Chapter 5
Harnessing Emerging Technologies to Build the Next Generation of Knowledge Creation Platform for School Students

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Introduction

Since the 1990s, the rapid development of information and communication technology (ICT) has facilitated the integration of technology into classroom teaching and learning activities and afforded learners opportunities to construct digital artifacts that represent their knowledge. In particular, ICT has been deployed to enhance collaborative learning and knowledge co-construction among learners (Solimeno et al. 2008). This kind of online learning environments is currently known as computer-supported collaborative learning (CSCL), which is designed to enable and promote social interaction between teacher and learners and among peers (Molinari 2004). Most CSCL environments are based on the theoretical foundation of sociocultural learning theories. They leverage on the notion of zone of proximal development (Vygotsky 1978), assuming that the multiple perspectives brought forth in a community create multiple zones of proximal development for the learners to be supported (Oshima 1998) and that the diversity of ideas could lead to the emergence of new ideas. As such, the integral feature of CSCL is the promotion and cultivation of group learning besides independent learning (Solimeno et al. 2008).

Within the CSCL literature, knowledge creation, rather than learning, is much emphasized especially among researchers associated with the knowledge building fraternity. Paavola and Hakkarainen (2005) argue that learning in the knowledge age needs to go beyond information given (i.e., acquisition of existing knowledge) by advancing current knowledge through collective improvement of shared understanding/ideas mediated through technology. In other words, they are arguing that knowledge creation should be the underlying thrust of today's classroom.

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Knowledge creation in a community involves "more than the creation of a new idea, it requires discourse (talk, writing, and other actions) to determine the limits of knowledge in the community, set goals, investigate problems, promote the impact of new ideas, and evaluate whether the state of knowledge in the community is advancing" (van Aalst 2009, p. 260). From the perspective of social constructivism, it emphasizes social interactions (i.e., active participation and peer discussion) among learners for constructing knowledge (Pena-Shaff and Nicholls 2004). Research undertaken in this field explores how social practices promote and facilitate knowledge creation. Many studies have investigated the influence of the presage factors (i.e., participation levels, interaction, reflection, literacy skills, scaffolding, etc.) on the quality of knowledge building (Cacciamani et al. 2012; So et al. 2010). There is a body of research investigating learners' knowledge creation processes using online platforms (e.g., Chai and Tan 2009; Hong 2011; Zhang et al. 2009). In addition, there is also an emerging trend in the application of technological innovations (e.g., Web 2.0) in knowledge creation. In general, these studies in knowledge creation are evolving along the interactive and constructivist perspectives.

Furthermore, in response to the need to transform education, knowledge creation that focuses on engaging learners to work directly on knowledge construction has received much attention (see Chai et al. 2011). Three of the more mature and well-researched knowledge creation models are the model of knowledge spiral (i.e., the SECI model, Nonaka and Takeuchi 1995), the expansive learning framework (Engeström 1999a), and the knowledge building approach (Scardamalia and Bereiter 1994). Paavola et al. (2004) and Tsai et al. (2013) indicated that these models highlighted the importance of innovative knowledge creation. While these models are derived from and associated with different disciplines of study, two common features of these models are (1) a focus on improving knowledge objects/conceptual artifacts that the knowledge creators have explicated and (2) an emphasis on the community as the social mechanism for the knowledge objects to be culturally accepted. Hence, the creation of technological platform in support of knowledge creation effort has to be anchored in the dual foci of the cognitive and social dimensions of knowledge creation.

In the following section, we will first review the three knowledge creation models. This will be followed by a brief discussion of the three main knowledge creation models and our attempt to synthesize them as a coherent framework to guide knowledge creation in classrooms. We will also review existing platforms for knowledge creation that incorporate the two aforementioned anchoring features and identify both strengths and limitations of these platforms. After reviewing from the perspectives of the underlying theories and existing platforms, we will provide a synthesis that brings together the theoretical and technological considerations to support the proposed new platform.

The Related Theories of Knowledge Creation

Paavola et al. (2004) and Tsai et al. (2013) indicated that three of the more mature and well-researched knowledge creation models are the model of knowledge spiral (i.e., the SECI model, Nonaka and Takeuchi 1995), the expansive learning framework (Engeström 1999a), and the knowledge building approach (Scardamalia 2002). The concise descriptions of these models are presented below.

The Model of Knowledge Spiral (the SECI Model)

Nonaka and Takeuchi's (1995) SECI model, a well-known framework for exploring knowledge spiral process, was proposed to explain the interaction between two kinds of knowledge: tacit knowledge (the knowledge regarding personal experience, beliefs, and perspectives) and explicit knowledge (the knowledge that is articulated through clear and effective expression). The interaction between tacit and explicit knowledge takes shape through four types of knowledge conversion: (a) socialization (from tacit to tacit knowledge), (b) externalization (from tacit to explicit knowledge), (c) combination (from explicit to explicit knowledge), and (d) internalization (from explicit to tacit knowledge). These processes are aimed at helping the organizations to explicate the workers' tacit knowledge that they obtain from their working experience so as to improve the organizations' products and performances (Chai et al. 2011).

