Chapter 17
Digital Knowledge Mapping as an Instructional Strategy to Enhance Knowledge Convergence: A Case Study

Darryl C. Draper and Robert F. Amason Jr.

Abstract This chapter discusses the effectiveness of digital knowledge mapping as an instructional strategy in an online graduate-level course at a North American university. Digital concept mapping tools would help students in constructivist online learning settings to collect ideas and generate and organize knowledge. The creation of digital knowledge maps enhances the cognitive processes, management, structuring, and restructuring of knowledge. Concept maps have proven to be a valuable cognitive tool in a variety of learning and instructional settings. An online course was designed using a knowledge-building *Community of Practice* (CoP) learning environment. A community is defined as a group of individuals who share experiences, learn together, and engage in regular interaction though discussion and knowledge sharing activities relevant to their domain. An online CoP may foster a high level of student interaction through group discussions and collaborative activities (Draper, The instructional effects of knowledge based communities of practice learning environments on student achievement and knowledge convergence. Ph.D. dissertation, Pennsylvania State University, 2010). In a moderated online instructional setting, graduate students collaborated and shared information to construct digital knowledge maps of instructional technology theories and concepts, which represent a shared meaning of complex theoretical concepts and content. This newly shared meaning represented knowledge convergence. This chapter begins by describing knowledge management, digital knowledge maps, communities of practice, and facilitator best practices, and then provides a document review and content analysis approach to evaluate the artifacts to determine common themes. Finally, suggestions and future research are provided.

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1 Introduction

What collaborative instructional strategies will promote knowledge convergence in digital environments? This is just one of many questions to address when designing college-level courses. Instructional Technology student populations consists of graduate-level students from varying professional backgrounds such as established teachers, technology specialists, researchers, instructional designers, corporate trainers, and from multicultural backgrounds. Technology has influenced the way courses are designed and delivered. There are two central challenges facing instructors today: the dynamic nature of technology, and the complexity and expansion of a field as a result of technological innovation and evolution.

Technological innovation influences research, behavior, instruction, design, delivery, expectations and expansion of a field of study. Across disciplines, there is pressure to utilize engaging and meaningful instructional strategies to help scaffold learners in the acquisition, organization, and management of knowledge. This chapter discusses the use of digital knowledge maps as a cognitive tool for the management of knowledge. The process of collaboration in group discussions and negotiation of concepts in the creation of digital knowledge maps promote the convergence of group mental models which are reified as external representations in the form of digital knowledge maps.

The goal of this chapter is to discuss instructional strategies that promote knowledge convergence through the use of digital knowledge maps within an online knowledge-building Community of Practice (CoP) learning environment. This exploratory research focuses on the facilitation, application, and structure of an online CoP learning environment and the use of the knowledge mapping application, Cmap Tools (http://cmap.ihmc.us/) to enhance knowledge management, convergence, and meaningful learning. This work is currently framing the author's pilot research in terms of how Cmap Tools can be utilized by teachers and instructional designers to facilitate knowledge management and knowledge convergence through the process of collaboration.

2 Knowledge Management and Digital Knowledge Maps

Knowledge management is the process of capturing and storing knowledge using a wide array of strategies and practices. For the purposes of this discussion, knowledge management efforts focus on educational objectives such as mastery of concepts, sharing knowledge, integration and generalization of concepts, and continuous knowledge building of the academe. An important element of knowledge management is knowledge portability and the development of academic memories. Knowledge portability allows for the capture (individually or in groups) and reapplication of knowledge artifacts. Much of the knowledge portability is predicated on the construction of knowledge repositories or academic memories.

Concept maps were developed in 1972 as a result of Joseph Novak's research based on David Ausubel's work on meaningful learning on the changes in children's knowledge of science (Novak & Musconda, 1991). An essential part of knowledge management is knowledge or concept mapping, which has been used in all aspects of training and education. "Concept maps are graphical tools of organizing and representing knowledge" (Novak & Cañas, 2008, p. 1). Typical concept maps contain shapes with key words or concepts and connecting lines often with directional arrows that represent relationships among the various words or ideas. Prepositions on the connecting lines are "linking words" or cross links between two or more concepts. Essentially, they are networks of concepts linked by phrases to show the relationship between concepts, which can be either causal or temporal. Novak (1977, 1998) suggested that knowledge creation is a high level of meaningful learning accomplished by individuals or groups who have a well organized knowledge structure in the particular domain of knowledge and have a high emotional commitment to persist in finding new meanings.

One way to increase knowledge transparency in groups and communities is by creating knowledge maps. Knowledge maps provide systematic access in the identification and sharing of critical knowledge. Probst, Raub, and Romhardt's model (2002) "Building Blocks of Knowledge Management" identified six building blocks described in Table 17.1. The six building blocks form the inner cycle of knowledge management. The table provides an explanation of each element and how it was applied in the digital knowledge mapping process.

Two additional elements form the outer cycle of the knowledge management cycle: knowledge goals and knowledge assessment. These elements directly relate to the design, development, and facilitation of instructional strategies as depicted in Table 17.2.

According to Probst's et al. model (2002), knowledge goals are broken down into three distinct areas: normative, strategic, and operational. Normative knowledge goals relate to the creation of community within groups to promote the preconditions for a culture of knowledge sharing and development. The overarching knowledge-building CoP learning environment provided the structure and student support for group culture nurturing and sustainability. Some instructional strategies used in this pilot study to foster normative knowledge goals was the use of a knowledge-building CoP learning environment, team-building activities during the initial face-to face class for community building and group selection. Each group collaborated to complete a learning team charter. The charter detailed each student's skill strengths and weakness, areas for improvement, group roles, and conflict management which became a learning "contract."

Strategic knowledge goal identification is an element of course development that identifies and defines the competencies needed for student success. Instructors use strategic knowledge goals to guide students through the content in a logical,

Table 17.1 Probst's et al. model (2002) inner cycle of the "Building Blocks of Knowledge Management" model

Knowledge management	Explanation	Application
Knowledge identification	An individual meta-cognitive activity. The process is finding knowledge in one's mind that is relevant to the learning task or objective.	Students construct their own knowledge map that can be evaluated for relevance in collaborative activities.
Knowledge acquisition	An individual or group process. The process is to determine what forms of knowledge/expertise should the individual or group acquire through relationship with others in collaborative activities.	Students identify knowledge gaps and work collaboratively to find knowledge and resources to fill the gaps. Digital knowledge maps help students visually search and store knowledge resources.
Knowledge development	Complements Knowledge Acquisition. Making sense of information and generating new knowledge. New knowledge is generated by integration, organization, and linking knowledge with application in contexts.	Students work collaboratively to elaborate, reorganize, fine-tune, and reformat existing knowledge structures. Digital knowledge maps help students to negotiate knowledge, concepts, resources, and links.
Knowledge distribution	An individual and/or group process. Knowledge sharing from individual to group and using knowledge in other contexts. Knowledge is communicated from instructor to student, between students, and from student to instructor.	Students work collaboratively to construct and communicate knowledge to create a shared representation or convergence of knowledge.
Knowledge utilization	External representations of knowledge are structured and represented task appropriately.	Students must construct digital knowledge maps that explicitly represent knowledge elements must be easily tracked and available.
Knowledge preservation	An individual or group process. The intentional selection of information and artifacts. Knowledge accessibility for future use. Organization of knowledge in a format that reflects the content or situation in a literal sense.	Students and groups use digital knowledge maps as a tool in knowledge management. Students represent the knowledge in a procedural or pragmatic format. Digital knowledge maps allow the inclusion of video, graphics, text, and hyperlinks that are organized in such a fashion that it makes sense.

