Knowledge Building and Reframed Conceptual Change – A Cross Fertilization

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Abstract

In this paper, we attempt to reposition knowledge building using the recent developments in conceptual change research mainly at a theoretical level. We highlighted the following in this paper: First, rather than rectifying isolated misconceptions, the notion of idea improvement is similar to changing naïve theories which are domain-specific lay theories. Second, naïve ideas are not suppressed or condemned as incorrect conceptions, but rather as the foundation for building deep understanding. Third, beyond cognitive factors, conceptual change should take into account situative factors; social cultural effort like assumption of collective cognitive responsibility in Knowledge Building are more effective than simply creating cognitive conflicts. Fourth, conceptual change involves metaconceptual awareness which could be achieved through Knowledge Building discourse. Last, Knowledge Building approach engages students directly in epistemic construction of knowledge, which could potentially change their epistemological beliefs that are conducive for conceptual change.

Introduction

For more than two decades, researchers and educators in the Knowledge Building communities have been working towards advancing the frontier of knowledge work and knowledge creation in education. Knowledge Building approach focuses on student-initiated problems of understanding of the world and continuous collaborative effort among students to improve their ideas; students assume collective cognitive responsibility in an environment of diversity and complexity to achieve new level of knowledge and understanding (Scardamalia and Bereiter, 2006). Parallel to the Knowledge Building community's effort, researchers in the field of conceptual change have proposed various theories on sources and strategies of changing misconceptions, alternative conceptions or naïve theories (Caravita, & Hallden, 1994; Hatano, 1994; Vosniadou & Verschaffel, 2004). We see some parallel developments in these two fields of research which could provide a fertile ground for research studies. For example, Chan, Burtis, & Bereiter (1997) found Knowledge Building as a mediator of cognitive conflict in conceptual change. We believe more research effort could be invested in this area. This paper marks our beginning effort to cross-fertilize ideas generated from the two fields of research work towards symmetric knowledge advancement between them.

In this paper, we examine the congruency and synergy between reframed conceptual change approach and the Knowledge Building principles. In the most recent attempts (Caravita, & Hallden, 1994; Hatano, 1994; Vosniadou & Verschaffel, 2004) to reframe the conceptual change approach, Vosniadou (2007a) proposed a constructivist, and domain-specific approach to address limitations surfaced by researchers in the field. This paper draws heavily on the conceptualization articulated by Vosniadou (2007a, 2007b).

Concepts, Naïve Theories and Ideas

For the past three decades, research in the area of science learning, especially in the field of cognition and instruction, have shown that students come to school with intuitive conceptualizations of physical phenomena which are different from those of scientist community (Nersessian, 1998). Children already attained a common-sense understanding of everyday phenomena, also known as “prior knowledge”, “informal knowledge”, “naïve theories”, “alternative conceptions” or “naïve theories”, when they first begin school (Schnotz & Preuß, 1999; Duit, 1999). In the past, research in conceptual change tends to focus on identifying students’ misconceptions that are erroneous from the scientists’ standpoint. Conceptual change in this perspective requires the effort to replace or remove such alternative conceptions with ‘correct’ conceptions. Despite efforts made to identify students’ misconceptions and review of science curricula to enhance learning, students continued to retain their misconceptions (Edwards & Soyibo, 2004). Such prior knowledge may not be a part of the coherent system of scientific concepts taught in school (Schnotz & Preuß, 1999) but they are relatively stable and resistant to change (Vosniadou, 1999; Ali, 1990; Brown, 1992; Gunstone, 1998; Schnotz & Preuß, 1999) as they are deeply rooted in daily life experiences and are continuously supported by such experiences as a coherent explanatory structure (Vosniadou, 1999; Duit, 1999).

In the reframed approach, what need to be changed are not the isolated misconceptions but the “naïve, intuitive, domain-specific theories in early childhood, on the basis of everyday experiences” (Vosniadou, 2007b, p. 4). In other words, misconceptions cannot be conceptualized as faulty isolated alternative conceptions, but as naïve theories that possess a coherent body of domain-specific knowledge system and that form the basis of students’ explanation and prediction based on lay experiences. In this regard, Knowledge Building offers an avenue for students to change their naïve theories rather than to correct their misconceptions.

In Knowledge Building, ideas are considered improvable and are treated with respect and valued according to their contributions to the group's knowledge base. Ideas are "systematically interconnected - one idea subsumes, contradicts, constraints, or otherwise relates to a number of others" (Scardamalia, 2002, p.6). The ideas proposed by students, regardless of how naïve they are, are not condemned as misconceptions. Rather, all ideas are treated as valuable and meaningful contributions, and initial ideas which may lack scientific explanations are regarded as a crucial starting point in the process of constructive idea improvement. Deep learning happens when students not only seek to explore and understand the interconnectedness of ideas but most importantly, to "rise-above" these ideas to achieve a new level of understanding. This is in alignment with what is called a "complex theory-like structure" of concepts (Vosniadou, 2007a, p.11; Thagard, 1990). Students in the Knowledge Building process seek to understand ideas not only through understanding the attributes of individual ideas, but also their integrative complex structure that connect the ideas.

