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# A Literature Review of Research on Knowledge Building Approach to Education

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## Abstract

Learning cannot be maximized when students merely meet the demands of school tasks by transforming knowledge. Researchers are trying to prompt students' learning to move beyond "knowledge reproduction" to "knowledge building." There is a lack of agreement on the meaning of the term "knowledge building" in education so this paper offers a literature review of research and practices related to knowledge building in education. The review offers a set of features derived from reflections on the theoretical development and instructional practice of knowledge building in education over the last twenty years, in order to explore the necessary conditions that an educational knowledge building practice should have. Based on these features, the origin and the development process of knowledge building theory in education is explored.

Keywords: *Knowledge Building, Knowledge creating society, Collective knowledge, Learning environment*

## 1. Introduction

John Dewey argues that "learning by doing" takes place when knowledge is put into practice. It is necessary to provide students with a practical environment where they are allowed to experience and interact with the curriculum (Herrington & Oliver, 2000). However, there is a gap between knowledge learned in class and knowledge necessary for everyday life and work (Bereiter, 2014). Students may fail to transfer the solutions from classroom problems to real-world problems, because classroom problems are often well structured, while real-world problems are often ill structured (Jonassen, 1999). It has been pointed out that learners accustomed to well-structured textbook problems in conventional school education are not well prepared for the ill-structured problems encountered in the real world. The amount of learning may be reduced when students simply solve textbook problems and efficiently meet the demands of school tasks just by transforming knowledge (Brown et al., 1983). In order to prepare students for practical applications of knowledge in the real world, researchers have tried to shift students' learning from "knowledge reproduction" to "knowledge building."

Knowledge building proposed by Scardamalia and Bereiter involves preparing students for "making a collective inquiry into problems or tasks on a specific topic and developing a deeper comprehension through self-expression, interactive questioning, arguing, and producing agreement", with the aim of helping students advance and create knowledge (2003). Students' self-constructed knowledge may be subject to over interpretation (Scardamalia, 1991), so the challenge is to design and develop creative learning environments

in order to structure students' knowledge building activities.

This literature review provides an overview of research regarding the knowledge building approach to education. It concentrates on the application of the knowledge building approach in education. Educational research most carried out in the past twenty years, covering three topics is analyzed: defining the features of knowledge building, taking a brief look at the theoretical underpinnings for the knowledge building approach, and analyzing challenges with the practice of knowledge building.

## 2. Definition of the features of knowledge building in education

Scardamalia and Bereiter (1989) suggested that they were the first to use the term “knowledge building” in education, interpreting the concept as “productive knowledge work”. Knowledge building refers to an educational approach of “initiating students in advancing knowledge that to be worked on the problems during the process of deep collective inquiry into questions of how and why” (Dunbar, 1997; Scardamalia & Bereiter, 2003; Chan, 2011). According to the definitions found in the Cambridge Handbook of the Learning Sciences, knowledge building requires processes that deepen learning by transforming “knowledge about” to “knowledge of” engaging students in group discourse with responsibilities for idea improvement and knowledge advancement (Scardamalia & Bereiter, 2006).

In recent years, knowledge building, with the objective of equipping students with skills and capacities oriented toward today's innovation-driven knowledge society (Scardamalia & Bereiter, 2014), has also been used synonymously with the phrase “knowledge creation”, both emphasizing innovative creation and advancement of an organization's knowledge. In the new edition of the Cambridge Handbook of the Learning Sciences (Edition II) (2014), Scardamalia and Bereiter discussed the challenges faced as knowledge creation is brought into education building on four themes elaborated in the 2006 edition: “community knowledge advancement, idea improvement, knowledge building discourse, constructive use of authoritative information” with the inclusion of a new theme of “understanding through collaborative explanation building”. By bringing the goals and processes of knowledge creation from organizations into education, the focus of education shifts from the enhancement of individual students' personal knowledge to the advancement of collective knowledge. A student's work is primarily valued for his or her contributions to community knowledge and secondarily for the representation of his ideas (Drucker, 1985; Scardamalia & Bereiter, 2014).

The diversity in the definition of knowledge building results in a great variety of knowledge building research and practices. To capture the distinguishing features of knowledge building, the following set of criteria were selected to determine the necessary conditions that a knowledge building practice should have. It is hoped that this will find commonalities across different knowledge building definitions.