Table 17.2 Probst's et al. model (2002) outer cycle of the "Building Blocks of Knowledge Management" model

Knowledge management	Explanation	Application
Knowledge goals	Instructor activity in the course design and development process. This process incorporates overall student learning outcomes and uses data from Knowledge Assessment to improve the quality of the instruction.	Instructors identify overall knowledge goals and objectives using Digital Knowledge Mapping as an instructional strategy to build highly interactive collaborative activities.
Knowledge assessment	An instructor activity that provides information about the reification of student/group knowledge convergence. Assessment must link to the Knowledge Goals. Assessment indicates course design effectiveness and provides useful information for future design iterations.	Digital Knowledge Maps provides instructors a visual representation student group knowledge convergence. Assessment of student/group digital knowledge maps provides gaps in content and resources for course improvement.

coherent fashion to ensure students meet core competencies identified in the course syllabus. Utilizing knowledge assessment data, instructors are able to determine desirable student outcomes for the future and hence are a segment of the course design process.

Operational knowledge goals ensure that the normative and strategic knowledge goals are actionable, tangible, and measurable. An operational knowledge goal example is the instruction and practice using a specific technology like Cmap Tools, the accessibility of resources and documents relating to weekly content and the opportunity to utilize the use of digital knowledge mapping activities to operationalize the learning goals established by the instructor.

3 Knowledge Convergence

Technology has enabled institutions to focus on learning spaces that blend social elements and technology specifically designed for collaborative learning (Norberg, Dziuban, & Moskal, 2011). The increasing proliferation of technological devices with connection to the Internet have enabled universities to develop online and blended courses that encourage individual and group learning in digital environments that foster the convergence of knowledge. "Computer Supported Collaborative Learning (CSCL) aims to afford knowledge construction and convergence in the context of collective activities supported by Computer Learning Environments (CLE)" (Romero & Lambropoulos, 2011 p. 312). The authors' research suggests that self and coregulation are necessary elements in the knowledge construction and convergence process. Robey, Khoo, and Powers (2000) argued that when learning is removed from where it is applied then it is less effective than when learning is situated. With this in mind, the design of the knowledge based CoP learning environment coupled with the digital knowledge mapping activities situated the learning in the online environment. In a sense, the design of the CoP course enabled the effective transfer of knowledge from one individual to another and to the collective.

Weinberger, Stegmann, and Fischer (2007, p. 1) define knowledge convergence as the "learners becoming more similar to their learning partners with regard to the extent of their individual knowledge." Developing a shared knowledge means that "learners have the knowledge of the very same concepts as their learning partners." Jeong and Chi (2007) define convergence as the outcome of a process by which two or more people share mutual understanding through social interaction. De Lisi and Goldbeck (1999) state that learners who collaborate influence one another when learning together.

Monereo's (2009) definition of knowledge convergence closely aligns with Jeong and Chi's (2007) definition. Monereo further explained the three different levels of knowledge sharing that correspond to varying knowledge convergence levels: consensus knowledge, common ground, and common knowledge. The three levels correspond to specific measurable levels of knowledge convergence (low, medium, and high). The lowest level of convergence, consensus knowledge, suggests a minimum level of convergence. This stage is rather shallow and includes sharing activities that include sharing information, clarifying understanding, and exchanging information without the transformation of an individual's perspective.

The medium level of convergence, common ground, is described as shared cognitive perspective. Common ground is dependent upon interaction that creates mutual understanding, beliefs, knowledge, and assumptions. This is accomplished by the exchange of information by students in the learning environment. The exchange of information through the completion of learning activities promotes shared meaning within the group. Common ground infers awareness of the knowledge of others but does not change knowledge structures of one's own knowledge.

Unlike common ground convergence, common knowledge convergence is the knowledge known by group members (Jeong & Chi, 2007). The highest level of convergence means that there are similarities in-group mental models that require deep individual high-level processing. Through interaction, individuals influence one another to achieve knowledge convergence. The CoP community element directly influences the outcome of knowledge convergence. A Community of Practice consists of a group of people who share prior knowledge and experiences as well as possessing prior unshared knowledge (Wenger, 1998a, 1998b). Collaboration with community members fosters the exchange of shared and unshared prior knowledge so that the community becomes similar in knowledge representations and group mental models. Fischer and Mandl (2005) stated that learners who converge in knowledge benefit more from collaborative learning than learners who do not engage in collaboration. One goal of a CoP is for individuals to converge or become more similar in thought through socially shared meaning.

Situated learning is a theory of knowledge acquisition whereby the learner gradually acquires knowledge and skills learned from experts in the context of day-to-day activities, social interactions and collaboration. Knowledge convergence is evident in communities of practice, specifically, the knowledge learned from others. Weinberger et al. (2007) research conceptualizes the similarity of knowledge prior to collaborative learning activities as shared prior knowledge. CoP practice element defines a set of common strategies and shared values that determine the way a process or skill is performed. CoP group members intuitively share common knowledge, concepts, and experiences to build knowledge. As each member contributes to the group, others analyze and build on ideas. Scardamalia's (2002) knowledge-building principles, in particular idea improvement, is evident in the outcome of knowledge convergence whereby individuals share the knowledge by contributing through dialog so that the others can integrate knowledge and add a new idea or element to improve on other's knowledge. Knowledge convergence in action is evident in the "transaction" of information. Teasley, (1997) states that transactivity is the degree to which learners refer and build on others' knowledge contributions and has been found to be positively related to individual knowledge acquisition in collaborative scenarios. Collaboration is the action among students that fosters the sharing of an individual's knowledge with others in the group to achieve knowledge convergence.

Weinberger et al. (2007) research suggests that knowledge convergence can be measured quantitatively. The analysis of knowledge convergence considers the dependency on how and what is being assessed. Evidence of convergence is measured in a meaningful context not by declarative knowledge tests. Assessing learners in the application of concepts within, complex contexts such as digital knowledge mapping is an appropriate measure of a group's knowledge convergence.

