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LESSONS IN LEARNING

Creating the learners society needs: An examination of knowledge building

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The workplace of the 21st century requires certain skills that employers find are in short supply. Recent research suggests that a learning strategy called knowledge building can help students acquire and develop these skills.

Although Canadian workers have more education than ever before, numerous surveys of business leaders indicate that employers are dissatisfied with their employees' so-called "soft" skills, such as teamwork, problem-solving, communication skills and self-motivation.[1]

Employers also complain that necessary skills—including the ability to communicate effectively, manage information, use numbers, think and solve problems—are in short supply in the labour force.[2] These concerns are confirmed by results from the International Adult Literacy and Skills Survey (2003),[3] which measured the proficiency of Canadians in prose literacy, numeracy and problem solving. The survey found that almost half of Canadians aged 16 to 65 do not have the level of competence required to cope with the demands of work in a complex society.

In addition to the significant value employers place on literacy skills and soft skills, employers also highly prize an aptitude and an appetite for learning, due to the rapid rate of change that occurs in virtually all settings, whether on the shop floor or in the nanotechnology lab.[4]

However, in a recent survey by the Canadian Federation of Independent Business, just 47% of employers expressed satisfaction with the competencies of high-school graduates, while satisfaction levels rose to just 65% for college grads and 64% for holders of university degrees.[5]

Viewed as a whole, these results suggest that traditional forms of teaching and learning might need to be revisited and revised if students are to acquire the attributes necessary to flourish in their working lives. One promising strategy worth exploring is knowledge building.

Conventional Classrooms vs. Knowledge Building

The traditional and still prevalent view of the teacher in Canada's classrooms is as the guardian of expertise, dispensing knowledge for students' benefit. The responsibility for identifying learning needs, planning lessons, developing meaningful learning experiences and evaluating students' mastery of the curriculum also falls to the teacher.

For the most part, students are relatively passive in this setting, and their learning is a by-product of writing essays, making posters, creating projects and completing worksheets developed by the teacher. This approach allows many students to pass standardized tests, while failing to develop expected workplace competencies.[6]

A number of learning strategies have been developed to address the limitations of the conventional classroom model. These include, for example, guided discovery and project-based learning in which learning activities are organized around a particular question and culminate in a final product that addresses that question.[7] Knowledge building is a more recent strategy that focusses on a community of learners collectively creating and recording knowledge.[8]

Knowledge building teaches students how to develop a repertoire of skills that allow them to become experts in the art of learning, a skill that, once developed, can be used across their academic and working lives. In a knowledge-building environment, students, rather than teachers, are invested with the individual and collective responsibility to identify holes in their knowledge, develop plans to close them, and assess progress in attaining their goals. Learning needs, rather than structured assignments, determine the activities students perform in order to master a specific subject.

This type of collaborative and self-directed learning is the norm in the world of work, especially in the so-called knowledge industries that are driving most of the job growth in Canada.[9] Knowledge building may bridge the chasm between the classroom and the corporation, because it allows students to develop the skills involved in learning, thinking critically and working co-operatively with others.

Knowledge building in action

Knowledge building has been defined as "the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions."[10]

An overview of how one Grade 4 class studied science illustrates the principles of knowledge building. In an Ontario knowledge-building classroom, students addressed real-world problems that are both meaningful to them and related to the curriculum.

When the teacher introduced the subject of optics, one of the many topics on the Ontario Curriculum of Science and Technology,[11] he did not specify issues for students to consider, or give them tasks and activities to complete. Students themselves raised questions of importance to them, including how light travels, sources of light, colours, lenses, mirrors and vision. They considered both factual questions ("What are the primary colours?") and explanatory ones ("Why are the colours of a rainbow always in the same order?").

Working collaboratively, often in small groups, students tracked down information, assessed its validity, shared research, proposed theories to explain results, identified gaps and errors in their understanding, and refined their ideas. As they jointly tackled these problems, students became adept at thinking critically, while also developing the diplomatic skills necessary for honest but fair feedback about each other's ideas.

While most nine-year olds are primarily interested in factual knowledge, this cohort of knowledge builders zeroed in on the more complex issues addressed by explanatory questions.[12] As the teacher explained, "We encourage a process of inquiry and ask 'why, why,' and not to be content with a superficial understanding."[13]

As the students worked, they discovered information that appeared to be contradictory. For instance, when considering how light travels, the students learned that it travelled in a straight line. This concept was shaken, however, when one child talked to an uncle with a science background, who introduced

him to the concept of light waves. When this knowledge was shared with the class, it triggered a debate: does light travel as a straight line or as a wave? One student accurately suggested the two can be synthesized: "Putting our knowledge together…light travels in a straight line but it is a wave. Light is made up of the electromagnetic waves."[14] This new insight then became the subject of further discussion.