### *Knowledge building is focused on the advancement and creation of knowledge.*

Learning puts emphasis on a internal changes in individual beliefs, attitudes, or skills, and knowledge building puts emphasis on the advancement and creation of knowledge through the “production of designs, theories, problem solutions, hypotheses, proofs, and the like” (Scardamalia & Bereiter, 2006). During the creation of knowledge through problem solving, learning activities have displaced taking notes in a lecture,

finding answers by reading textbooks, or progressing towards predetermined “truth”. Knowledge building is based on the premise that “authentic creative knowledge work can take place substantively in the classroom, not merely between mature scholars” (Scardamalia & Bereiter, 2014). In judging whether students are actually capable of authentic knowledge creation, Scardamalia (2014) argued that the standards should not be as high as for researchers. Knowledge creation can be realized as long as something new is achieved, such as the identification and clarification of problems, the insightful interpretations or explanations of the work of others, or presentation of a different perspective on an issue.

### *Knowledge building process incorporates both collaborative and personal phases*

Some instructional practices show that the effect of the knowledge building approach tends to be weakened when it is applied to an ordinary classroom, where a teacher serves as a communication hub through which all information passes (Scardamalia & Bereiter, 1996). Discourses among students, where individual student's knowledge is openly shared, discussed and debated, plays a constructive role in knowledge building, (Scardamalia & Bereiter, 2006). Despite the recognizable value of group knowledge building activities, schools are held responsible for individual students' learning. As promotion of collaborative knowledge building advances, individual learning of subject matter advances (Zhang et al., 2009). Evidence indicates that knowledge building enhances individual learning according to conventional measures of learning (Chuy et al., 2010). Stahl (2000) presents a model of knowledge building (Fig1) as a social process, incorporating multiple distinguishable phases that constitute a cycle of personal and social knowledge building. Personal knowledge building can be seen as the preparation for collaborative knowledge building, and the collaborative phase provides a continuous improvement of collective and individual knowledge.

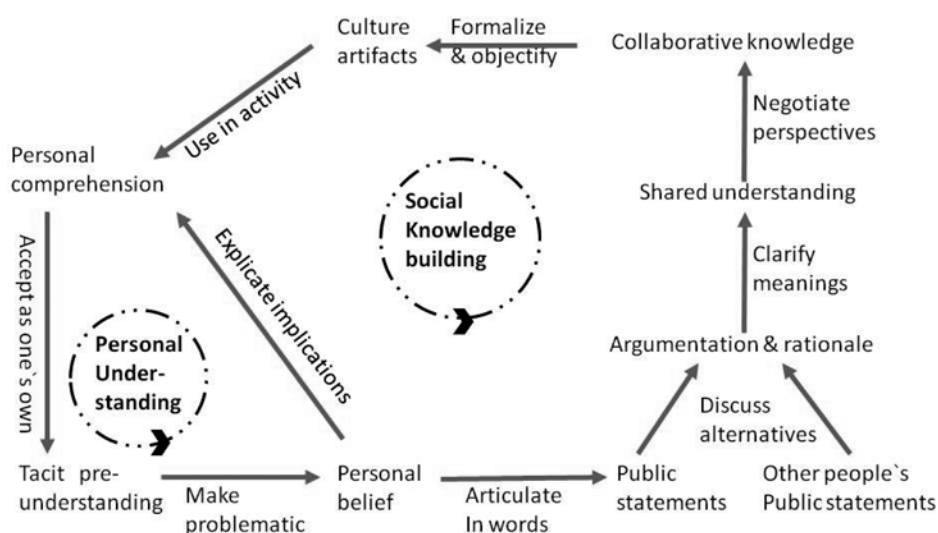


Fig1. Stahl's Diagram of knowledge building processes in classroom (Source: Stahl, 2000)

### *Knowledge building involves student-driven practical activities.*

Different from teacher-led, scripted, or packaged exercises, knowledge building activities incorporate a large amount of student interaction and autonomy (i.e. having students formulate their own goals, direct their own inquiries, and drive their own knowledge creation) rather than simply ending with a preconceived outcome or learning along a predetermined path. In recent research, learning goals have shifted away from understanding and explanation toward practical goals. Bereiter (2014) brings practical goals into the knowledge building approach by engaging students to actively seek and create knowledge through the practical application and realization of the connections between knowledge and practical activities. Scardamalia emphasizes the importance of students having experiences that build knowledge and serve practical purposes, such as providing solutions to social problems (Scardamalia & Bereiter 2014).

The featured definitions in the literature of knowledge building pedagogy involve a set of regulative principles and generative procedures to stimulate teachers to put the knowledge building approach into practice. These principle and procedures not only provide teachers with a guide to achieve desired instructional results (Zhang, et al. 2011), but also can be used by students to build their own creative knowledge work (Scardamalia & Bereiter, 2014).