4 Communities of Practice

Social anthropologist, Jean Lave and social learning theorist Etienne Wenger first introduced the term community of practice (CoP) in 1991 to describe a group of individuals who share similar interests and through interaction and activities collectively develop new practices and knowledge. Lave suggests that the "relationship between human thought, human action, and the environment is so tightly interwoven that the mind cannot be studied independently of the culturally organized settings within which people function" (Hewitt & Scardamalia, 1998, p. 75).

As the first knowledge-based social structures, CoPs are not a new phenomenon. They have been in existence for many centuries. Lave and Wenger (1991, p. 47) described a CoP as "a set of relations among persons, activity and world, over time and in relation with other tangential and overlapping communities of practice." Socialization among members is a key component to the success of a CoP. "The central feature of CoPs is the relationships that develop between their members; it is here that the key to understanding the softer aspects of knowledge can be found" (Kimble & Hildreth, 2005).

Characteristics of CoPs vary. However, there are three essential elements: domain, community, and practice (Lave & Wenger, 1991). The domain of knowledge focuses on a shared interest that relates to members' interests and provides the community value and purpose. "The domain of the community is the *raison d'*ê*tre*" (Wenger, McDermott, & Snyder, 2002, p. 31). Members' shared interest provides the motivation to discuss and share what is most important to the community and guides the way knowledge is organized. "A domain is not an abstract area of interest, but consists of key issues or problems that members commonly experience" (Wenger et al., 2002, p. 32). The domain is the center of gravity though its boundaries are permeable due to shifts in member focus. "Over time, they develop a unique perspective on their topic as well as a body of common knowledge, practices, and approaches. They also develop personal relationships and established ways of interacting" (Wenger et al., 2002, p. 5).

Wenger et al. (2002) argue that the second element, community, is "critical to an effective knowledge structure" (p. 34). A community is defined as a group of individuals who share experiences, learn together, and engage in regular interaction through discussion and knowledge sharing activities relevant to their domain. The community is the social fabric of learning where mutual respect, goodwill, trust, and communal identity are intertwined to build interpersonal relationships that promote a sense of belonging. Through regular interaction, members begin to increase collective domain knowledge and acquire individual knowledge and skills. "Over time, they build a sense of common history and identity" (Wenger et al., 2002 p. 35).

The third element, practice, is the engine that drives knowledge, fuels critical reflection, and fosters social identity. "Practice denotes a set of socially defined ways of doing things in a specific domain: a set of common approaches and shared standards that create a basis for action, communication, problem solving, performance and accountability" (Wenger et al., 2002, p. 38). Practice is steeped in the past however, directed toward the future. Members share real world experiences, challenges, stories, tools, and techniques to build and apply new knowledge through interaction and collaboration. Membership implies a level of competence or a baseline of common knowledge as the foundation for which members are able to use their individual perspectives to build knowledge and effectively work together. The community uses activities like brainstorming and negotiation to create new processes, and tools through ongoing interactions for validation of new knowledge. It is important for members to share implicit and explicit knowledge and experiences so that individual members construct their own knowledge. Essentially, a community operates in a living curriculum. Lave and Wenger (1991) suggested the learning that occurred in these CoPs is a form of "socialization into a community, where the newcomer gradually becomes a legitimate member of the community by learning the practice, language and conventions of the community through interaction with its established members" (Kimble & Hildreth, 2005, p. 3). In this sense, "learning is viewed as a situated activity and has as its central defining characteristic a process called Legitimate Peripheral Participation (LPP)" (Lave & Wenger, 1991, p. 92). There is an important connection between individual learning and social identity. Within a CoP, members learn by acquiring new knowledge through a lens of how the member sees the world, based on beliefs and past experiences, and how others see the member. Brown and Duguid (2001) suggested that what individuals learn always and inevitably reflects the social context in which they put it into practice.

A *knowledge-based Community of Practice* is a type of learning environment intended to codify and convert valuable, tacit knowledge into explicit knowledge. The reification process results in a collection of permeable repository of knowledge that can be shared by others in the Community of Practice. Knowledge based CoPs are the vehicle in which its passengers are able to propel the advancement of collective knowledge to develop individual skills and practices by achieving full participation of the members. The following section details the characteristics of knowledge-based Communities of Practice.

4.1 Tacit/Explicit Dimensions of Knowledge

"The knowledge of experts is an accumulation of experience – a kind of residue of their actions, thinking, and conversations" (Wenger, 1998b, p. 9). Explicit knowledge is easily articulated and takes a "hard" form such as documents, websites, podcasts, videos, spreadsheet data, and manuals that can be shared, and transferred to others within a group. In the classroom, explicit knowledge such as a text book is used as a learning tool to influence an individual's knowledge. While these tools are helpful to document knowledge for the individual or group, explicit knowledge is dependent upon tacit knowledge to be truly effective. Tacit or implicit knowledge has an inarticulate component that is the result of how individuals obtain this type of knowledge, which is mostly contextualized, personalized, and acquired through practice and experience and socialization.

Tacit knowledge puts explicit knowledge into practice. Tacit knowledge is present the classroom and described as "know how" transferred by storytelling, conversation, and narrative. "It is quite possible to acquire a tool but to be unable to use it" (Brown & Duguid, 2001, p. 33). The importance of the "know how" or tacit knowledge, "to use a tool involves far more than can be accounted for in any set of explicit rules" (Brown & Duguid, 2001, p. 33). Instead, such activities are framed by a set of cultural assumptions and practices Brown, Collins, and Duguid (1989). It is challenging to use a tool appropriately without understanding the community or culture in which it is used.

The use of concept maps to help create meaningful learning is supported by Vygotsky's (1928, 1979) positions on the importance of social interaction in learning. Lev Vygotsky's theory of cognitive development suggests the importance of social interactions in the development of human intelligence. He argues that the higher cognitive function or consciousness is the product of socially meaningful activities and that an individual's mind is created from social interactions through observation. His work "stresses that individual intelligence emerges as a result of biological factors that interact with physical and especially a social environment through a developmental process" (Lindblom & Ziemke, 2003, p. 80).

According to Vygotsky (1934, 1978) there are elementary and higher levels of mental function. Elementary mental functions are inherent in a human or animal and are referred to as signalization. Signalization is the direct link between the stimulus and the response that is limited to simple memory, attention, and other rudimentary sensory functions that lack thought. Vygotsky further postulates that higher mental function is an exclusively human phenomenon and is a direct result from human interaction. Higher mental function requires an intermediate step such as language or other psychological tools that generates thought in an individual to bridge the path between the stimuli that result in a different response. There are two levels that comprise the higher mental function: the interpsychological level is the interaction between people, and the intrapsychological level is the interaction within the individual. An individual has the ability to behave in a certain manner through observation and integration of knowledge both deliberately and unconsciously.