The Theory of Expansive Learning

The theory of expansive learning, which is based on activity theory, focused on the sociocultural context and collectives in learning processes; that is, learners' behaviors cannot be comprehended independently of the social cultural contexts (Engeström and Sannino 2010). A collective activity system involved six elements: tools, subject, object, community, division of labor, and rules. Simply put, an activity system is constituted through a subject (a person) who uses tools to work on an object (a problem) to achieve an outcome. The work is situated within a sociocultural system in a community (the organization), which comprises other people who assume associated roles/duties, and the community is shaped by implicit and explicit rules. For example, a teacher (subject) uses computer-based drill and practices (tools) to improve students' mastery of mathematical operations (the object) in a school (community) to achieve good examination (the outcome). The teacher is supervised and supported by other associated school personnel (roles/division of labor), and the teacher has to follow certain code of conducts and even pedagogical practices (rules). Many studies utilized the expansive

learning to analyze existing activity systems and identify contradictions among elements (Ahonen et al. 2000; Engeström 1999b; Nummijoki and Engeström 2009). Through changing and redefining the elements and the relationships among the elements, expansive learning activity creates new practices and the associated new knowledge (Engeström 1999a). The activity theory has been used to create new knowledge in designing instructional or teaching and learning environments (e.g., Lim and Chai 2008) and human and computer interaction (e.g., Nardi 1996).

The Knowledge Building Approach

The knowledge building approach is undergirded by a focus towards learners' collective creation and improvement of ideas (Bereiter 2002). In practice, knowledge building is a process where learners identify problems of understanding that interest them; articulate their ideas about the problems in a community; build on, argue, criticize, discuss, and refine the ideas; and also organize, relate, and synthesize the ideas. These interactive and dynamic processes are supported by the Knowledge Forum reviewed below. Bereiter views such endeavor of working on ideas as the essence of knowledge creation work. Much research has been conducted on the knowledge building approach, and they generally indicate that the approach is conducive for the cultivation of knowledge creation practices among learners (see, e.g., Scardamalia and Bereiter 2006).

Scardamalia (2002) proposed 12 principles encompassing the socio-cognitive and technological dynamics involved in community-based knowledge creation process. These principles underlie the emergence of knowledge building practices among learners. These 12 principles are (a) real ideas and authentic problems, (b) improvable ideas, (c) idea diversity, (d) rise above, (e) epistemic agency, (f) community knowledge and collective cognitive responsibility, (g) democratizing knowledge, (h) symmetric knowledge advancement, (i) pervasive knowledge building, (j) constructive uses of authoritative sources, (k) knowledge building discourse, and (l) embedded and transformative assessment. In the socio-cognitive dimension, the principles can be institutionalized through pedagogical approaches, and in technological dimension, the principles can be substantiated through the use of Knowledge Forum. These principles were widely utilized as indicators for designing knowledge building activity (Zhang et al. 2011).

Synthesizing the Three Models of Knowledge Creation

This chapter synthesizes the three models of knowledge creation together, as shown in Fig. 5.1. The model of knowledge spiral provided the foundation for the phasing of knowledge creation activities. Building on the SECI model, we propose that

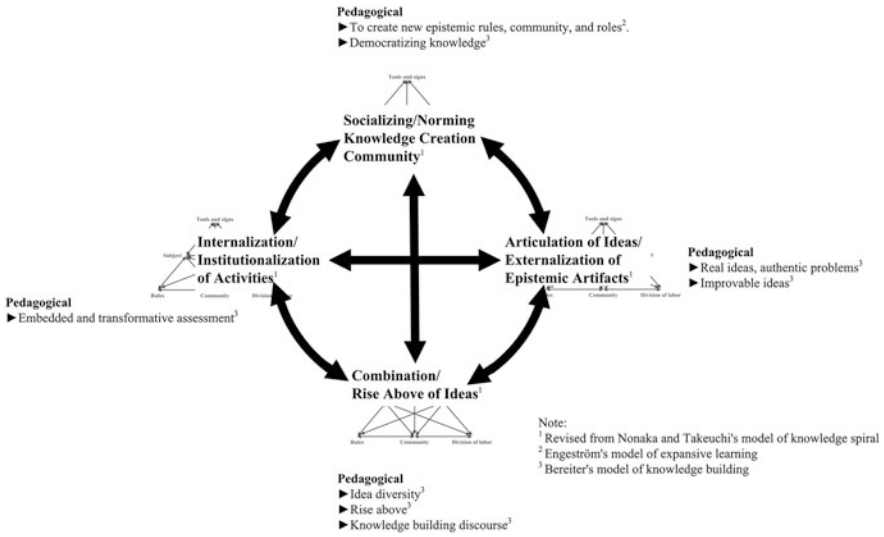

Fig. 5.1 The framework of synthesizing the three models of knowledge creation

fostering knowledge creation involves socializing/norming knowledge creation community, articulation of ideas/externalization of epistemic artifacts, combination/rise above of ideas, and internalization/institutionalization of the knowledge created. Depending on the history of the knowledge creation communities, the phases could be more or less dynamic. A mature knowledge creation is likely to be able to start and traverse the various phases of knowledge creation, but a beginning community may be better off in undertaking a more linear phase-by-phase progression.

In addition, each phase of the knowledge creation activities can be examined through the expansive learning framework. For example, during the *socializing/norming knowledge creation community* phase, the object of interest is the formation of the sociocultural ethos that promotes epistemic agency among the learners. This would involve creating new epistemic rules through pedagogical events, support by others in the immediate and associated contexts (e.g., leadership and parent support), and also changes in the roles of teachers and students (Lim and Chai 2008).