## **3. Underpinnings of knowledge building research and practice in education**

To better understand the evolution of knowledge building theory, it is helpful to investigate the theoretical basis of knowledge building. In the following section, we will introduce the underpinnings of knowledge building research and practice and their potential and implications for knowledge building theory. The scope of knowledge building will be further explained by making a comparison between current knowledge building theory and its originating theories.

### *Postmodernism*

Knowledge building pedagogy with a Postmodernism viewpoint shuns the educational approach of moving towards a final goal referred as the “truth” (Scardamalia, 2010). It makes the knowledge building process more constructive by treating the “discrepancy from truth as an interesting new problem, rather than a mistake” (Bereiter et al., 1997). An example to help understand the knowledge advancement and creation that this knowledge building approach advocates can be seen by looking at a Postmodernist approach to science education.

Traditional science education in school often pursues “absolute truths” of some subject authority or “standard answers” from textbooks. Science education is highlighted here, not because Postmodernism effects only work in science education, but because science education places more emphasis on truth than other subjects such as the Arts or Literature.

With the educational goals of “satisfying students’ natural curiosity about the world and encouraging students to think more about knowledge and their relation to it” (Bereiter et al., 1997), Postmodernists

challenge the entire approach to the pursuit of knowledge advocated by mainstream science (Whitson, 1991). From Postmodernists' perspective, "Science itself has no absolute truth, so the pursuit of truth is an illusion" (Bereiter et al., 1997). Scientific progress is not a matter of getting closer to the truth, but rather a matter of advancement of existing knowledge. By trying to advance their initial theories and create something new rather than to attain fixed answers, students can experience science and building knowledge in a creative and positive atmosphere.

### *Collaborative learning*

Donald (1991) points out that "isolated from social interaction, human brains are poor thinkers and could never have developed into powerful minds". Collaborative learning is rooted in Vygotsky's concept of cognition development through social interactions: students learn in a zone of proximal development defined as the area between learning with external guidance and individualized learning. However, collaborative learning will be limited as long as teachers or adults participate as facilitators and children as receivers (Paradise, 1985). Nowadays, collaborative learning is more often seen as "a joint intellectual effort" (Smith & MacGregor, 1992) conducted among students with the premise that knowledge can be created within a small group where members actively interact by sharing, discussing, negotiating and finally reaching a consensus. Knowledge building that emphasizes community knowledge advancement engages students into a collective inquiry that increases collaboration among students.

Collaborative learning research theory must consider interaction in online environments. Computer Supported Collaborative Learning (CSCL), combining studies of "Computer technology," "Collaborative social interaction", and "Learning sciences or Educational practice"(Stahl, 2006), plays a leading role in the study of the knowledge building approach in online environments. Stahl (2000) proposed a list of forms of computer support (Table 1) corresponding to personal and collaborative knowledge building phases in Stahl's diagram of knowledge building processes (Fig 1). Scardamalia (1991) proposed a model of Computer Supported Intentional Learning Environments (CSILE) that grew out of research on writing processes and intentional learning conducted with two principles: "providing external supports" and "making metacognitive activity." They conducted an experiment in writing by providing children with procedural supports in the form of sentence openers, e.g., "This is not very convincing because---". They found evidence that "more expert students were engaged in a kind of dialectical process that enhances their knowledge and understanding".

Phase of knowledge building	Form of computer support
a. Articulate in words	Articulation editor
b. Public statements	Personal perspective
c. Other people's public statements	Comparison perspective
d. Discuss alternatives	Discussion forum
e. Argumentation & rationale	Argumentation graph
f. Clarify meanings	Glossary discussion
g. Shared understanding	Glossary
h. Negotiate perspectives	Negotiation support
i. Collaborative knowledge	Group perspective
j. Formalize and objectify	Bibliography discussion
k. Cultural artifacts	Bibliography
And representations	Other community repository

**Table 1. Forms of computer support for phases of knowledge building in education**  
(Source: Stahl, 2000)

### *Constructivism*

In the theory of Constructivism, knowledge is not transferred from a teacher to a student, but between students themselves constructing their own understanding. Constructivists propose that students as individual cognition agencies have the ability to construct knowledge in their own minds during the process of discovery learning and problem solving and knowledge construction is assumed to be an innate function of the individual human mind. Constructivism is derived from Piaget' theory of children's cognitive development, where a child constructs meaning about his or her surroundings during a process of active interaction with his or her environment. Education according to Constructivists is a way of motivating an individual to "assimilate" or "accommodate" (Piaget, 1957) existing knowledge and past cognitive experience to realize a new meaning. Constructivists have promoted wide-ranging educational reform to promote students to be more active and take ownership of their own learning process.