The internalization process is related to Vygotsky's theory, Zone of Proximal Development (ZPD) where the transformation of interpersonal functions to intrapersonal function occurs. The individual learns through the interactions with others to use psychological tools in order to acquire and integrate knowledge. The zone represents the "distance" between an individual's actual level of independent problem solving and the level of potential ability to problem solve under supervision or in collaboration with more capable people. In this respect, Lave's (1988) apprenticeship learning theory and the relationship between the novice and master is similar to Vygotsky's concept of ZPD.

5 Method

The argument of this study is supported by the idea that collaboration through knowledge mapping activities in a CoP learning environment has a central role to play in knowledge convergence and meaningful learning. Additionally, this work is currently framing the authors' pilot research in terms of how Cmap Tools can be utilized by teachers and instructional designers to facilitate knowledge management and knowledge convergence through the process of collaboration.

5.1 Participants

The participants for this study included 20 graduate-level students (13 female, 7 male) at varying levels of graduate study (9 doctoral, 11 master) at a North American university. Students' major emphases of study are: Literacy Education (1) Adult and Higher Education (2) and Instructional Technology (18). All graduate students in the Instructional Technology program must successfully complete the course in order to graduate from the program.

5.2 Research Context and Materials

The ProSeminar class in Instructional Technology is the foundation course for the Educational Technology Program. Students are required to complete this course early in their academic career. The Department and College Curriculum Committee approved the content. The 15-week course was originally developed for traditional, face-to-face delivery. As technology has evolved, the course was redesigned into a blended, accelerated 7-week format. The following topics are included:

- The Instructional Technology field and definition
- Learning Theories
- Instructional Design Models
- Social Learning
- Informal Learning
- Literature Review and Annotated Bibliography

Each week focused on a specific concept. The students were required to complete individual and group activities. Individual assignments included a reflective response to a forum question, responding to other students' postings, submitting an annotated bibliography on the weekly concept and writing a reflection paper. Group activities included collaboration on the creation of five digital knowledge maps and a group literature review.

The ProSeminar in Instructional Technology course was developed and designed to operate in Moodle (Modular Object-Oriented Dynamic Learning Environment). Moodle (https://moodle.org/) is an open source Learning Management System application developed and maintained by a consortium of educators to promote constructivist pedagogy. Moodle's functionality offers many features for the design of online instruction. Instructional designers have the ability to create comprehensive, content-rich, highly collaborative learning environments that complement the CoP elements.

5.3 Instructor Activities That Support Learning

The instructor plays a pivotal role in the success of a community of practice learning environment. The traditional instructor role of "sage on the stage" is no longer effective in the online environment. Rather, the instructor becomes a coach, mentor, learner, and champion in the community. Wilson, Ludwig-Hardman, Thornam, and Dunlap's (2004) research on bounded learning communities suggested that the instructor must have a teaching presence within the online community. The instructor's role includes modeling knowledge construction, troubleshooting and resolving problems, monitor learning, use meaningful instructional strategies and establish trusting relationships with students. The following facilitation strategies were implemented in the delivery of the ProSeminar in Instructional Technology course.

Precourse activities. One week before the class began, a welcome letter was sent to the students that detailing course content, login instructions for Moodle, and instructor expectations. The students were required to create a "digital introduction" and post their presentation in a designated discussion forum in Moodle before the start of the semester. One instructional strategy employed in the course was the use of Cmap Tools to create concept maps. The Unified Theory of Acceptance and Use of Technology (UTAUT) instrument was administered to determine student behavioral intent in the use of knowledge mapping technology. The results determined the increase or decrease of instructor scaffolding activities and resources to help promote the use of the concept mapping application. Venkatesh, Morris, Davis, and Davis (2003) developed and validated the UTUAT incorporating seven paradigms: performance expectancy, effort expectancy, and attitude toward using technology, social influence, facilitating conditions, self-efficacy, and anxiety.

Course activities. The first class meeting focused on team-building skills. Each group completed a team charter that inventoried student strengths and weakness, contact information, areas for growth, roles, and a conflict management process. Essentially, the team charter became a learning contract between the students and a mediation tool for the instructor. During the first class meeting students downloaded Cmap Tools and started working with the application. Additional resources were uploaded in Moodle to provide ongoing support for mastering Cmap Tools. After each collaborative knowledge mapping activity, the students completed a Team Assessment and Diagnostic Instrument (TADI) that measured general types of knowledge. The empirically validated tool is shown to be strong indicator of a group's shared cognition and also determines if team intervention is needed. "The TADI was specifically created to measure the degree of team-related knowledge in order to determine team-related knowledge sharedness" (Johnson, Silkorski, Mendenhall, Khalil, & Lee, 2010, p. 338). The instrument is segmented into five factors: general task and team knowledge, general communication skills, attitude toward team and task, and team resources and working environment. The results provided the instructor with an indication of team processes and team performance. The data for each factor and combined factors can be used to determine the type of intervention that is most appropriate.

Support for knowledge map creation. Novak's (1977) research on concept mapping for children suggests two different techniques to start concept mapping activities: focus question and a list of concepts called the "parking lot" and using an expert concept map for more complex knowledge. For the purposes of this study, the researchers used a modified version of the former technique that utilized a focus question without the parking lot. In addition to the focus question, a number of readings or web resources were provided to start the process of the creation of knowledge maps.

6 Results and General Discussion

The goal of this chapter was to demonstrate instructional strategies that promote knowledge convergence through the use of digital knowledge mapping within an online knowledge-building Community of Practice (CoP) learning environment. This exploratory research focused on leveraging the knowledge mapping application, Cmap Tools to enhance knowledge management and group convergence. The following section will discuss the results of the UTUAT instrument and the emergent themes and evolution of group digital knowledge maps.

6.1 UTUAT

The four constructs of the UTUAT instrument: effort expectancy, performance expectancy, social influence, and attitude are hypothesized to have a significant impact on user acceptance and behavioral intent. The highest student response average rating for effort expectancy in "learning to use knowledge mapping technology is easy" statement shows 4.52 and "it is easy for me to become skillful at using Knowledge Mapping Technology" statement shows 4.48 which indicates that the students perception to the degree of simplicity associated with the knowledge mapping technology is high (Fig. 17.1).