The knowledge building approaches provided the epistemic frameworks and valuable principles in shaping knowledge creation practices. Building on Scardamalia's (2002) articulation of the socio-cognitive and technological dynamics, these principles are viewed as a pedagogical focus in knowledge creation practices. For example, during the *internalization/institutionalization of activities* phase, the objective is the enhancement of learner's tacit knowledge. This would include each learner's internal assessment during the knowledge creation processes that is similar to the principles of embedded and transformative assessment (Scardamalia 2002). While the new synthesized framework did not include all the 12 principles, we believe that the most important pedagogical principles have been

incorporated. Hence, the new synthesized framework only includes seven principles, that is, socializing/norming knowledge creation community phase reflecting the principles of *democratizing knowledge*; articulation of idea/externalization of epistemic artifacts phase reflecting the principles of *real ideas, authentic problems*, and *improvable ideas*; combination/rise above of ideas phase reflecting the principles of *idea diversity, rise above*, and *knowledge building discourse*; and internalization/institutionalization of activities phase reflecting the principles of *embedded and transformative assessment*, as shown in Fig. 5.1. Detailed descriptions of the synthesized framework of related theories of knowledge creation are presented below.

Socializing/Norming Knowledge Creation Community

In this phase, drawing from the socialization stage in Nonaka and Takeuchi's (1995) SECI model, the emphasis is on establishing trust and understanding among the learners and providing initial explanation and discussion of why and how knowledge creation is likely to happen. The process of developing a community at this stage is often enacted in face-to-face learning environments. Face-to-face meeting affords much subtle communication richness such as that of verbal intonations and body language. Hence, this chapter proposes that the teacher assumes the main role of forming the community with technology support geared towards building social bonding. One of the important roles of teachers in knowledge creation is to construct and negotiate the rules and the roles (division of labor) in the community, which are the basic elements of expansive learning theory; that is, teachers could propose some regulations and norms for conducting knowledge creation and helping students to understand individuals' roles in knowledge creation community.

Articulation of Ideas/Externalization of Epistemic Artifacts

This stage, closely associated with the externalization stage in Nonaka and Takeuchi's (1995) SECI model, focuses on the articulation and development of epistemic artifacts, which are World 3 objects in Popper's (1978) three worlds. Popper delineates World 3 as the world of immaterial objects created by the human mind. Bereiter (2002) drew upon Popper's three worlds as the foundation of knowledge building work. As each individual views the world (the physical World 1) that they encounter in unique ways, the ideas they formed about the world are more or less different. These ideas (intramental private World 2 objects) are raw materials that could be shaped to form many epistemic artifacts. Theories, explanations, proposals, and hypotheses created by epistemic agents through the articulation of World 2 objects are examples of World 3 objects. The World 3 objects are thus man-made cognitive objects, and it needs to be made accessible to the community. Once created and shared, the World 3 objects are epistemic

artifacts that can be further manipulated, improved, and transformed by the epistemic agent and other people. To work directly on epistemic artifacts with the intention of advancing its utility is, in essence, the knowledge creation works.

Combination/Rise Above of Ideas

In the combination/rise above of ideas stage, drawing from the combination stage in Nonaka and Takeuchi's (1995) SECI model, the stress is on interrelating and combining learners' ideas and thinking to attain deeper understanding. This stage is the main process in knowledge creation (Paavola et al. 2004). However, this stage is not easily achievable. For instance, Chan (2011) pointed out that the major behaviors of learners are in knowledge sharing rather than knowledge creation. Students often view their online postings as notes to share knowledge, rather than ideas to create knowledge. The format of a thread-based discussion forum may limit the interactions among ideas. Pedagogically, this stage highlights a higher-level combinative process of ideas. It is similar to the concept of "rise above" in that related knowledge can be systematically integrated and new insights could be derived. Scardamalia (2004, p.189) indicated that "the idea (rise above), based on the philosophical concept of dialectic, is that the most constructive way of dealing with divergent or opposing ideas is not to decide on a winner or a compromise position but rather to create a new idea that preserves the value of the competing ideas while rising above their incompatibilities." Several studies pointed out that the "rise above" process plays an important role in improving ideas during knowledge creation activity (Howland et al. 2012). For example, Zhang et al. (2007) found that the "rise above" process helped Grade 4 students to create more sophisticated conceptualization. That is, the "rise above" allows a learner to subsume some online posts that are created by peers and explore the content deeper.

Internalization/Institutionalization of Activities

Finally, in this phase, based on the internalization stage in Nonaka and Takeuchi's (1995) SECI model, the focus is on transforming the existing explicit knowledge in the group or organization level into individual's tacit knowledge. The concept of internalization process is akin to working on World 2 objects in the Popper's (1978) postulation of the three worlds. Working on World 2 has been a prevalent school practice, and it has been criticized as essentially transmission oriented and noncreative (Bereiter 2002). However, we argue that working on World 2 after one has devoted substantial work on World 3 is different from the prevalent school practice. It is a process of consolidating epistemic artifacts and processes in creating the artifacts, which could serve as epistemic resources for the subsequent World 3 works (see Tsai et al. 2013). Therefore, in the design of a knowledge creation platform, working on World 2 should also be addressed with equal importance as working on World 3.

