

## invention, transfer, efficiency, and innovation: 21st-century learning abilities can be taught

The research reports of Daniel L. Schwartz and colleagues (Schwartz & Martin, 2004; Schwartz, Sears, & Bransford, 2005) investigate strategies that produce learners who are able to compete in a global world. Can such qualities of inventiveness (developing novel ideas and being creative), transfer (applying learning to new situations), efficiency (doing better and more work in less time), and innovation (developing new ways for solving problems) be taught, or are they reserved for a special class of people with innate abilities? Schwartz's initial experiments indicate uncommon success with common learners. Standardized tests, as they exist right now, do not identify the desirable abilities.

At the beginning of teaching a learning experience, Schwartz asks students to manipulate data on the lesson topic to come up with a formula or an explanation of relationships. In other words, the students are challenged to invent explanations that might apply to many data sets. They are challenged to think before they encounter the usual plug-and-chug math. After this invention exercise, where "right" answers are not necessarily discovered, students are taught the methods that some experts have used to solve the problem at hand. Compared to a control group that learns just the plug-and-chug math formula, the more inventive thinkers are superior when given novel problems to solve. In other words, systems thinking, higher-level thinking, and creativity become a part of the inventive thinkers' learning from the outset, and it serves them well.

Schwartz explains other experiments where efficiency and innovation are taught within one learning experience. Most learning experiences currently concentrate on efficiency: coming up with right answers using recognized techniques. Schwartz

warns, however, that these desirable learning characteristics—if really valued by society—must be assessed by using methods different from current standardized tests. He also states that such higher-level techniques can be taught to learners in any discipline, not just those in mathematics.

Schwartz challenges educators to trust their instincts about what good education is, in spite of the emphasis of a required test. Although this requires a leap of faith and some risk taking, we see results of current measures as a piece of the kind of learner we want in the 21st century. Best of all, our inventive learners do as well on the standardized tests as those taught in the traditional plug-and-chug way. The risk is worth it.

Action steps for the teacher-librarian when teaching alone or in collaboration with the classroom teacher follow:

At the beginning of a lesson, ask students to manipulate data on a topic to come up with an explanation, a formula, a way of seeing relationships—a preliminary invention of ideas. Do not criticize these efforts, even if they seem wrong. For example, if you know that students are going to face a wide spectrum of opinions on an issue, then provide them with a range of opinions in random order and ask groups or pairs of students to come up with a way to picture, group, or explain differences of opinion. Do not criticize charts or groupings; the students are inventing ways of thinking about data.

Teach the students how some experts deal with a range of opinions, by constructing an *opinion line*, such as that demonstrating for-and-against opinions or pro-and-con opinions. Have students retrieve articles on the subject and place the various opinions from the articles onto the opinion line; have them defend their placement.

Present students with a task that requires them to place articles on the opinion line as taught. They may argue among themselves about the position of a particular authority that seems to be taking a middle-of-the-road stance.

Assess their work as you normally would.

Finally, give the students a unique problem to solve where the technique taught might be one key in the solution to the problem. Assess their ability to encounter this novel problem in a new situation.

Trust the fact that those students who approach learning experiences with more global thinking before they are taught the "right" way of doing something will not only succeed more often in higher-level tasks but also be more efficient in the traditional sense.

If we really expect students to become information literate, then this research will help us to understand that the slavish following of one information literacy model over another might not be the biggest gift that we can give students in our classes. Rather, if they understand our information literacy model as one way of doing research, then they will begin to invent their own ways of doing research that will fit their learning styles and become adaptable given the various kinds of problems to solve.

### REFERENCES

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