The highest student response average rating for performance expectancy in "using knowledge mapping technology increases my chances of producing quality work" statement shows and average rating of 4.71 and "using knowledge mapping technology increases my productivity" and "I find knowledge mapping technology useful in my day to day job tasks" statements shows an average rating of 4.67 which indicates that the students perception to the degree to which students believe that

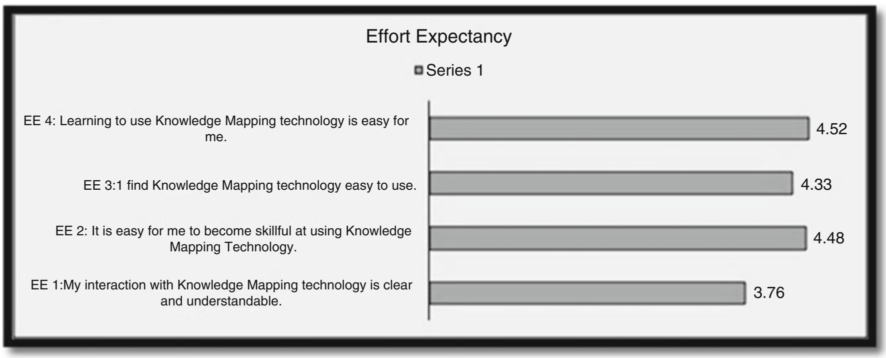

Fig. 17.1 Effort Expectancy (EE) The degree of simplicity with the use of Knowledge Mapping technology

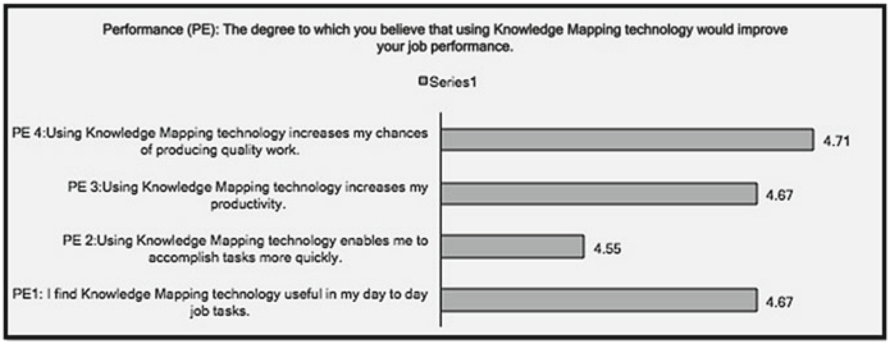

Fig. 17.2 (PE) Performance expectancy

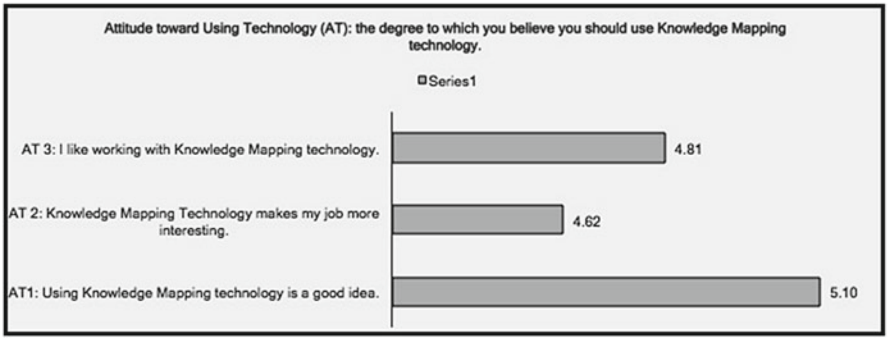

Fig. 17.3 (AT) Attitude toward using technology

using knowledge mapping technology would improve their performance is high. However, students responded lower to the statement "using knowledge mapping technology enables me to accomplish tasks more quickly" with an average rating of 4.55 which indicates that the students' perception is that knowledge mapping activities increase performance but takes longer to complete (Fig. 17.2).

The highest student response average rating for attitude toward using knowledge mapping technology in "using knowledge mapping technology is a good idea" statement shows an average rating 5.10 and "I like working with knowledge mapping technology" statement shows an average rating 4.81 which indicates that the students the degree to which students believe they should use knowledge mapping technology is high (Fig. 17.3).

The highest student response average rating for the social influence category in "people who are my superiors think that I should use knowledge mapping technology" statement shows an average rating 3.33 and "people who influence my behavior think that I should use knowledge mapping technology" statement shows

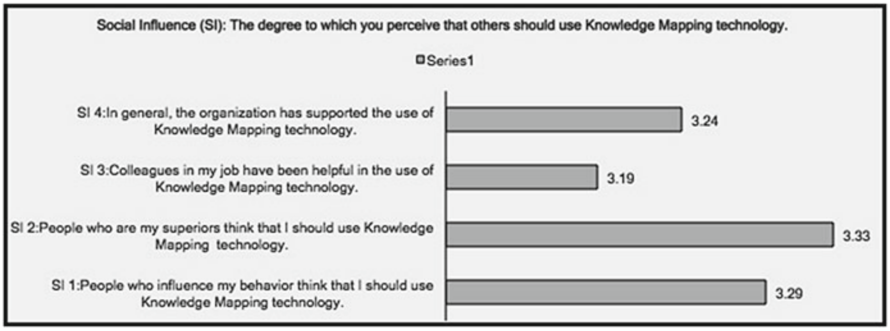

Fig. 17.4 (SI) Social Influence

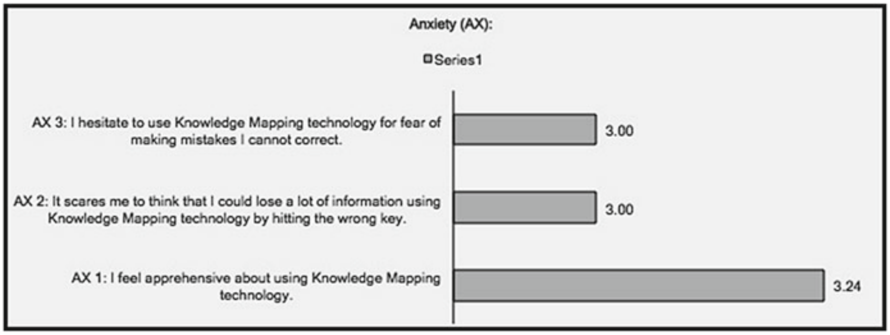

Fig. 17.5 (AX) Anxiety

an average rating 3.29 which indicates that the students perception to the degree of to which their instructor should use knowledge mapping technologies (Fig. 17.4).

The highest student response average rating for anxiety in "I feel apprehensive about using knowledge mapping technology" statement shows an average rating of 3.24 and "I hesitate to use knowledge mapping technology for fear of making mistakes I cannot correct" and "It scares me to think that I could lose a lot of information using knowledge mapping technology by hitting the wrong key" statements shows an average rating 3.00 which indicates that the students' anxiety regarding the use of knowledge mapping technology is low (Fig. 17.5).

Students' intent to use knowledge mapping technology in the future is high. The highest student response average rating for behavioral intent in "I predict I would use knowledge mapping technology in years to come" statement shows an average rating 5.00 and "I intend to use knowledge mapping technology in the next year" statement shows an average rating 4.81 (Fig. 17.6).