The Current Platforms of Knowledge Creation

To date, researchers have created several platforms to support knowledge creation activities among learners. Among these platforms, the Computer-Supported Intentional Learning Environments (CSILE), Knowledge Forum, Synergeia, Future Learning Environment (Fle3), and wiki have been identified as important environments in the literature. The detailed descriptions, strengths, and limitations of these platforms are as follows.

Computer-Supported Intentional Learning Environments (CSILE) and Knowledge Forum

Computer-Supported Intentional Learning Environments (CSILE) is a pioneering knowledge building environment that supports learners' intentional learning and co-construction of an online knowledge repository of learners' ideas (Scardamalia et al. 1989). CSILE supports a process of knowledge building by asking a problem; collecting information; collaborating with experts (scientists and scholars), teachers, and learners; and providing scaffolding. For example, learners can type text, draw diagrams, and insert graphs to represent their ideas in the form of an online post which is called "a note." They can also search, comment, and revise existing notes for knowledge integration. CSILE aims to support learners in actively sharing their knowledge, finding their knowledge gaps, and improving their knowledge (Scardamalia et al. 1994). Some studies conducted on CSILE have revealed positive findings on learners' learning and knowledge building (Cuthbert and Hoadley 1998; Oshima and Oshima 1999). For instance, Cuthbert and Hoadley (1998) studied how the design of problem structure can scaffold middle school students' thinking and encourage them to integrate knowledge using CSILE. These studies provide some evidence that CSILE supports knowledge building and promotes interactions between the learners and their teacher and among group members.

Knowledge Forum, the second-generation CSILE, supports the process of collaborative knowledge building and idea improvement. Similar to CSILE, Knowledge Forum is a collaborative platform that supports students in working with ideas and developing deeper understanding about the topics. It mainly uses a threaded discussion forum in supporting the process of collaborative knowledge creation, as shown in Fig. 5.2.

The design of Knowledge Forum focuses on the process of idea improvement and knowledge building. One of the key characteristics of Knowledge Forum is the "rise above," which plays an important role in improving ideas (Howland et al. 2012). In addition, central to the idea of knowledge building, learners are expected to be contributors of knowledge. Hence, in Knowledge Forum, several analysis tools are provided for teachers to explore learners' contributions, such as

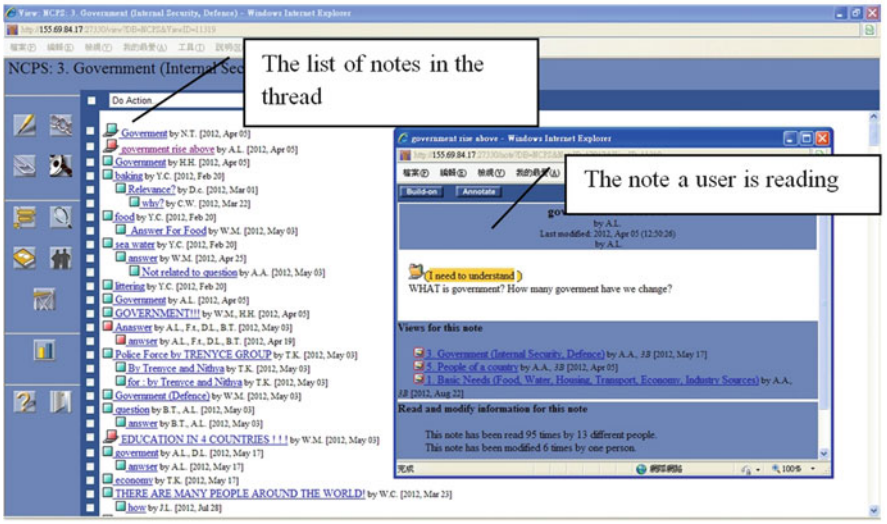

Fig. 5.2 Example of using knowledge forum in social studies

indicators (e.g., notes created, note revision, percentage of notes read, and percentage of notes with links) (van Aalst 2009), and Social Network Analysis (SNA) indices (Zhang et al. 2009). Zhang et al. (2011) revealed that providing feedback to learners such as analysis of dormancy in online discourse could encourage them to participate in knowledge building with more considerable and elaborative contributions. In sum, these studies demonstrated that Knowledge Forum provides a shared collaborative space for teachers and learners to be engaged in knowledge-creating practices.

Although previous research has revealed the advantages of utilizing the CSILE and Knowledge Forum in enhancing the knowledge creation process, problems with these learning environments have also been identified. Van Aalst and Truong (2011) suggested that Knowledge Forum is not easy to use for both teachers and learners. In fact, our experience shows that the interface design of Knowledge Forum at times militates against deepening cocreation of knowledge and often confuses learners by their complicated buttons and multiple cascading windows (Chai et al. 2012). In particular, the "rise above" function in the Knowledge Forum is only designed to copy selected notes into a new file, necessitating users to write a new note to explain what or why he/she is rising above. Similarly, for teachers and researchers using analysis tools in Knowledge Forum, understanding of learners' behaviors is handicapped by the somewhat unintuitive presentation modality (Chai et al. 2012). Moreover, learners may experience futility in a knowledge building activity; that is, they can be engaged in knowledge sharing predominantly rather than knowledge cocreation (Chan 2011). These problems may be due to learners' cultural backgrounds and technical aspects of using discussion forums which influence learners' learning processes.

