cluster of their own and others' best notes that deepen their content and metacognitive understanding; as well, they were also asked to monitor what knowledge advance they have made both in domain understanding and discussion on Knowledge Forum®. Specifically, different metacognitive scaffolds were provided to help students develop their portfolio notes, including "What I thought initially", "What we inquired and discussed", "Putting our knowledge together", and "What we have learned".

Measures

Multiple sources of data were collected and a mixed-method analysis was adopted. Quantitative analyses was used to examine students' pretest and posttest on domain knowledge as well as the relations among domain knowledge, knowledge building and regulation of learning. Qualitative analysis was used to assess students' discourses and portfolio notes on Knowledge Forum®.

Domain knowledge

At the beginning of the first session, students did a pretest on domain knowledge that they were asked to write their initial understanding about the novel. At the end of the last session, students also wrote what they had learned about the novel in the portfolio note as posttest domain knowledge. For pretest, a 4-point scale was used to analyze, and another 4-point scale was used to analyze posttest on students' understanding of the novel ranging from fragmented to explanatory responses. Students' domain knowledge include both personal and collective understanding of what they learned about the novel.

Knowledge Forum participation

Students' participation and their interaction on Knowledge Forum® was analyzed using the Analytic Toolkit (ATK) for Knowledge Forum (Burtis, 1998); this is assessment software embedded in Knowledge Forum. The ATK provides quantitative indices about students' activity on the database. In the present study, four main factors were selected to provide quantitative indices of students' engagement and collaboration on Knowledge Forum: number of notes created, percentage of notes read, percentage of notes linked and number of different scaffolds used.

Depth of inquiry and depth of explanation

Students' questions and explanations in forum notes were analyzed. Student writing was first parsed into inquiry thread for tracking idea development and then individual notes were analyzed. Students' questions and responses were coded on two separate coding schemes that adapted from previous study on knowledge building (Lee et al., 2006).

Knowledge building portfolio notes

Students were asked to construct an e-portfolio note at the end of the last session. They were required to select some of the best clusters of notes, and to write explanations of what they had learned from them. This measure has been used in various previous studies to examine students' individual and collective knowledge advances (e.g. Lee et al., 2006; van Aalst & Chan, 2007). In the present study, scaffolds including "What I thought initially", "What we inquired and discussed", "Putting our knowledge together", and "What we have learned" were used in the portfolios. Based on top-down and bottom-up analysis, a new coding scheme that focused on students' regulation activities including self-regulation, co-regulation, and collective regulation was designed. Portfolio notes were also coded based on four knowledge building principles including diverse ideas, idea improvement, rise-above and constructive use of information.

Analysis and Findings

1. Difference in Pre and posttest on domain knowledge

A paired sample t-test was conducted to analyze students' pretest and posttest on domain knowledge. Results indicated there is a significant difference of pretest and posttest on domain knowledge. The mean and standard deviation of pretest score and posttest score were 1.48 (.55) and 2.23 (1.03); t (39) = 4.713, p<.01. A second rater was trained and coded 30% of the domain knowledge from each of the pretest and posttest. Cohen's Kappa was K=.760, P<.001 for pretest, and K=.736, P<.001 for posttest, indicating an acceptable inter-rater agreement.

2. Students participation on Knowledge Forum

Knowledge building participation (ATK indices)

The Analytic Toolkit (ATK) provides an overview of students' participation and degree of activity on Knowledge Forum. Over one month period, there were 159 notes. The percentage of notes linked was 63.20%. The size of build-on trees included 15 small clusters (2-5 notes), 3 medium cluster (6-20 notes), 1 large clusters (21-40 notes), and 1 very large clusters (over 40 notes).

Depth of inquiry and depth of explanation

Students' notes on the Knowledge Forum were examined to investigate the quality of students' questions and explanations. 47 notes were classified as questions and 133 notes were identified as explanations. When a note included both questions and explanations, it would be treated as two separate notes if the note contained different ideas or topics; otherwise, it would be regarded as one note. Table 1 and table 2 showed the coding scheme in assessing the depth of inquiry and depth of explanation, respectively.