In recent years, constructivism has become a watchword for many of the efforts to give students more autonomy in the learning process including inquiry learning, discovery learning, project/problem-based learning, and task-oriented learning. Compared with the traditional didactic approach that is based on direct transfer of knowledge from teacher to student without an intervening constructive process, constructivism gives students more active roles in school learning. However, leaving students to construct knowledge by themselves leads to a "dangerously romantic optimism". The knowledge building approach adopts "the prevailing constructivist view, but with a special concern for the kinds of competence that are needed if students are to function successfully as agents of their own education" (Scardamalia, 1991). Scardamalia focuses on knowledge building that does not wholly adopt any of the primary constructivism views that are typically linked to Piaget or to Vygotsky, but with a special concern for the role of authoritative information and of teacher guidance and of social construction of knowledge.

#### 4. Challenges in the practice of knowledge building in education

Even though research shows clear support for the effectiveness of knowledge-building-aimed activities for creative knowledge advancement (Bereiter, 1994, Scardamalia, 2002, Stahl, 2002, Scardamalia & Bereiter, 2003, Zhang, 2010), there are also a number of areas of concern, three of which are explored in this section.

##### *“Creation accompanied by learning” versus “Learn first, create later”*

During the process of knowledge building, students encounter and learn the central concepts of a discipline via knowledge creation. Scardamalia (2002) points out that students in knowledge building classes are trying to learn but also are trying to produce something new at the same time. However, in educational practice, there is a prevailing belief that is detrimental to the knowledge building approach: creative knowledge work can come only after accumulating a certain degree of acquired knowledge. One concern arises from the focus on accomplishment of learning goals set by governments and boards of education. A students' knowledge building process does not always begin with a fixed problem or finish at an anticipated goal. It often splits off in exploration of an unexpected knowledge area or makes a detour around the problem completely. Knowledge building gains in such a process may go unnoticed in a traditional school education assessment system.

##### *“Individual knowledge” versus “Community knowledge”*

Most of the research on knowledge building has formulated a perspective on learning as a social process of community knowledge advancement. In this viewpoint, personal ideas contribute to collective knowledge through social interaction, communication, discussion, clarification and negotiation. In contrast, schools often care most about individual learning outcomes. Educational activities are ultimately judged according to what individual students learn from them. And the concept that knowledge is a product of social communication alone does not mean that collaboration in knowledge building is effective. In practice, knowledge building tasks usually lead to less exposure of individual work during the collaborative learning process so it is possible that certain students may “loaf” and rely on the participation and products created by others with minimal or no participation by themselves.

##### *“Scripted and packaged student-driven” versus “More autonomy student-driven”*

Scardamalia raises a concern about providing students with support to build their own knowledge, including “scheming their own goals, doing their own activating of prior knowledge, proposing their own questions, directing their own inquiry and doing their own monitoring of comprehension” (2002). However, in practice, a distrust of students' motivation and ability often results in knowledge building activities that tend to be overstructured and overmanaged, resulting in the sacrifice of some of the basic characteristics of knowledge building such as authentic problems and epistemic agency.



## 5. Conclusions

Making no distinction between the knowledge building process and traditional learning tasks such as homework completion might minimize the effect of a knowledge building approach. This review explored the essential features of knowledge building tasks. First, from a Postmodernism viewpoint, the knowledge building process advocates the creation of knowledge in the classroom instead of the repetition of existing knowledge. Educational artifacts should be improvement over previous work and varied. If a task can be carried out with the application of already-learned information or skills, it is an exercise, not a knowledge building process. Second, collaboration in knowledge building tasks involves students making a collective inquiry into knowledge, and coming to a deeper understanding through interactive questioning, dialogue, and continuing improvement of ideas. Third knowledge building tasks should serve practical purposes and be student-driven incorporating autonomy, choice, unsupervised work time and responsibility more than traditional instruction.

From the literature related to knowledge building in educational theory and practice from the last twenty years, we can learn that pedagogy research on knowledge building has not developed a substantial influence on the educational practice today. In addition, as the surveyed research was primarily conducted at the elementary and secondary level, future research should expand to include university level education.

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## 教育における知識構築に関する先行研究のレビュー

孫 帙・李 哲・ゼオースキ スペンス・カルピオ マリフェ

### 要旨

学習者が学校で知識を再生するという活動を行うだけでは、学習の効果は限られる。そのため、「知識再生」のみならず、「知識構築」を促す研究が多くなされている。しかしながら、教育における知識構築の定義はまだ定まっていない。そこで、本稿では、最近20年間の理論や教育実践を対象として、先行研究を検討し、知識創造、協働活動、学習者主導の実践が重要な要素であることを示した。さらに、ポストモダニズム、協働学習、構成主義が主な基礎理論になっていることを明らかにした。