Synergeia and Future Learning Environment (Fle3)

Synergeia and Future Learning Environment (Fle3) are two web-based platforms for supporting collaborative knowledge creation in classrooms and the development of knowledge artifacts (Leinonen et al. 2003), which were developed in a European project called ITCOLE, which stands for Innovative Technologies for Collaborative Learning (Rubens et al. 2005). Both platforms consist of four spaces, including three spaces for students to engage in knowledge creation practices and one space for teacher to manage the functions of platform. The three spaces for students include a *personal space*, a *collaborative knowledge building space*, and a *knowledge artifacts space*. The *personal space* aims to develop individual's ideas. Each learner can collect various resources (e.g., texts, links, documents, images, and multimedia) that are related to the topics, organize them for enhancing his/her understanding about the topics, and also decide whether or not to share them with group members. In the *collaborative knowledge building space*, similar to the threaded discussion forum in Knowledge Forum, learners can share documents with peers, initiate a discourse, or build on peers' contributions based on predefined knowledge types to attain deeper understanding of a topic, as shown in Fig. 5.3. In the *knowledge artifacts space*, learners can construct, externalize, and subsequently reconstruct and improve the knowledge artifacts through the groups' knowledge building process (Applet et al. 2002; Cacciamani et al. 2012). Moreover, a management space is created for teachers to select and adjust the functions to fit in with their courses; hence, teachers can adopt the platform to meet different course goals and different pedagogical approaches (Applet et al. 2002).

Research on knowledge building with Synergeia or Fle3 has also revealed the advantages and disadvantages of these two platforms. For example, Rubens et al. (2005) explored teachers' perspectives of user-friendliness and satisfaction with respect to the collaborative and pedagogical functions of Synergeia and Fle3 and found that teachers are satisfied with these systems. However, Chen (2006) indicated that although Fle3 provides managing functions to teachers, teachers could not regulate their courses by themselves. These findings may also bring forth the influence of teachers' pedagogical background and cultural context in the teaching.

Wikis

Recently, wikis, a Web 2.0 technology, has been proposed as a useful tool for building knowledge (Joubert and Wishart 2012; Kimmerle et al. 2011; Moskaliuk et al. 2009). For example, Joubert and Wishart (2012) indicated that discussion forums with wikis could be useful tools for collecting knowledge. Wikis can be a knowledge creation environment that supports the collaborative process as web

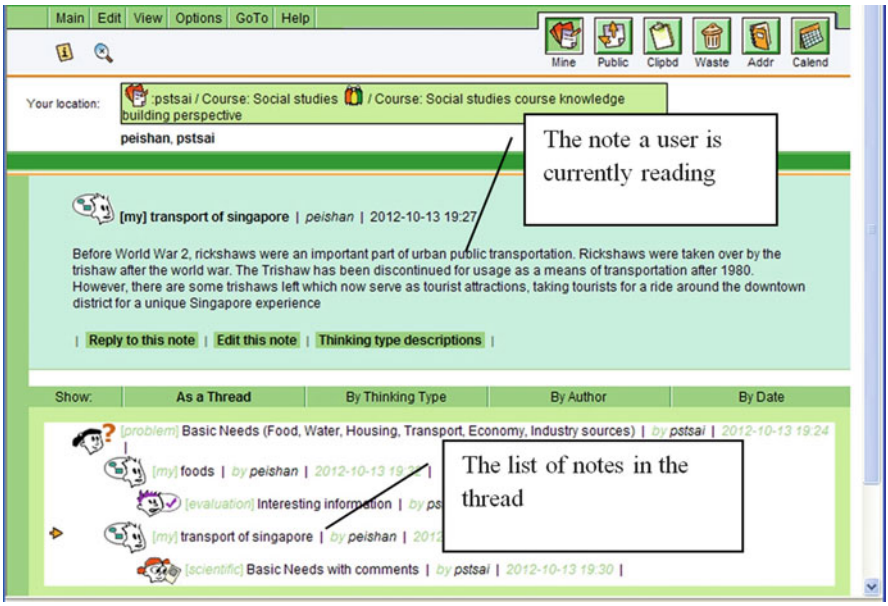

Fig. 5.3 The interface of knowledge building area in Synergeia

users cocreate, coedit, and comodify any parts of knowledge. It has potential for supporting the co-construction of knowledge.

The results of using wikis in knowledge creation revealed similar cultural, pedagogical, and technological findings. For example, review had shown that the functional characteristics of wikis were highly supportive of knowledge creation in both personal and group collective learning scenarios (Cress and Kimmerle 2008). Other researches, however, addressed the handicaps of using wikis, such as students arguing over the delays between buildings on contributions and receiving responses, some students reporting that their postings were difficult to see, and not all teachers were willing to support their students in contributing to the discussions in wikis (Joubert and Wishart 2012). Scardamalia and Bereiter (2010) had also warned that although the emergence of technologies (e.g., wiki) could be utilized to support knowledge building, the learners' behaviors (i.e., knowledge telling and knowledge transforming) depended on their purposes and contexts.