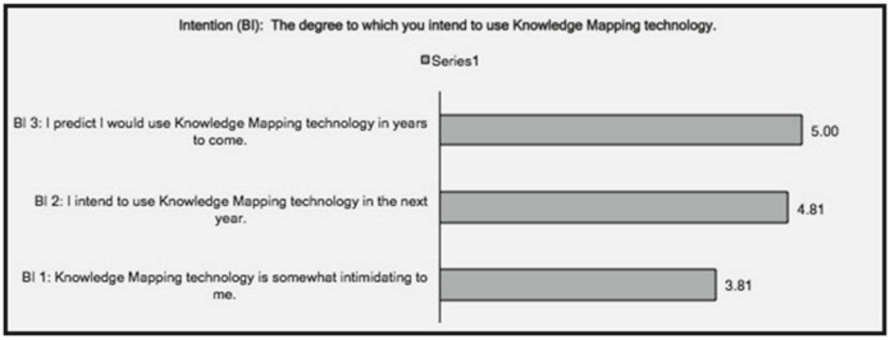

Fig. 17.6 (BI) Behavioral intent

6.2 Digital Knowledge Map Analysis

"Cmap Tools supports the construction of 'knowledge models': sets of concept maps and associated resources about a particular topic." (Cañas, Hill, & Lott, 2003 p. 2) Digital knowledge map creation emphasizes relating new knowledge to the student's existing knowledge structures to facilitate meaningful learning. This section provides a discussion of the researchers' observations of the common themes and evolution of the characteristics of group digital knowledge maps throughout the semester.

Thematic content was derived from widely varying concept map designs by searching for commonalities and taking simple counts of concepts addressed as well as through use of a matrix rubric developed as themes emerged from the analysis. Rubric analysis of the content was required by hand since concept maps do not readily lend themselves to software applications for qualitative analysis. Moreover, the manageable amount of data permitted an informal approach to coding while larger amounts of data would have demanded more complex approaches. The following tables provide a list of knowledge map concepts broken down by group.

All group knowledge mapping activities were prompted by a focus question. Students worked collaboratively to create a knowledge map that relates to the week's topic. The first knowledge map developed by the groups was created during the first class session. The simple knowledge map is an example of Monereo's (2009) lowest level of convergence which is consensus knowledge and suggests a minimum level of convergence. The students shared information and exchanged information without the transformation of an individual's perspective (Fig. 17.7).

The groups worked collaboratively to define the Instructional Technology field. Figure 17.8 below represents an example of the simplicity of the group's mental model of the topic and creation of the first Cmap.

All five groups converged on a link to learning theories, ethical practice, instructional design models, and professional practice in response the focus question: Define the Instructional Technology field. The data shows that many concepts were

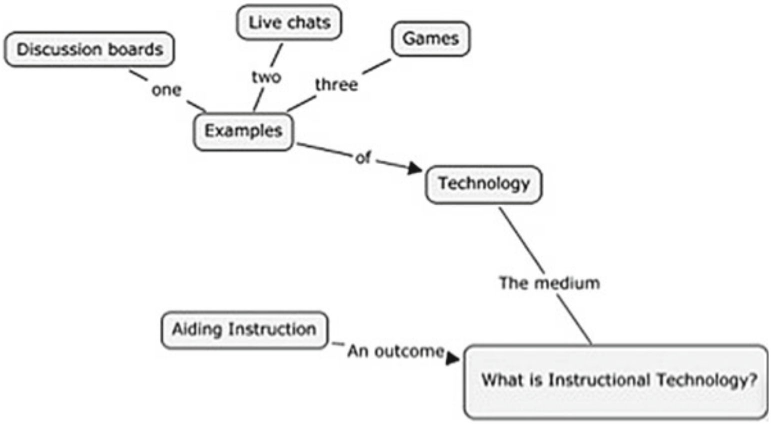

Fig. 17.7 Example of pretest knowledge map

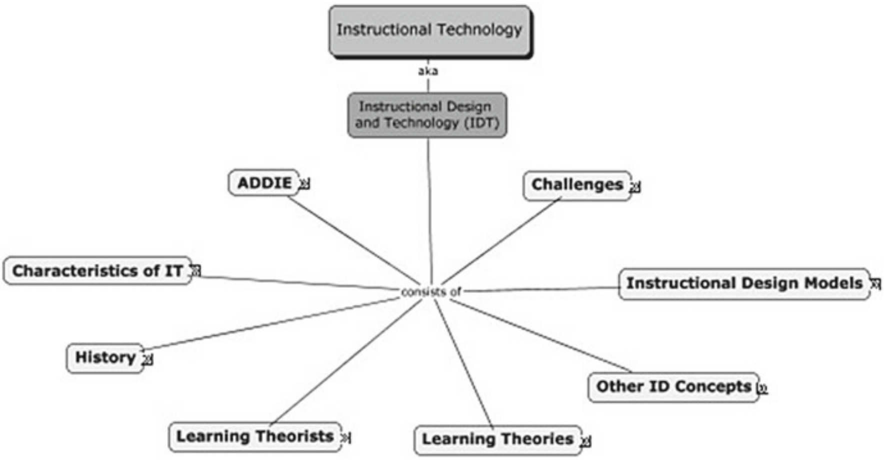

Fig. 17.8 Example of topic one group knowledge map

shared among the groups with the "history" concept consistent across all five groups (Table 17.3).

The number of concepts range from six to eight nodes. The knowledge maps represent a free-style format. It is interesting to note that some of the groups used a timeline format as shown in Fig. 17.9 to structure the knowledge maps while others used a hierarchical structure as shown in Fig. 17.10.

The second knowledge map activity focused on different instructional design models. The concept totals are low across the groups; however, groups two, four, and five referenced each other's theorists as influencers of their assigned ID model (Table 17.4).