Situative Factors and Collective Cognitive Responsibility

Previous research on conceptual change primarily focused on three areas of investigation: (a) cognitive factors that influence conceptual change; (b) developmental changes in students' knowledge representations; and (c) design of instructional strategies and methods to foster change (Sinatra, 2005). Although such research has made contributions to the field, they gave little accounts on factors such as motivational, situational, and affective factors that are likely to influence conceptual change. They were referred to as "cold conceptual change" by Pintrich, Marx, and Boyle (1993) in their highly referenced writing. In recent conceptual models such as the Cognitive Reconstruction of Knowledge Model (CRKM) and Cognitive-Affective Model of Conceptual Change (CAMCC) that were proposed by Dole and Sinatra (1998) and Gregoire (2003) respectively, factors that were not previously accounted for in the process of conceptual change were considered: motivational, affective and contextual components were discussed and elaborated. In the reframed approach, Vosniadou (2007a) stresses that conceptual change is not merely an internal cognitive process but rather one that happens in a broader situational, cultural and educational context, and that is significantly influenced by socio-cultural factors. Hatano and Inagaki (2003) explicitly discussed why socio-cultural factor is germane to intentional conceptual change in comprehension. Using their research findings on collective comprehension activity, they argued that it was not sufficient for teachers to provide students with experience that showed the inadequacy of their conceptual knowledge (see Chin & Brewer, 1993). Such experience may induce motivation for students to check for the inconsistencies in their understanding but it may not be strong enough. By providing students with socio-cultural and cognitive support, such motivation for deeper understanding may be amplified.

The notion that conceptual change process may be influenced by situative factors is congruent with one of the central idea of Knowledge Building: collective cognitive responsibility. In the Knowledge Building community, knowledge advancement relies on community's effort rather than on individual's achievement (Scardamalia & Bereiter, 2006). The emphasis is on the production and continual improvement of ideas of value to a community (Scardamalia & Bereiter, 2003, p. 1371). The contribution of individual is honored as it will "give rise to and speed the development of yet newer knowledge" (Scardamalia, & Bereiter, 2006, pp. 99). Moreover, knowledge building in the reframed conceptual change approach can be seen as "requiring the ability to take multiple perspectives, examine different points of view" (Vosniadou, 2007a, p. 10). The focus of conceptual change in this sense is no longer just the replacement of misconceptions or an incorrect theory with a correct one, but rather the ability to gain a wider and broader perspective. For this reason, we suggest building Knowledge Building community that enables individuals to assume responsibility for collective cognition a long term endeavor of conceptual change.

Mechanisms of conceptual change

Research on conceptual change has spawn from two major fields: cognitive developmental psychology and science education. Conceptual change approach developed by science educators is designed to support instruction that will bring about conceptual change (Vosniadou, 1999), whereas the cognitive developmental psychologists advocate for rich descriptions on various internal cognitive processes that mediate conceptual change (Sinatra & Pintrich, 2003). Although both have contributed largely to the investigation of conceptual change, a common shortcoming is that both perspectives suggest that when learners are aware of the conflict between existing knowledge and the scientifically proven information, conceptual change is most probable to happen (Sinatra, & Pintrich, 2003). On the contrary, many studies have shown that cognitive conflict strategy, which is a common approach (Posner, Strike, Hewson, &

Gertzog, 1982; Niaz, 1995) to foster conceptual change, is insufficient to induce change (Dole, & Sinatra, 1998; Alervemann & Hague, 1989, Guzzetti & Glass, 1993; Hynd & Alvermann, 1989) because even when learners are able to use scientific conception in formal learning situations, they continued to use their non scientific conceptions in their encounters with phenomena in the everyday context.

Under the reframed approach, conceptual change process is a slow and gradual process as it requires constant effort to intentionally re-examine o one's conceptual understanding and students usually lack the metaconceptual awareness of their own beliefs and of the process for change (Vosniadou, 2003). This reframed approach accounts for why certain instructions failed to change students' naïve conceptions. Vosniadou (2007a; 2007b) proposes using instruction-induced conceptual change rather than bottom-up implicit additive mechanisms which may produce synthetic models, to achieve more significant change in learning.

Let us illustrate the formation of synthetic model with a case example. In our earlier attempts to understand conceptual change process in students' learning (Lee & Tan, 2006), we observed that the bottom-up implicit additive approach may in a way contribute to the formation of synthetic models. In our study, we gave students a diagram of a man, a tree and the sun and we required them to draw arrows to show how light travels and also explain the process in words. In the pretest, one student drew arrows from the sun to the tree and he explained: "because the sun shines everywhere." After instruction that was supposed to remove such misconception, the same student on the same question drew accurately. However, he explained: "the sun shines the tree then the tree shines the boy so that the boy can see." This was an attempt made by the boy to incorporate new information into this existing knowledge structure. We concluded that because the new information given to the boy was inconsistent with his naïve model of the reflection of light which was built based on his everyday observation, the boy has yet to fully understand the complex and abstract nature of the science concept. Hence, he added the new information to his initial understanding in order to reconcile the conflict and this was done without realizing that a synthetic model was being created instead of a scientifically accepted one.