Computers also played a significant role in the Grade 4 knowledge-building class. The students entered their observations, research and questions into an online database accessible to the entire class. Students and teacher also used online discussions to raise questions, to discuss connections among facts, and to debate and clarify their ideas. Teachers may also participate in the online discussions. For example, the teacher asked questions such as, "What's your evidence for your theory that….?" and "What do you mean by …?"[15] in order to stimulate deeper understandings of the issue.

In coming to terms with how light travels, these Grade 4 students learned that knowledge is provisional and is subject to continuous improvement. Although this perspective is at odds with much conventional teaching, which posits knowledge as fixed and final,[16] it conforms to the assumptions of the knowledge industries: an engineer who proclaims a new car design to be so perfect as to be beyond improvement would be quickly shown the door.[17]

When human knowledge is viewed as a collective endeavour that requires all learners to consider ways of adding to it, students are more likely to identify themselves as part of the long march of humanity toward ever greater understanding of the world.[18] Such a view implies that knowledge is infinitely perfectible, and learning is a lifelong process. All the same, knowledge building does not suggest that nine-year-olds will make stunning breakthroughs in the understanding of physics. However, it does contend that through sustained, creative and common efforts, students will master information on their own terms and will be able to apply it to new problems.[19]

Knowledge building's emphasis on the twin principles of critical thinking and rigorous evaluation of ideas is a potential antidote to a problem that has been the subject of considerable research: the fact that students can hold serious misconceptions about subjects they excel in at school and university. One study offers a particularly potent illustration of this problem. When researchers asked Harvard graduates to explain seasons, a majority incorrectly answered that they resulted from the earth's movement toward and away from the sun. As Scardamalia and Bereiter note, "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."[20]

What does research tell us about knowledge building?

Studies of knowledge building in elementary school are promising. In the Grade 4 class studying optics, students mastered all of the topics related to "Materials that Transmit, Reflect or Absorb Light" in the provincial Grade 4 curriculum,

and also many others that do not appear on the curriculum until Grade 8, such as light waves, colour vision, colours of opaque objects and lenses.[21] Likewise, other researchers have found that this approach stimulates students to reflect more deeply on their own and others' work in writing, mathematics and science.[22] It also pushes them to develop higher order cognitive strategies, increases motivation, improves engagement with learning goals and raises their contributions to the classroom community.[23]

Knowledge building has also been shown to shift the culture of the classroom, so that students use factual knowledge as a springboard to more complex issues.[24] Students using knowledge building successfully use abstract and scientific concepts, and are able to assess research methods. Moreover, the longer that students are exposed to knowledge building, the more refined their approach to issues, theories and information becomes.[25]

High-school students' mastery of conceptual understanding is also enhanced: one study of Grade 12 chemistry students found that knowledge builders outperformed their traditionally instructed peers on measures of conceptual comprehension, as well as on the depth of their engagement with learning.[26] Another study of Grade 12 physical geography students found similar gains.[27]

Assessments of students who have participated in knowledge building have shown that these students demonstrate greater gains in literacy, mathematics, problem solving, reflections on learning, graphical knowledge presentations and beliefs about learning, when compared to their conventionally instructed peers.[28] In addition, they outperformed conventionally instructed students on measures of meta-cognition, levels of explanation, quality of goals and conceptions of the nature of learning.[29]

Post-secondary applications of knowledge building

In research at four hospitals in Hamilton, Ontario, medical students at different locations used a computer-supported knowledge-building environment to study two common problems seen by ear, nose and throat specialists: vertigo and ailments of the tonsils. When the performance of the knowledge-building group was compared to students who attended a traditional lecture or seminar format, researchers found that the knowledge-building group mastered the material better than their conventionally taught peers, especially with regard to the depth of their comprehension of the material.[30]

Future directions for knowledge building

Despite its track record and fit with the kinds of skills required for workers of the 21st century, knowledge building has not been widely adopted in schools. Educators raise a number of objections to knowledge building. They worry that it:

- benefits only high-achieving students,
- is too time-consuming to cover the prescribed curriculum adequately, and
- may leave students unprepared for external, standardized exams.[31]

The available research suggests that these concerns are unfounded. A study of knowledge building in two classes of student in grades 5 and 6, revealed that students at or below grade level made greater gains in reading comprehension, spelling and vocabulary than did those who were above grade level.[32] As well, students engaged in knowledge building often exceed the curricular requirements of their own grade levels.[33] More research is required to assess the performance of knowledge building students on standardized exams and, more importantly, in their subsequent educational and vocational pursuits.