Implications

Juxtaposing the existing knowledge creation platforms reveals technological differences among them. Though not so prominent in Knowledge Forum and wikis, with Synergeia and Fle3 being the most inclusive, it is helpful to group the design characteristics into the following four categories of functionality to further guide

our discussion: (a) teacher's management space, (b) knowledge construction space for epistemic artifacts, (c) collaborative knowledge creation space, and (d) personal space for the building of individual e-portfolio. These functionalities are of course interdependent on one another. *Teacher's management space* caters to teachers' pedagogical design and the management of functions in the platforms. Teachers' ability to be engaged in innovating instructional practices and contributing to knowledge advancement is a key aspect factor in enhancing their instruction and student learning (Chai and Lim 2011). *Knowledge construction space for epistemic artifacts* focuses on the creation and refinement of the epistemic artifacts that learners work on in the knowledge building activity. Epistemic artifacts are defined as tools for thinking, that is, the central part for the explanation of human culture and intelligence (Sterelny 2004). This space needs to cater efficient tools to prompt and support individual's effort in explicating the tacit World 2 objects.

The premise of knowledge creation is that learners collaboratively work on their epistemic artifacts. For example, in Synergeia and Fle3, a learner can collaborate with his/her peers to create their artifacts as the products of knowledge creation activity. *Collaborative knowledge creation space* caters for learners' co-construction of knowledge through ICT or knowledge building discourse. It is the major socially oriented activity in knowledge creation. In Knowledge Forum, Synergeia, Fle3, and wiki, the focal point of these systems is the provision of a threaded discussion forum for students to share their knowledge. Finally, *personal space for the building of individual e-portfolio* focuses on learner's individual effort in advancing personal knowledge and building personal epistemic repertoire (Tsai et al. 2013). The concept of building individual e-portfolio in personal space is similar to the concept of a personal space in Synergeia and Fle3. Learners actively collect various types of resources (involving texts, images, links, and multimedia) to develop their ideas and make the decisions whether they want to make public and share these resources with peers. In addition, the teachers can provide individual feedback to students in their personal space.

Many researchers utilized these platforms to explore learners' knowledge building processes and pointed out that exploring the quality of interactions and behaviors made by students in a knowledge building platform is helpful to the researchers and teachers in understanding students' problems and learning patterns (Joubert and Wishart 2012). These studies have revealed the importance of analyzing the behaviors of students in knowledge creation activities. However, there is a limitation in the usefulness of the knowledge building indicators afforded by current learning analytic frameworks. That is, the outcomes of these analyses are currently not provided to the students and teachers in real time when they are engaged in knowledge building activity. Teachers and students have to activate certain analytic tool to obtain the information and it requires dedicated time for the analysis to be run. Such arrangement may impede the flow of the lesson. Caswell and Bielaczyc (2001), Shell et al. (2005), and So et al. (2010) pointed out that teacher guidance plays an important role to encourage students to engage in knowledge building processes. It is therefore important that the teachers and the students are provided

with timely feedback to address emerging issues during the knowledge building processes.

Other problems in the current available platforms may arise from the learners' diverse cultural, pedagogical, and technical backgrounds that influence their knowledge creation practice. Some general problems in using knowledge building platforms have been reported. For example, Zhang et al. (2011) revealed that students at lower grade might need help for writing and using the platform, such as saving the notes. Particularly, forgetting password, for online system access, is another common problem faced by young learners, some of whom have faint idea of self-responsibility. When school children are involved, it is important to provide adequate support for their effort in knowledge creation. Building on emerging technologies (technical aspect), this chapter hopes to further develop the technological and pedagogical capacities of knowledge creation platforms to alleviate some of these problems.

From the perspective of technological affordances, this chapter proposes that the new knowledge creation platform should provide relevant information for tracing and analyzing the learners' interactive activities to assist teachers in leading learners in knowledge creation. In the previous studies, the analysis of the learners' behaviors and interactions for knowledge creation is often conducted through participatory indicators (e.g., number of notes created per learner, number of posts, and rise-above notes) (Joubert and Wishart 2012; van Aalst and Truong 2011; Zhang et al. 2011), content analysis (Hong 2011; van Aalst and Truong 2011), semantic cloud (Cress et al. 2013), and Social Network Analysis (SNA) (Erkunt 2010; Hong 2011; Zhang et al. 2009). In the aspect of providing analytic feedbacks, the Knowledge Forum platform is one of the pioneering platforms. However, several potential improvements can still be made. For example, the outcomes of these analyses are currently not provided to the learners in real time when they are engaged in knowledge building activity. Java applets designed to provide the feedbacks have to be run before the learners can obtain the feedback. Also, the current analytics required the students to interpret the results, which is not easy for young children.

From the perspective of pedagogical affordances, this chapter provides some suggestions based on the new synthesized framework (describe above), which draws from the basic elements of expansive learning (i.e., rules, community, and division of labor) (Engeström 1999a) and the principles of knowledge building (Scardamalia 2002). These suggestions can be incorporated in the four major spaces identified from current knowledge creation platforms (i.e., teachers' management space, epistemological artifacts construction space, collaborative knowledge creation space, and individual e-portfolio space) to further engage students in knowledge creation practices. Therefore, the next section integrates the concept of new synthesized framework from both technical and pedagogical standpoints, and the four major spaces identified from current knowledge creation platforms, to propose a new knowledge creation platform.