Table 17.3 Topic one coding rubric for knowledge maps

Topic one: definition of instructional technology and field					
Themes	Group 1	Group 2	Group 3	Group 4	Group 5
Professional organization	1				
History	1	1	1	1	1
Instructional design					
Ethics	1			1	1
Instructional technology		1	1	1	1
Learning theories	1	1		1	
Analysis of performance problems	1			1	1
Instruction	1	1	1		
Contexts			1	1	1
Learners	1	1	1	1	1
ID Models	1	1	1	1	1
Total:	8	6	6	8	7

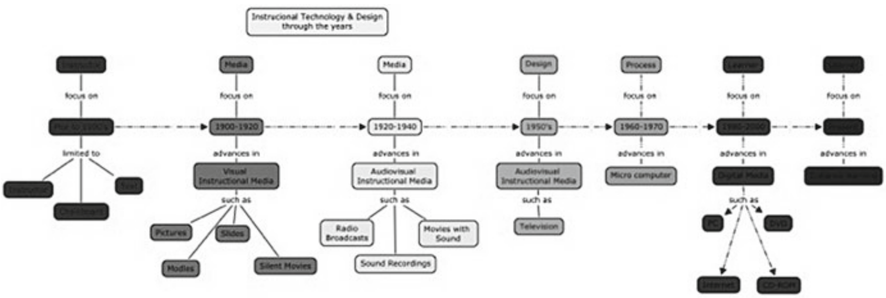

Fig. 17.9 Example of timeline structure

The sophistication of the group knowledge maps grew throughout the semester. As students' expertise with the software functionality increased additional elements such as color, shape, resources, and graphics emerged. The groups' knowledge maps indicate a medium level of convergence, or common ground, which is shared cognitive perspective. This is accomplished by the exchange of information by students in the learning environment. Common ground infers awareness of the knowledge of others but does not change knowledge structures of one's own knowledge (Table 17.5).

Over time, the knowledge maps became more complex in the number of concepts, links, cross-links, and prepositions. The knowledge map shown below is an example of a group knowledge map that shows a more complex representation of the topic that includes imbedded documents, graphics, hyperlinks, videos, and podcasts (Fig. 17.11).

The last knowledge map represented the highest level of concepts that overlapped across the groups. Concept nodes ranged from five to eleven primary nodes and included theorists and concepts that were consistent across groups (Table 17.6).

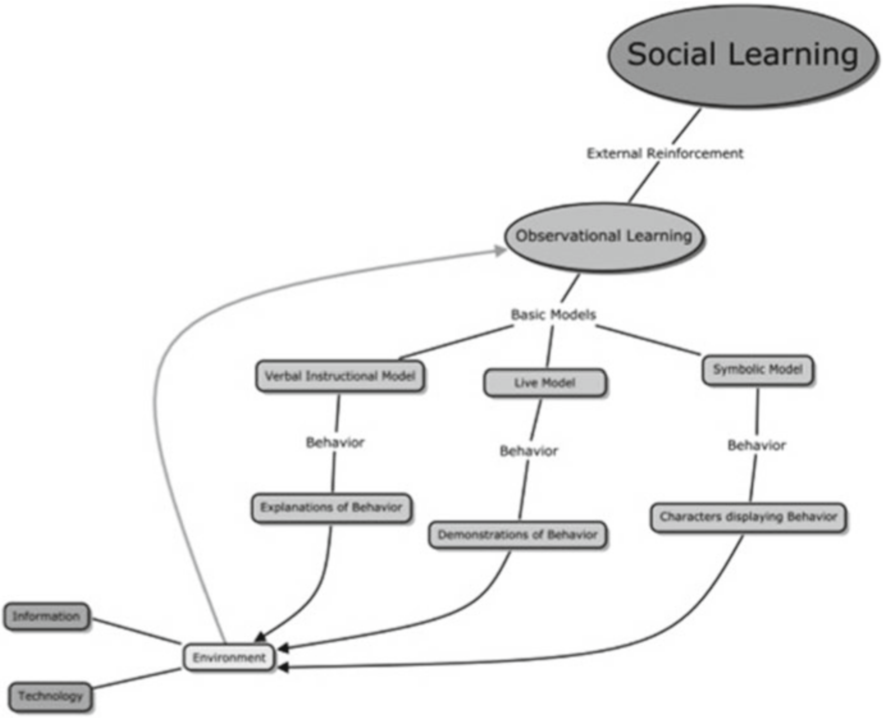

Fig. 17.10 Example of hierarchy structure

Table 17.4 Topic two coding rubric for knowledge maps

Topic two: instructional design models					
	Group 1	Group 2	Group 3	Group 4	Group 5
Gagne	1	1			
Understanding by design			1		
Dick and reiser				1	1
Dick and carey				1	1
ASSURE		1			
Categories of learning	1				
Learning events	1				
Systemic	1	1	1	1	1
Bransford					1
Total	4	3	2	3	4

Visual complexity, on the other hand, grew significantly as teams sought images to represent the various concepts. Figure 17.12 represents a knowledge map of Vygotsky's (1978) Zone of Proximal Development that uses graphics instead of concept nodes and text to represent cross-links.

Table 17.5 Topic three coding rubric for knowledge maps

Topic three: informal learning					
	Group 1	Group 2	Group 3	Group 4	Group 5
Informal learning	1				1
Nonformal learning	1	1			
Situated cognition			1	1	
Communities of practice				1	
Social learning	1		1	1	1
Constructivist		1			
Formal learning	1				
Incidental learning	1				
Context	1	1		1	1
Authentic activities		1	1	1	
Definition	1				1
Instructor		1	1		
Outcomes		1	1		1
Total	7	6	5	5	5