Lessons in learning

Successful applications of the knowledge-building principles make use of the following components:

- Students are engaged in the entire process of learning, beginning with identifying problems that are of interest to them. These are typically complex, and generally do not have a single, agreed-upon answer.
- Individual and group work is framed by the collective goal of improving the state of knowledge in the class, and relationships between students are collaborative rather than competitive.
- Students use any relevant resources they can understand to expand their knowledge, and are not limited to instructional materials, such as textbooks, that are designed for their age and grade.
- Students are expected to chart their own learning paths, diagnose omissions and errors in the class' understanding of problems, and evaluate progress.
- Verbal and online written discussion of research findings, and ideas arising from those findings, allows students to keep tabs on the state of knowledge in the classroom.
- The communal database is at the centre of the classroom discourse. Students record and share their growing knowledge in written and multimedia forms.

While further research is required to examine the long-term efficacy of knowledge building as a pedagogical tool, there are good reasons to expect that employees having the competencies cultivated by knowledge building face a bright future. As the CEO of an international chemical company commented, "Imagine the power of an organization that can quickly channel its collective brain-power toward priority issues that arise."[34]

Links

ikit.org

learningrelationshipslab.org

designbasedresearch.org

helsinki.fi/science/networkedlearning/eng/index.html

References

[1] Kuhn, P. Skills, Human Capital and the Life Cycle (Ottawa: Skills Research Initiative, Human Resources and Social Development Canada and Social Sciences and Humanities Research Council, 2005). Working Paper 2005 A-04.

[2] See, for example, Bill Coplin. A Skills Perspective for Liberal Arts. Education Digest (70) 4: 52-55 (2004).

[3] Human Resources and Skills Development and Statistics Canada. Building on Our Competencies: Canadian Results of the International Adult Literacy and Skills Survey, 2003 (Ottawa: Human Resources and Social Development and Statistics Canada, 2005). Accessed 11 June, 2007.

[4] Almost three-quarters (73.3%) of Canadian employers report "willingness to learn," as the most valuable employee skill. Doug Bruce and Andreea Dulipovici. Help Wanted: Research Results of CFIB Surveys on the Shortage of Qualified Labour (Willowdale: Canadian Federation of Independent Business, 2001). Accessed June 11, 2007.

[5] Dulipovici, A. Skilled in Training: Results of CFIB Surveys on Training (Willowdale: Canadian Federation of Independent Business, 2003). Accessed June 11, 2007.

[6] Barton, P.E. "Employers and High Schools: The Fit Between Learning and Working," Peabody Journal of Education, 63, (2), (1986). pp. 103-149.

[7] Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palincsar, A. "Motivating project-based learning: Sustaining the doing, supporting the learning," Educational Psychologist, 26 (3 & 4), 369-398 (1991).

[8] Bereiter, C., & Scardamalia, M. "Learning to work creatively with knowledge," Unravelling basic components and dimensions of powerful learning environments. EARLI Advances in Learning and Instruction Series, E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.) (Oxford: Elsevier Science, 2003).

[9] Between 1991 and 2003, the number of high-knowledge businesses in Canada grew by 78% and the number of low-knowledge businesses fell by 3%. Some economists estimate that 60% of the workers in the industrialized world are "knowledge workers." See Ernst and Young. What is the Knowledge Economy? (Auckland: Ministry of Economic Development, 1999). Accessed 20 May, 2007.

[10] Scardamalia, M. & Bereiter, C. "Knowledge Building," Encyclopedia of Education, 2nd ed. (New York: Macmillan Reference, USA, 2003). pp. 1370-1373.

[11] Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. "Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds," Education Technology Research and Development, 55: 117-145 (2007).

[12] Ibid.

[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] Bereiter, C., & Scardamalia, M. "Learning to work creatively with knowledge," 2007 draft of chapter to appear in E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), Unravelling basic components and dimensions of powerful learning environments. EARLI Advances in Learning and Instruction Series. p. 15. Accessed May 17, 2007.

[17] Bereiter, C., & Scardamalia, M. "Beyond Brainstorming: sustained creative work with ideas," Education Canada (43) 4 (2003); see also Carl Bereiter and Marlene Scardamalia. "Learning to work creatively with knowledge," 2007 draft of chapter to appear in E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), Unravelling basic components and dimensions of powerful learning environments. EARLI Advances in Learning and Instruction Series. Accessed May 17, 2007.