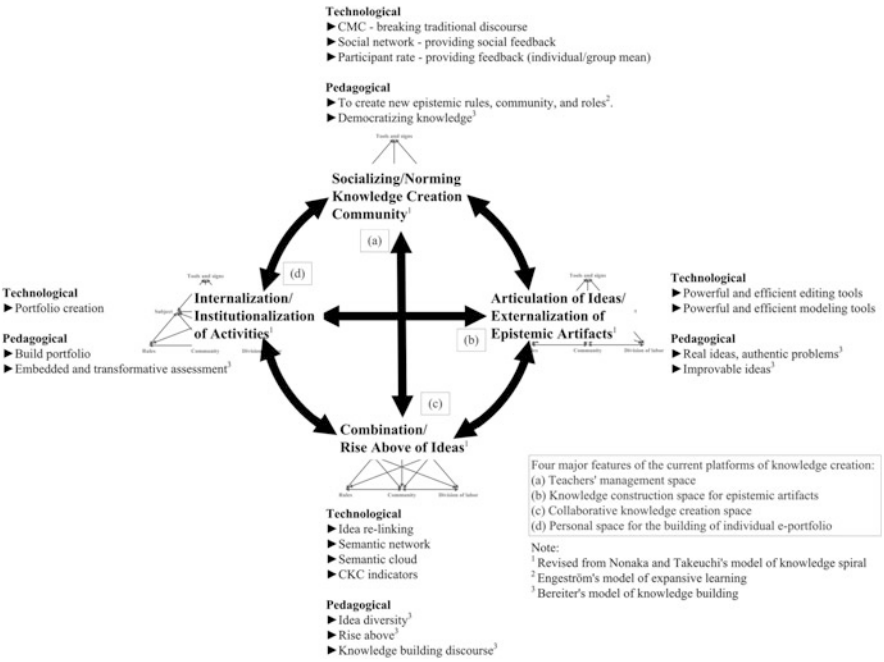

Fig. 5.4 The theoretical and technological considerations to support the new knowledge creation platform

The Theoretical and Technological Considerations to Support the Proposed New Knowledge Creation Platform

This chapter further provides a synthesis that brings together the concept of new synthesized framework from both technical and pedagogical standpoints, and the four major spaces identified from current knowledge creation platforms to support the proposed platform, as shown in Fig. 5.4. The detailed descriptions of the proposed platform are presented below.

Socializing/Norming Knowledge Creation Community

A community is formed by the accumulation of social interactions and relations among learners (Frank 1998). This aspect is often enacted in face-to-face learning environments. Online platforms break the limitations of classroom time and space, and turn-taking structure to extend the discourse, which is essential for idea

development. However, the platform by itself would not engender the sociocultural environment conducive for knowledge creation. As explained earlier, a teacher has to lead in this aspect to construct a knowledge creation community. The teacher should be an active agent to help learners to assume their individual roles in the knowledge creation activity and facilitate deeper knowledge creation. As these are demanding tasks, supporting teachers in tracking and analyzing learning behaviors, and outlining strategies in facilitation of the knowledge creation processes, becomes one of the important issues in knowledge creation.

This chapter further proposes that the use of learning analytics in the new knowledge creation platform may help in fostering the sociocultural environment through providing appropriate indicators. Previous studies utilized s*ocial network* to explore the learners' social interactions among peers in the knowledge creation activities and further identify the learners as belonging to one of these categories: asking, sharing, and doing inquiry (Erkunt 2010; Hong 2011). In other words, the use of *social network* diagrams can help to inform the teachers whether the community is taking shape. Through simple graphical visualization, active and inactive learners are highlighted. Moreover, providing *social network* diagrams during the knowledge creation processes can create awareness among learners about personal and peers' social presence, for example, period of dormancy or active contribution. In sum, the new knowledge creation platform should provide adaptable assistance (i.e., learning analytics) for teachers in tracking and analyzing learners' learning behaviors, and strategies in the facilitation of knowledge creation processes, as well as in supporting learners in co-constructing knowledge.

Articulation of Ideas/Externalization of Epistemic Artifacts

The new knowledge creation platform is, in general, an amalgamation of the previous platforms with added features. It is, therefore, an online platform that allows users to build epistemic artifacts and interact based on those artifacts. From a pedagogical perspective, this stage emphasizes the formation of authentic problems and real ideas to be the anchors for subsequent idea improvements, which occurs through the collaborative space where ideas are shared as community-owned epistemic artifacts. In addition, from a technological view, the essential technological support could be a good multimedia editor that allows the epistemic agent to articulate and create the ideas either through text and drawings or even through dynamic models. Ease in writing, drawing, indexing, prototyping, and using multimedia elements is crucial consideration for this space, and the process of creating the epistemic artifacts should not impede the learners' flow of ideation. Therefore, providing powerful and efficient editing/modeling tools to support students in articulating their ideas, and later improve and organize their ideas in authentic problem solving, should be addressed in the new knowledge creation platform.

Combination/Rise Above of Ideas

This stage is one of the main processes in knowledge creation (Paavola et al. 2004), and it highlights a higher-level combinative process of ideas. As mentioned above, the "rise above" in the Knowledge Forum was only designed to copy selected notes into a new file. Our experience shows that students may not understand the purpose of the "rise above" nor utilize the "rise above" to link their ideas (Chai et al. 2012). The design of new knowledge creation platform should provide a more efficient way of combining learners' explicit knowledge to help learners to work on improving ideas and synthesizing the ideas at increasingly higher levels. For example, after the users selected a series of notes that they believe should rise above, the content of the selected notes would be included into a new note for the users to edit. In addition, Howland et al. (2012) indicated that building visual models enable people to externalize the mental models that they construct and encourage the process of conceptual change. This chapter proposes that the edited rise above or any set of selected notes can be exported to commonly used format such as PowerPoint slides or web pages for easy sharing and further collective refinement. In other words, learners can put the edited rise above or any set of selected notes into one editable artifact and share with their group members. Hence, learners can easily make sense of the relations between their ideas and then make deeper explorations and understanding.