Table 1: Coding scheme for depth of inquiry

Level	Description
1	Asking fact-seeking questions on definitions and simple explanation
2	Asking questions for general information
3	Asking open-ended questions with different viewpoints
4	Asking explanation-seeking questions, focusing on possible explanations and further discussion

Table 2: Coding scheme for depth of explanation

Level	Description
1	Repeating an existed statement or only giving isolated responses
2	Providing general description and factual information
3	Giving explanations with evidence and specific relevant examples
4	Putting different points together, highlighting key conceptual problems and giving personal reflections for further inquiry

Table 3 showed the percentage of notes on questions and explanations at each level during period 1 (the first two weeks) and period 2 (the last two weeks). The results indicated that students made progress in constructing higher level questions and explanations from period 1 to period 2. To test the inter-rater reliability, the same rater who coded the test on domain knowledge was independently coded 30% of the notes from each of the questions notes and explanations notes. Cohen's Kappa was K=.800, P<.001 for depth of inquiry, and K=.825, P<.001 for depth of explanation, indicating a good inter-rater agreement.

Table 3: Percentage of questions and explanations on Knowledge Forum for period 1 and period 2

Level	Percentage of Questions		Percentage of Explanations	
	Period 1	Period 2	Period 1	Period 2
Level 1	14.29%	3.85%	18.33%	6.85%
Level 2	66.67%	53.85%	50.00%	47.96%
Level 3	9.52%	34.62%	26.67%	42.47%
Level 4	4.76%	7.69%	1.67%	2.74%

3. Characterization of regulated learning and relations among KB measures

Knowledge building portfolio notes

Table 4: Coding scheme for regulation of learning

Code	Sub-code	Description
Self-regulation	Metacognitive (low)	Simple prior knowledge activating noted what they thought earlier and what they knew now at a superficial level
	Metacognitive (high)	Detailed prior knowledge activating reflected on what they thought earlier and what they knew now with explanation
	Questions asking (low)	Fact-seeking questions asking; monitor knowledge understanding (simple questions)
	Questions asking (high)	Explanation-seeking questions asking; monitor knowledge gaps (explanation seeking)
	Reflection (low)	Reflecting on what had learned from discussion with simple explanation
	Reflection (high)	Reflecting on what had learned from discussion with detailed explanation and example
	Continued questions asking	Continued to ask questions for further discussion
Co-regulation	Appraising	Appraising other students' notes with simple description
	Reference	Reference to other students' notes to advance understanding
Collective regulation	Collective understanding (low)	Putting group discussion together and summarizing it with simple explanation
	Collective understanding (high)	Putting group discussion together and summarizing it with detailed explanation
	Meta-discourse	Explaining how the group has progressed and evaluated benefits of community inquiry; identified what advances have been made

Qualitative analysis of students' portfolio notes revealed students' regulation of learning and knowledge building engagement. Analyses of portfolio notes were conducted and different themes of regulation emerged. There were three main themes: self-regulation, co-regulation, and collective regulation with different sub-codes for high level and low levels. Table 4 showed the detailed coding scheme for the portfolio notes.

Three examples are provided here to illustrate students' self-regulation, co-regulation and collective regulation in the knowledge building environment (Table 5). Moreover, four examples are also provided to explain students' knowledge building processes with knowledge building principles (Table 6).

Table 5: An example of students' portfolio note on self-regulation, co-regulation and collective regulation

Regulation patterns	Examples
Self-regulation	3C26 *<My question and opinion> Earlier I though the novel is about the war and people fight with each other to expand the territory. <What I have learned> Later I thought that the novel is about the theme of humanity and loyalty through the discussion. And I also learned the conditions for a good discussion.*
Co-regulation	3C15 *<Putting our knowledge together> No. 08 student think Romance of the Three Kingdoms is a novel about loyalty which is one of the characteristics of Chinese. I really appreciate the note because it found the themes of the book and generate a good title, it also solve the problem that I did not understand initially. It will be more persuasive if more evidence provided.*
Collective regulation	3C40 *<Putting our knowledge together> Most of the students think that the main theme of the novel is loyalty. For example, Kong Ming live in seclusion, but why he helps Liu Bei? For loyalty? For peace of the world? Or any other reasons? In addition, we get to know various different essential themes of the novel through our group discussion compared with our initial ideas about the novel.*