[18] Bereiter, C., & Scardamalia, M. "Learning to work creatively with knowledge," 2007 draft of chapter to appear in E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), Unravelling basic components and dimensions of powerful learning environments. EARLI Advances in Learning and Instruction Series. p. 18. Accessed May 17, 2007.

[19] Bereiter, C., & Scardamalia, M. "Learning to work creatively with knowledge," 2007 draft of chapter to appear in E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), Unravelling basic components and dimensions of powerful learning environments. EARLI Advances in Learning and Instruction Series. p. 14. Accessed May 17, 2007.

[20] Bereiter, C., & Scardamalia, M. Beyond Brainstorming: sustained creative work with ideas. Education Canada (43) 4 (2003).

[21] Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. "Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds," Education Technology Research and Development, 55: 117-145 (2007).

[22] Lamon, M., Abeygunawardena, H., Cohen, A., Lee, E., & Wasson, B. Student's reflections on learning: A portfolio study. Symposium at the Meeting of the American Educational Research Association, San Francisco, CA, (April 1992).

Lamon, M., Lee, E., & Scardamalia, M. (1993). "Cognitive technologies and peer collaboration: The growth of reflection, Design experiments: School restructuring through technology, A. Collins & J. Hawkins, (Eds,) (New York, NY: Cambridge University Press, 1993).

[23] Scardamalia, M., Bereiter, C., McLean, R., Swallow, J., & Woodruff, E. "Computer supported intentional learning environments," Journal of Educational Computing Research, 5, 51-68 (1989).

[24] Lipponen, L. "Towards knowledge building: From facts to explanations in primary students' computer mediated discourse," Learning Environments Research, 3, 179-199 (2000).

[25] Hakkarainen, K. "Emergence of progressive-inquiry culture in computer-supported collaborative learning," Learning Environments Research, 6, 199-220 (2003).

[26] Chan, C.K.K., Lee, E., & van Aalst, J. Collaborative inquiry of scientific phenomena in a computer supported learning environment, a paper presented at the 9th biannual conference of EARLI, August 2001. Accessed July 2, 2005.

Chan, C., Lam, I., & van Aalst, J. (2003, April). Social-constructivist assessment, knowledge building discourse, and conceptual understanding. A paper presented at International Design Principles on Knowledge Building, a structured poster session at the annual meeting of the American Educational Research Association, Chicago, IL. Accessed July 2, 2005.

[27] Chan, C.K.K., Lee, E., & van Aalst, J. Collaborative inquiry of scientific phenomena in a computer supported learning environment, a paper presented at the 9th biannual conference of EARLI, August 2001. Accessed July 2, 2005.

[28] Scardamalia, M., & Bereiter, C. "An architecture for collaborative knowledge-building," Computer-based learning environments and problem solving, E. Dc Corte, M. Linn, H. Mandl, & L. Verschaffel (Eds.) (Berlin: Springer-Verlag, 1992). NATO-ASI Series F: Computer and Systems Science, pp. 41-46.

Scardamalia, M., Bereiter, C., & Lamon, M. "The CSILE project: Trying to bring the classroom into World 3," Classroom lessons: Integrating cognitive theory and classroom practice, K. McGilley (Ed.) (Cambridge, MA: MIT Press, 1994). pp. 201-228.

[29] Scardamalia, M., & Bereiter, C. "Computer support for knowledge-building communities," The Journal of the Learning Sciences, 3(3), 265-283. (1994);

Chan, C., Lam, I., & van Aalst, J. (2003, April). Social-constructivist assessment, knowledge building discourse, and conceptual understanding. A paper presented at International Design Principles on Knowledge Building, a structured poster session at the annual meeting of the American Educational Research Association, Chicago, IL. Accessed July 2, 2005.

[30] MM Carr, M.M., Hewitt, J., Scardamalia, M., & Reznick, R.K. "Internet-based Otolaryngology Case Discussions for Medical Students," Journal of Otolaryngology 31 (4): 197-201.

[31] Niu, H., & van Aalst, J. Is knowledge building only for certain students? An exploration of online interaction patterns in two grade 10 social studies courses (2005). Paper presented at IKIT Summer Institute 2005.

[32] Scardamalia, M., Bereiter, C., Brett, C., Burpis, P., Calhoun, C. & Smith Lea, N. "Educational applications of a networked communal database," Interactive Learning Environments, 2(1), 45-71 (1992).

[33] Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. "Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds," Education Technology Research and Development, 55: 117-145 (2007).

[34] Quoted by Janz, B. D. & Prasarnphanich, P. "Understanding the antecedents of effective knowledge management: The importance of a knowledge-centered culture," Decision Sciences(34)2 (2003). p. 352.