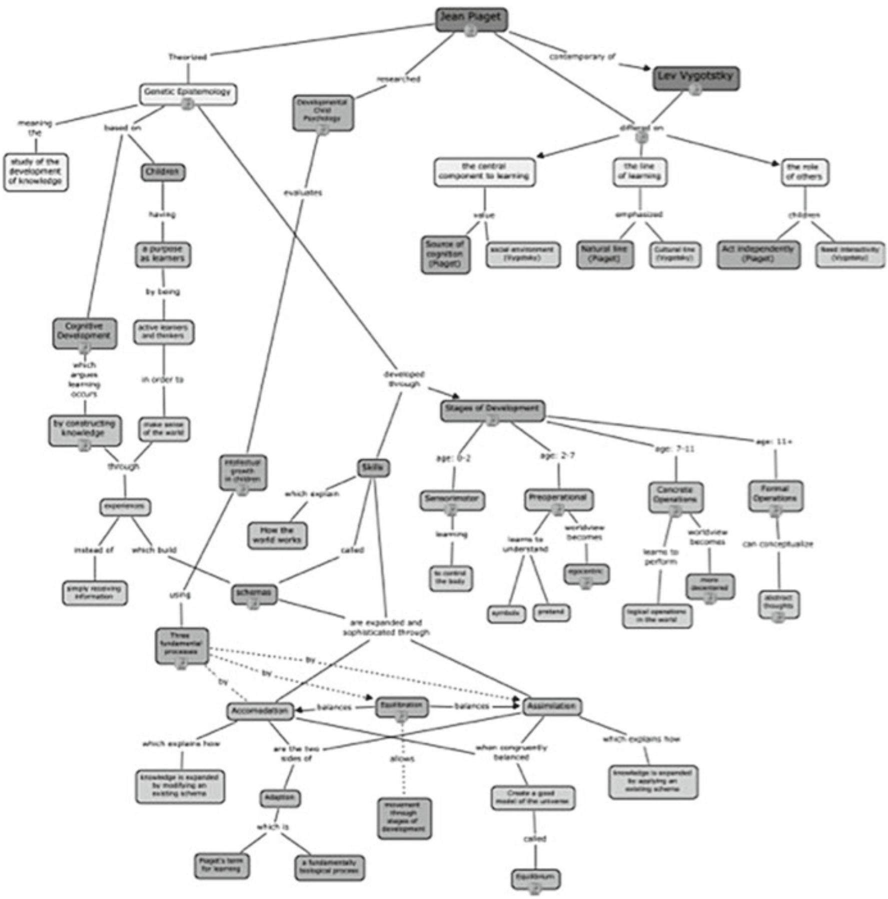

Fig. 17.11 Example increasing complex knowledge maps

Table 17.6 Topic four coding rubric for knowledge maps

Topic four: Vygotsky and Piaget					
	Group 1	Group 2	Group 3	Group 4	Group 5
Vygotsky	1	1	1	1	1
Piaget	1	1		1	
Social development theory	1	1		1	1
Elementary mental functions	1		1		
Knowledge development				1	1
Cognitive development	1			1	
Stages of development	1	1		1	
Higher mental functions		1	1		
ZPD	1		1		1
Developmental psychology				1	
Sociocultural approach	1				
Tools of intellectual development	1		1		1
More knowledgeable others	1		1		
Assisted performance					1
Individual performance					1
Language	1		1		
Inner speech			1		
Total	11	5	8	7	7

Instructor and individual team member checking added truthfulness to the data analysis (Glesne, 1999). Member checking activities include reviewing the knowledge maps and making interpretations that are brought back to the students to verify their perspective and to help the researchers develop new ideas or interpretations (Glesne, 1999, p. 152). Individual students' within the teams reviewed their maps independently and as a group and refined where necessary, working with the researchers to assure accurate interpretation. The teams then negotiated the final integrative concept map that coalesce the ideas of all five teams into a coherent whole that represented conceptual convergence on the core themes discussed above. The final class knowledge map complexity was seen to decrease as each group began to chunk concepts and develop more coherent schema for the data. More efficient use of Cmap functionality afforded the streamlining of concepts which utilized the "expand and collapse" functionality. Additionally, the highest level of knowledge convergence, common knowledge, was evidenced by the final class map. The highest level of convergence means that there are similarities in-group mental models that require deep individual high level processing.

6.3 Conclusion

Research on the design and development of online Communities of Practice is still emerging. Among the issues is "the evolutionary pattern of CoP development is poorly understood" (Schwen & Hara, 2003, p. 262). Schwen and Hara (2003)

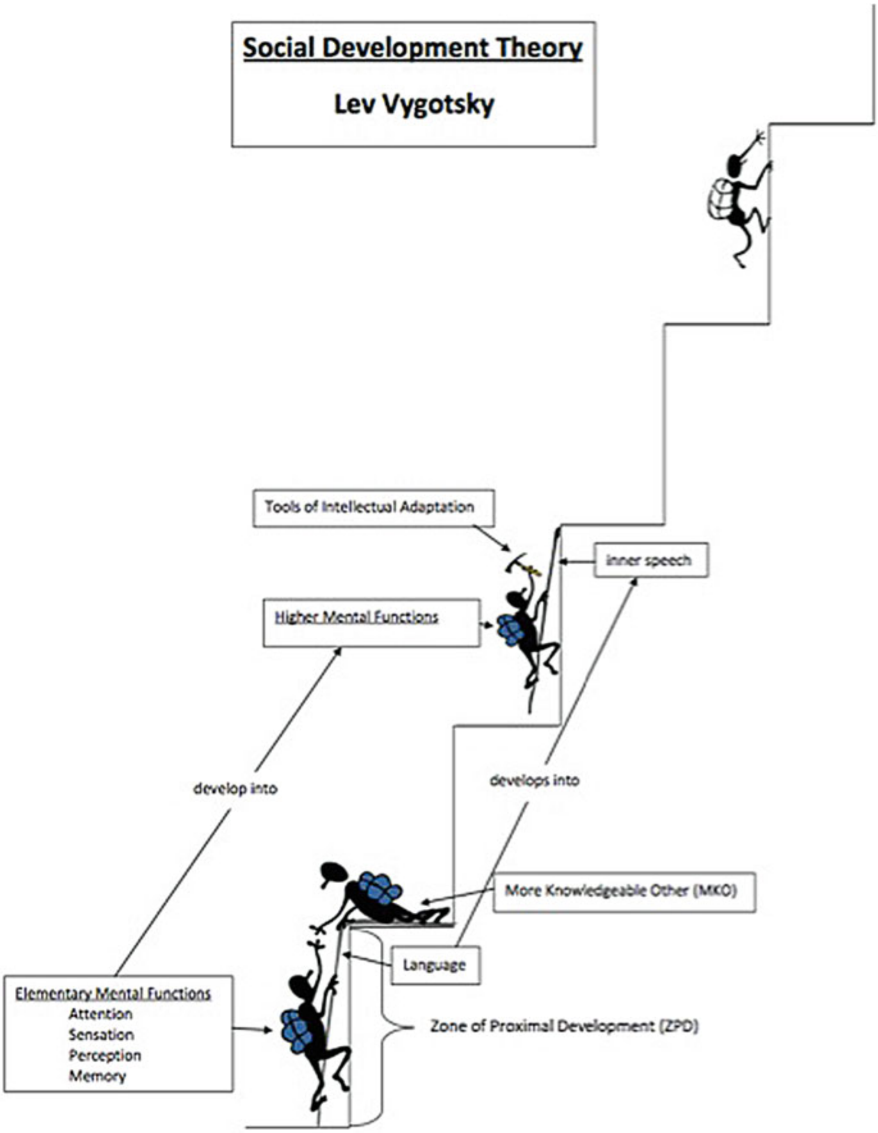

Fig. 17.12 Example of visuals instead of traditional nodes

suggested that Communities of Practice are fully functioning when they evolve over time, which makes them difficult to study. Questions also have been raised about the role of knowledge in Communities of Practice. Researchers have varied interpretations of knowledge, particularly with regard to knowing in practice, and hence it is worth studying. Schwen and Hara (2003, p. 263) stated "knowledge and knowing epistemologies are two distinct processes that require different designs to support optimal community learning."

Knowledge convergence is the common thread throughout this discussion. Instructional strategies such as digital knowledge mapping can foster communication and collaboration among students to develop and grow a thriving knowledge base. Instructors, who use online CoP learning environments as a vehicle to foster relationships, collaborate to build knowledge so that individuals and groups effectively share to achieve knowledge convergence. The evolution of the knowledge maps throughout the semester provides a visual representation of the three types of knowledge convergence as defined by Monereo (2009).

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