As the examples in table 5 shows, firstly, student 3C26 generated his questions in the beginning and evaluated what he had learned and how his initial opinion has changed from the discussion. For example, he though the book is about war, but later on he thought that it is about the humanity and loyalty after discussion ("*Earlier I though…Later I thought…*"). Secondly, student 3C15 identified and appraised his group member's notes and monitored what this note made his think his initial questions as well as how the note could be better. For example, he appreciated No. 08 student's notes because he found the themes of the book as well as solve his initial questions ("*I really appreciate the note because…it also solve the problem that I did not understand initially. It will be more persuasive if more evidence provided*"). Lastly, student 3C40 showed an example of regulated learning at a collaborative level. For example, he provided what themes the group discussed and summarized. And then he showed examples related to the novel and ask questions for further discussion. Furthermore, he explained how his group has progressed and what advances they made ("Most of the students think…for example…but why…or any other reasons…we get to know…through our group discussion compared with our initial ideas…"). In summary, the three examples revealed students regulated learning at individual, peer, and collaborative level in the knowledge-building environment.

In addition, we also analyzed the portfolio notes for how students reflected on their discourse to illustrate knowledge-building principles. In the examples that showed in table 6, student 3C38 mentioned the importance of different views in a group discussion, especially the ideas contrasting to it ("*there is a necessary to have different views including ideas contrast to it…a good discussion need at least two opposed opinions…*"). Student 3C01 mentioned what they learned about good discussion and how to make ideas improved ("*Many of us think that…our group members said that we need to make ideas better and better…to further our discussion*"). Student 3C26 paid attention to the significance for higher level concepts and discussions ("*…to construct higher level discussion and ideas*"). Student 3C40 referred to the importance of constructive use of authoritative sources ("*we can use some authoritative sources to support our idea*"). In short, the four examples showed how students engaged in knowledge building process based on the knowledge building principles. A second rater coded 30% of the portfolio notes, Cohen's Kappa was, K=.886, P<.001, indicating a good inter-rater agreement.

Table 6: An example of students' engagement in knowledge building processes based on four principles

Knowledge building principles	Examples
Diverse ideas	3C38 *In the discussion, there is necessary to have different views including ideas contrast to it, and then students need to summarize other group members' ideas and make the direction of discussion more clearly. Meanwhile, a good discussion need at least two opposed opinions or ideas so that students can continued to provide evidence to further discussion.*
Idea improvement	3C01 *We discussed a lot about what we learned about good discussion. Many of us think that good discussion means go into deeper layers. Our group members said that we need to make ideas better and better and to provide more evidence to further our discussion.*
Rise-above	3C26 *We learned how to summarize others' ideas, and then contribute our own ideas to construct higher level discussion and ideas. Furthermore, we also need to question others' notes because questions can make deeper discussion.*
Constructive use of information	3C40 *In the discussion, we can use some authoritative sources to support our idea and make our ideas become more reasonable.*

Relations between knowledge building, regulation of learning and domain understanding

Correlation analyses were conducted to investigate the relationship among regulation of learning, knowledge building and domain understanding (Table 7). First, factor analysis was conducted for the ATK indices. Two factors were extracted including Factor One (KF ATK including notes created, notes read and notes linked), which explained 44.4% of variance; and Factor Two (KF Scaffolds including my idea and my evidence), which explained 33.5% of variance. In the correlation analyses, only high level of self-, co-, and collective regulation were examined. Primarily the three patterns of regulation was significantly correlated with each other; there were also significant correlation between KB principles with KF scaffolds (r=.680, p<.01); high-level explanation (r=.477, p<.01); self- and collective regulation (r=.703, p<.01; r=.507, p<.01). Domain knowledge was correlated with different patterns of regulation: self-regulation (high) (r=.536, p<.01), co-regulation (high) (r=.496, p<.01), collective regulation (high) (r=.417, p<.01) and knowledge building principles (r=.323, p<.05). These findings indicated that students' domain knowledge was related to self-regulation (high), co-regulation (high), collective regulation (high), and knowledge building principles. As well, students' knowledge building principles was related to KF scaffolds, high-level explanation, self- and collective regulation (high).