In contrast to bottom-up additive approach which assumes that new information is adding to the existing explanatory framework through participation in socio-cultural activities, instruction-induced approach entails systematic instruction so that children can understand the complex counter-intuitive scientific theory which has a different explanatory framework as compared to their naïve theories. In this reframed approach, instruction-induced approach requires the restructuring of one's naïve theories, and also one's modes of learning, with the creation of metaconceptual awareness (Vosniadou, 2003: chapter from Erik De corte) and intentionality (Sinatra & Pintrinch, 2003).

At first glance, instruction-induced approach may sound antithetical to Knowledge Building approach, we argue, however, that Knowledge Building can achieve similar goal by building student's epistemic capacity in gaining metaconceptual awareness. We believe that with careful implementation, Knowledge Building intervention can achieve conceptual change while avoiding the formation of synthetic models by engaging students in Knowledge Building discourse or KB talk, both in online forum and in class. Through the use of cues like "My theory is", "I need to understand", "My theory cannot explain" or "A better theory is" in Knowledge Forum, students are scaffolded to gain metacognition and epistemic capacity by constantly examining their understanding. Explanations generated as synthetic models will be under the scrutiny of peers and teachers. At appropriate juncture, the teacher could organize KB-talks where students share their “Knowledge Advance” (findings from their investigation) and “Problems of Understanding” with their peers (Messina, Reeve, & Scardamalia, 2003). These are explicit attempts to critically examine students’ conception through self-examination and peer critique by constructing a communal knowledge base and engaging in Knowledge Building discourse.

Epistemic beliefs

Over the past 20 years, numerous studies have documented the influence of personal epistemological beliefs on learning (Qian & Alvermann, 1995; Windschitl & Andre, 1998). For instance, Hofer and Pintrich (1997) argued that “if one believes knowledge is simple, there is no reason to attempt to use deeper processing strategies such as elaboration; simple memorization will suffice” (p. 128). The influence of epistemological beliefs is intensified especially when we observed that some students are more inclined toward changing their understanding while others hold on tightly to their understanding (Lee, 2006).

Conceptual change is a complex process which entails cognitive factor as well as non cognitive factors such as socio-cultural, affective, and motivational factors. Researchers also stress the importance of personal epistemological beliefs, as it is functioning as a third-order monitoring process of the epistemological nature of problems (Kitchner, 1983). In the reframed approach, Vosniadou (2007a) emphasizes the direct or indirect influences of epistemological beliefs on conceptual change. To be specific, when students believe that knowledge is certain, simple and stable, they are less likely to accept new information that questions their assumptions. On the other hand, when students believe that knowledge is complex, unstable, and evolving, they are more receptive to new information even when such information is inconsistent with their presuppositions. Epistemological beliefs can also influence learning indirectly by influencing students' learning strategies or goal setting.

We propose that Knowledge Building could influence students' epistemological beliefs which in turn could be critical for conceptual change. In a Knowledge Building community, individuals work in a "design mode", starting with their initial ideas and taking ownership of building, expanding, validating their understanding conceptualized by the community. Students are taught and encultured to be critical on beliefs, judgments, and challenged to use evidences and logics to build their knowledge. This is similar to the "deep approach" articulated by Entwistle (2007) which involves students paying careful attention to how well the evidence supports the conclusions. A high level of involvement in idea improvement is required from all members in the community, with the focus on the usefulness, adequacy, improvability, and development of ideas (Bereiter & Scardamalia, 2003). The advancement of knowledge (in this case, possibly a conceptual change) is then facilitated by students who believe that great efforts are required to understand and validate the complex and constantly evolving knowledge. Knowledge Building may instill in students that "all understandings are inventions" (Bereiter & Scardamalia, 2006, p. 103) and this may in turn indirectly alter the way students acquire their knowledge, creating the intention for possible conceptual change.

The roles of teachers could be important in influencing students' epistemological beliefs. In a Knowledge Building intervention, the roles of tutors (Chai & Khine, 2006) may indirectly influence students' epistemological beliefs, changing the way they normally would conceive of knowledge, changing the mode of their knowledge construction process, which may in turn lead to a change in their knowledge structures.

Conclusion

In this paper, we attempt to cross conceptualize ideas generated from current developments in conceptual change research and Knowledge Building communities, mainly at a theoretical level. Our contribution could be summarized as follow: First, rather than rectifying isolated misconceptions, the notion of idea improvement is similar to changing naïve theories which are domain-specific lay theories. Second, naïve ideas are not suppressed or condemned as incorrect conceptions, but rather as the foundation for building deep understanding. Third, beyond cognitive factors, conceptual change should take into account situative factors; social cultural effort like assumption of collective cognitive responsibility in Knowledge Building are more effective than simply creating cognitive conflicts. Fourth, conceptual change involves metaconceptual awareness which could be achieved through Knowledge Building discourse. Last, Knowledge Building approach engages students directly in epistemic construction of knowledge, which could potentially change their epistemological beliefs that are conducive for conceptual change.

The above ideas are mainly derived through theoretical reasoning. In order to see the fruits of cross fertilization, research could to be conducted for empirical evidence.

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