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Beyond Brainstorming: Sustained Creative Work With Ideas

Marlene Scardamalia and Carl Bereiter

The traditional view of creativity is symbolized by a light bulb flashing on in the thinker's mind. Today the light bulbs are flashing everywhere; a brainstorming session in a school class will produce dozens of ideas that have at least some glint of originality. But that is not what creativity in the Knowledge Age is about. "Innovation," said Peter Drucker, "must be part and parcel of the ordinary, the norm, if not routine." (1)The challenge in all knowledge-based organizations is sustained creativity: working with and developing ideas into powerful and useful processes, products, or theories(2). Coming up with the initial idea represents one small step; creative knowledge workers are able to make something of the idea.

Developing a capacity for sustained creative work with ideas is a new challenge for education. To show what is so challenging about it, we turn to evidence of the most spectacular failures – the evidence on students' misconceptions.

Misconceptions: Clever Ideas that Don't Work

In recent decades, hundreds of research studies have shown that students harbor serious misconceptions in subjects spanning the curriculum, despite earning good marks in these same subjects. Misconceptions appear not only in the work of school children but among university students and professionals.

Many educators have had reservations about calling students' non-canonical beliefs "misconceptions." (3)They point out that students' conceptions usually have a basis in everyday experience and that they often reflect imaginative attempts to make sense of what they have observed and been taught. For instance, a group of Grade 5 students was wrestling with the problem of how the world could be round, yet people in Australia are not upside down. One student came up with the following ingenious theory: The world is like a ferris wheel, which is round and which turns, but the people on it are always right side up.

It is easy to see the creativity in this child's theory – and the misconceptions literature contains many similar examples. Moreover, the child's thinking is comparable to that of scientific theorists. She was aiming at "explanatory coherence"– the hallmark of successful theories(4). To achieve it she used "abductive reasoning,"(5) inventing premises from which the conclusions logically follow. So what is wrong with it? Nothing at all, if it represents a first step in a process of sustained theory development. But what the misconceptions literature makes so distressingly clear is that this process does not normally occur. Students' ideas may gradually change as they are exposed to more advanced knowledge, but often students carry their naive ideas on into adult life, unexamined and unimproved.

This was most dramatically illustrated in a study by Sadler(6) showing that the majority of Harvard graduates interviewed wrongly believed that the seasons result from the earth’s changing distance from the sun (rather than from the tilt of the Earth's rotation axis relative to the plane of the Earth's orbit around the Sun.) This faulty reasoning persisted despite the fact that seasons are taught in almost all school curricula, often repeatedly, and the “changing distance” theory does not fit with a number of other ideas that are typically taught (e.g., that the Earth's orbit around the Sun is nearly circular, with insufficient variation in distance to explain the large temperature variations between summer and winter) or with common factual knowledge (e.g., that when it is summer in the Northern Hemisphere it is winter in the Southern Hemisphere, whereas if the distance-from-the-sun theory were correct, the seasons should be the same all over).

Coming from a child of 10, the theory that seasons change because of distance from the sun deserves credit as a creative synthesis of what the child has learned. Coming from Harvard graduates, however, it makes us wonder how their ideas could have remained unimproved through so many years of schooling.

Students Taking Responsibility for Improving Their Ideas

To what extent teachers should be concerned about modifying students’ naive conceptions is a controversial issue. Opinions differ on both the ethics and the practicalities of inducing conceptual change. However, one question is almost entirely missing from the debate: to what extent should students themselves be concerned with their naive conceptions and attempt to change them? The assumption seems to be that conceptual change is something that either comes about naturally through experience or is engineered by the teacher. Students are assumed to be perfectly happy with their conceptions and resistant to efforts to change them.

This is quite at variance with the norms of every knowledge-based enterprise. Whether in pure research or industry, ideas are always assumed to be improvable. It is assumed that every theory or design will eventually be replaced by a better one, and creative knowledge workers of all sorts strive to bring this about. The engineer who declares “I have designed the ultimate automobile; there can be no further improvements” would soon be out of a job, replaced by someone with ideas for improvement. If students are to feel at home in the Knowledge Society, they must learn to feel comfortable with the knowledge that their own ideas, no matter how satisfactory they may seem at present, are improvable – and that improving them is their job, not something that a teacher or mentor can be expected to do for them.

Can students deliberately pursue idea improvement? We must recognize that it does not come naturally. Although most students take naturally to generating ideas and playing with them, working to improve ideas is an acquired disposition. Unless they come from a home environment where sustained work with ideas goes on at the dinner table, students will likely have very limited experience and need a great deal of support and guidance at school, from teachers, mentors, fellow students, or technology. In fact, all of these may be required. As members of a knowledge building community students share responsibility for producing ideas of value to others and receiving and responding constructively to feedback. They take charge of knowledge work at the highest levels, gaining expertise in the socio-cognitive dynamics of cognition. Based on two decades of experience with students of many kinds from many parts of the world, we are prepared to say that sustained creative work with ideas is within the grasp of even the youngest and least prepared students.

Knowledge Building Pedagogy and Technology

The term we introduced to refer to sustained creative work with ideas is knowledge building(7). As the word "building" implies, it is a constructive process; but the object of knowledge building is to produce public knowledge of value to the community, not simply to improve the content of individual minds. Thus, knowledge building applies to the work of researchers, designers, planners, and other knowledge workers. When applied to work in schools, it has the same meaning: it is productive work that advances the frontiers of knowledge as these are perceived by the community. Learning – or improving the content of individual minds – results as a by-product. An important part of that learning is learning to be a knowledge builder.