Various technology-based modeling tools can be utilized to help learners to construct and externalize their thinking and ideas so as to make the theories public. This chapter also proposes some tools for supporting the development of ideas, making the relationships among ideas explicit, and visualizing learners' knowledge creation behaviors, such as idea relinking, semantic network, semantic cloud, and collaborative knowledge creation (CKC) indicators. *Idea relinking* allows students to relink the ideas posted after extended discussion. Students' active organization of association between ideas may help in idea improvement, which is an essential part of knowledge creation. *Semantic network* highlights the relationship between learners' ideas by presenting the flow of ideas in a semantic web with edges annotated by common keywords. *Semantic cloud* extracts popular keywords from the discussion based on semantic references inherent in the main topic. By selecting a particular keyword, which is hyperlinked to the associated notes, the learner can efficiently deepen its inquiry into a particular topic of interest and further build on the discourse, rather than having to browse through many notes to find what one is interested in. In other words, we suggest that some succinct forms of highlighting idea evolvement may help to reduce cognitive load and facilitate rapid idea improvement. CKC indicators, as an extension of the concept of participatory indicators (Joubert and Wishart 2012; van Aalst and Truong 2011; Zhang et al. 2011), aim to provide data to understand learners' behaviors and their interactions with notes. The participatory indicators, which are provided in Knowledge Forum, are mainly idiosyncratic, providing teachers and researchers an insight into a learner's personal behaviors reckoned by the number of notes, responses, and

rise-above notes created. The collaborative aspect, which means the interactions with their peers' notes was ignored, such as number of response notes posted by group members, number of response notes created by learner, number of group members' notes, etc. Hence, the new knowledge creation platform is expected to provide personal and collaborative CKC indicators for teachers and learners to gain a better understanding in the note management economics of a learner. In particular, these CKC indicators can be utilized to explore learners' strategies during the knowledge creation activity. Such CKC indicators that are updated real time can promote active collaboration among students.

Internalization/Institutionalization of Activities

This chapter proposes that the learner himself/herself plays a critical role working on his/her intramental world that resides inside the human mind (World 2). One of the important roles of learners in knowledge creation is to build their e-portfolio, which is a valuable method to help each student to organize, develop, and reflect ideas individually and explore the topic deeper in knowledge creation activity. That is, in the process of building e-portfolio, each learner can reflect and thus create metacognitive awareness of his/her actions and strategies in the knowledge creation processes. The creation of e-portfolio is a reflection of one's enhanced World 2. It should be noted that the concept of e-portfolio extends the framework of personal space that Synergeia and fle3 provide. That is, the learner can create, organize, and record his/her ideas about the inquiry at hand and also record his/her reflections of the ideas during the process of knowledge creation. In addition, teachers may be allowed to give their comments or feedback to encourage learners to make reflections in knowledge creation activity. In other words, a space for learners to reflect and build on their tacit knowledge can serve as an important step for personal consolidation. It can also serve as a precursor before the next externalization occurs. Hence, the provision of an individual space for each learner to improve and reflect on his/her ideas, as well as collect various resources, should be addressed in the knowledge creation activity.

Conclusion

In this chapter, we argue that the design of the new knowledge creation platform should not only help learners engage in the activity but also assist teachers in understanding learners' behaviors in knowledge creation. This will enhance teachers' pedagogical competencies in fostering instructional practices and enhancing learners' activity in knowledge creation (Chai et al. 2011; Joubert and Wishart 2012). Hence, we elaborated the theoretical models and analyzed the current platforms in supporting knowledge creation activities, such as the Computer-

Supported Intentional Learning Environments (CSILE), Knowledge Forum, Synergeia, Future Learning Environment (Fle3), and wiki, to provide some suggestions for the development of a new knowledge creation platform. The integration of the theories of knowledge spiral, the expansive learning framework, and the knowledge building approach provided the fundamental ideologies for suggesting a new synthesized framework for knowledge creation. The results of reviewing the current knowledge creation platforms revealed that the major design characteristics of the platforms can be grouped into four categories of functionality, including teacher's creation of social climate, constructing epistemic artifacts, collaborative knowledge creation, and building individual e-portfolio. Associated technological affordances, that could support knowledge creation by students in a community setting, were introduced within the four phases of knowledge creation.

Furthermore, emerging ICT tools can play important roles in empowering learners to engage in idea work. Mobile technologies such as smartphones can be utilized to collect associated in situ data that students encounter when working with ideas (e.g., fieldtrips, interviewing key personnel). Video clips and simulated environments can act as epistemic anchors for the encounter when the "real world" is not accessible. As such, the new knowledge creation environment should allow many forms of web-based objects to be easily integrated into the online platform in support of learners' knowledge work. Currently, the platforms of knowledge creation are lacking in this aspect. The environment therefore needs to be more open.

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