Table 7: Correlations among ATK indices, knowledge building, and regulation of learning

1	2	3	4	5	6	7	8
1postdom	.046	.041	**.400***	**.536****	**.496****	**.417****	**.323***
2KFATK		.000	.422**	.229	.163	-.044	.045
3KFscaf			.275	**.352***	.221	.387*	.680**
4Hnotes				.538**	.367*	.212	.477**
5srH					.393*	.416**	.703**
6coH						.391*	.310
7colH							.507**

**. Correlation is significant at the 0.01 level (2-tailed) *. Correlation is significant at the 0.05 level (2-tailed)
Note: 1. Posttest domain knowledge; 2. KF ATK; 3. KF Scaffold; 4. High level explanation; 5. Self-regulation (high level); 6. Co-regulation (high level); 7. Collective regulation (high level); 8. KB principles.

Prediction of prior knowledge, high level explanation, regulated activities and knowledge building principles

Hierarchical regression analyses were conducted on posttest domain knowledge, first entering pretest domain knowledge scores, followed by high level explanation, followed by regulated activities including high level of self-, co-, and collective regulation, and then knowledge building principles. Results indicated that prior knowledge explains 9.0% of variance (R^2=.09), when high level notes was added, an additional 9.2% variance was explained. When regulated activities were added, another 22.4% variance was explained. When knowledge

building principles was added, another further 3.1% variance was explained. Results indicated that over and above prior knowledge, high level notes, regulated activities and knowledge building principles contributed to the post domain knowledge.

Table 8: Prediction of high level explanation, regulated activities, and knowledge building principles on post domain knowledge

	R	R^2	R^2 Change	F Change	Sig.
Pretest domain knowledge	.30	.09	.092	3.858	.057
High level explanation	.43	.18	.092	4.168*	.023
Regulated activities	.64	.41	.224	4.293**	.002
KB principles	.66	.44	.031	1.850**	.003

Note: *p<.05; **p<.01

Conclusions and Implications

This study examined the role of a designed knowledge building environment on students' regulation of knowledge advance and domain knowledge, and investigated the relationships with knowledge building measures. A coding scheme was designed to examine students' regulation of learning activities including self-regulation, co-regulation and collective regulation. Qualitative analyses of students' portfolio notes showed how the designed learning environment help students to be engaged in regulation of learning at both individual and collaborative levels and knowledge building processes. Results indicated that students' domain knowledge was improved significantly from pretest to posttest. Furthermore, correlation analysis showed that students' regulation of learning is positively correlated with principles, KF scaffolds and domain knowledge. Hierarchical regression analysis indicated the contribution of principles over and above contribution of regulation and explanation and prior knowledge. These findings suggest that while prior knowledge and explanation are important, regulated strategies and principles predict further students' domain understanding. The findings also suggest possible relationships between principles and regulated activities in the knowledge-building environment; principles may help guide the use of personal and collective regulation for learning and knowledge advancement.

The study also shows the possible role of the portfolio design to help students to reflect, monitor and regulate their understanding and knowledge advances. The scaffolds of "what I thought initially", "what we discussed", and "putting our knowledge together" helped students to reflect and to monitor their understanding and knowledge advances. This study also expanded the social and collaborative aspects of regulated learning in a computer-supported knowledge building environment and it has shown the possibility to help students to monitor and regulate their learning and knowledge advance through a designed knowledge building environment. Metacognitive scaffolding, which is one of the essential features of Knowledge Forum®, has positively correlated with students' regulation of learning and understanding. Furthermore, knowledge building principles, such as improvable ideas, idea diversity, rise-above, and constructive use of information, are key to the knowledge building environment. The study suggests that it might be possible for principles to be instantiated through some kinds of regulated activities in particular collective regulation. Students can reflect and regulate their knowledge advances and trajectory in relation to how it relates to knowledge building principles. Implications of portfolio design for students to reflect and to regulate their learning and knowledge advances need to be examined further. In conclusion, this paper presented the preliminary findings and further analyses would be conducted including a comparison group as well as a high and low performance groups and to provide a more holistic picture for the relationships of knowledge building, principles, collective responsibility and knowledge advance.

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