A vital support for knowledge building is technology that gives ideas a place to live and develop – a place where ideas themselves, and their continual improvement, are the main focus of attention. Various activities, deadlines, presentations, and products may have a role in improving an idea, but these are steps along the way, not the objective of the activity. The technology we have developed to support knowledge building was originally called CSILE, and in more recent versions is called Knowledge Forum. It is essentially a community multimedia database, to which all participants contribute, with help from a variety of supports for higher-level knowledge processes(8).

As an indication of the universality of the knowledge building processes it supports, the same technology has been used without modification from kindergarten through graduate school and into adult knowledge work. The younger students not only use the technology, but they use it in ways consistent with the uses made by advanced students, scientists, and knowledge workers in professional organizations. When Grade 1 students who had been using Knowledge Forum moved on to a grade where Knowledge Forum was not being used, one of them reportedly asked, "Where will I put my ideas? Who will help me improve them?" Striking examples of idea improvement come from Grade 1 classes in which students develop theories, design experiments to test those theories, and assess their implications in light of events outside the classroom. Piaget called this the "hypothetico-deductive method" and believed it required attainment of the stage of formal operational thought, which did not appear until adolescence, and then not for everyone. But active engagement in knowledge building, as contrasted to solving puzzle problems set by someone else, seems to bring on this kind of constructive thought at a much earlier age.

Technology alone does not do the job, of course. Successful knowledge building classrooms are ones in which the teacher has fostered a community in which students feel that their ideas matter and are worthy of extended, collaborative effort at development. Importantly, this is not a community that isolates the students from the rest of the world. With support from the technology, collaborative knowledge building can go on across geographical, age, and cultural boundaries. Moreover, students come to feel their work as part of humanity's long-term effort to advance knowledge. This larger cultural identification was epitomized in Knowledge Forum by one student's comment on another's note in a unit on genetics: "Mendel worked on Karen's problem."

Creativity as Design

Modern thinking about creativity has moved beyond the light-bulb-in-the-mind model. In Simonton's extensive studies of genius and creativity, many contributing factors are identified; but the key factor is sustained, high-output productivity. (9)The great artist, Simonton points out, produces not only more good paintings but also more bad paintings than the lesser artist. Creative experts, we observed in our own investigations of creativity, work at the growing edge of their competence and take greater risks. (10)That is what made them creative experts in the first place and what keeps them growing. In his general theory of creativity, Perkins sees creative production of all kinds as a progressive design process(11).

This modern conception has begun to be reflected in educational activities. Consider the popular "process" approach to writing. What mainly sets it apart from older "take up your pen and write" approaches is that a composition is developed over an extended period of time, with revisions and improvements all along the line—to plans, purposes, and to content as well as style of the composition itself. Innovations such as the writing conference and the "hot seat" turn design improvement into a collaborative activity(12).

In Learning by Design™(13), a similar process of sustained, collaborative improvement is applied to the design and construction of actual models or toys. For instance, one design challenge is to build a toy vehicle that can travel over a rough terrain without stalling or tipping over. Weeks of work may go into building and trying out models, comparing one design with another, learning and applying relevant physical principles, testing variables, and modifying designs to overcome difficulties.

In both of these cases, what goes on in the classroom more closely resembles creativity as pursued in the real world than do more traditional writing and hands-on science activities, and the difference is in sustained idea improvement. In knowledge building, advancing theories, explanations, proofs, interpretations, problem formulations, and other abstract knowledge objects is just as much a design process as crafting a story or inventing a gadget. It allows design and creative work with ideas to extend into all aspects of the curriculum and to redefine the curriculum to increase its relevance to the Knowledge Age. Sustained and creative work is no longer limited to brainstorming or to special tasks and curriculum activities designed to support it(14).

Some teachers who readily accept process writing and Learning by Design™ draw the line at theory building. It is too abstract for young students, they feel, and it is too risky. It can lead to creating and spreading wrong theories. Students should first master what is already known before venturing to produce new knowledge. Our research counters these arguments. As for the fear of producing faulty knowledge, the massive evidence on misconceptions ought to make clear that conventional instruction is not working. With conventional instruction, misconceptions develop behind the scenes and are only detected through special tests. Knowledge Building brings students' conceptions out into the open and enlists the students themselves in criticizing and revising them. And we have shown that students have no fear of the abstract. Even the youngest students delight in producing and working with ideas. Kids are more than ready for the Knowledge Age. The question is, are we?

Author Notes

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(2) Conference Board of Canada. Solving Canada's Innovation Conundrum: How Education Can Help. (Issue Statement #1, July, 2003). Available online at http://www.conferenceboard.ca/boardwiseii/LayoutAbstract.asp?DID=567 (registration required).

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(10) C. Bereiter and M. Scardamalia, Surpassing Ourselves: An Inquiry into the Nature and Implications of Expertise (La Salle, IL: Open Court, 1993).

(11) D. N. Perkins, The Mind's Best Work (Cambridge, MA: Harvard University Press, 1981).

(12) D. R.Graves, Writing: Teachers and Children at Work (Exeter, NH: Heinemann Educational Books, 1983).

(13) J. L. Kolodner, “Learning by Design™: Interations of Design Challenges for Better Learning of Science Skills,” Cognitive Studies 9, vol. 3 (2002): 338-350

(14) Demonstrating the potential of knowledge building is the goal of a bold new effort funded by the Social Sciences and Humanities Research Council’s Initiative on the New Economy. Under the title, “Beyond Best Practice,” this work brings together a multinational, multi-sectorial team of researchers and practitioners committed to extending the limits of the possible in education. (See www.ikit.org).