



Educating for innovation

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Abstract

In the last several decades many of the world's most developed countries have shifted from an industrial economy to a knowledge economy, one based on the creation of knowledge, information, and innovation. Educational researchers have paid very little scholarly attention to this economic shift, although it has substantial implications. After all, educational historians have repeatedly shown how today's schools were designed in the first half of the 20th century to meet the economic needs of the industrial economy; if that economy is a thing of the past, then many features of contemporary schools may become obsolete. In today's knowledge society, creativity always occurs in complex collaborative and organizational settings. Teams and organizations innovate using open-ended, improvisational group processes. I argue that education should be structured around disciplined improvisation, and I advocate the use of situated, collaborative knowledge-building activities. I argue that creative collaboration in classrooms aligns with the social nature of innovation in today's economy.

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In the last several decades many of the world's most developed countries have shifted from an industrial economy to a knowledge economy (e.g., Bell, 1973; Drucker, 1993). The knowledge economy is based on “the production and distribution of knowledge and information, rather than the production and distribution of things” (Drucker, 1993, p. 182). In the knowledge economy, knowledge workers are “symbolic analysts” (Reich, 1991) who manipulate symbols rather than machines, and who create conceptual artifacts rather than physical objects (Bereiter, 2002; Drucker, 1993). Several economists have begun to argue that in today's economy, knowledge is an intrinsic part of the economic system—a third factor, added to the traditional two of labor and capital (Florida, 2002; Romer, 1990).

These analysts emphasize the importance of creativity, innovation, and ingenuity in the knowledge economy. In fact, some scholars refer to today's economy as a *creative economy* (Florida, 2002; Howkins, 2001). Florida argued that “we now have an economy powered by human creativity” (Florida, 2002, pp. 5–6) and that human creativity is “the defining feature of economic life” (p. 21). Florida represents an economic school of thought known as New Growth Theory, which argues that creativity and idea generation are central to today's economy (Cortright, 2001).

Educational researchers have paid very little scholarly attention to the recent shift to an innovation economy, although it has substantial implications. After all, educational historians have repeatedly shown how today's schools were designed in the first half of the 20th century to meet the economic needs of the industrial economy (e.g., Callahan, 1962); if that economy is a thing of the past, then many features of contemporary schools may become obsolete

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(Bereiter, 2002; Hargreaves, 2003). If the core of the knowledge society is creativity, then the key task for educators is to prepare learners to be capable of participating creatively in an innovation economy (OECD, 2000).

Today's schools often fail to meet this need. Very few schools teach students how to create knowledge; instead, students are taught that knowledge is static and complete, and they become experts at consuming knowledge rather than producing knowledge. In fact, in the U.S. there are some educational reform movements afoot that run in the opposite direction—toward rigid teaching that emphasizes a rote learning of material, instead of creative appropriation and deeper understanding (Sawyer, 2004a).

In this article, I recommend that educators draw on research on creativity and collaboration to better understand teaching and creativity and their role in the knowledge society (e.g., Sawyer, 2003a, 2004a, 2004b, in press-b). I elaborate what sort of creativity is required in today's knowledge economy, with the goal of identifying what kind of education is best suited to preparing graduates to participate in the knowledge society.

1. The innovation economy is based on collaboration

A common but misleading myth is that the innovative economy is based on a few brilliant and creative inventors and entrepreneurs. If this were true, then the role of education in the creative economy would be to identify and nurture those few special individuals with the potential to invent new technologies and to found new businesses. In fact, during the 1960s burst of creativity research in the U.S., this is exactly how researchers and educators viewed their mission (Sawyer, in press-b). However, in the last 20 years, scholars of innovation have discovered that innovation is rarely a solitary individual creation. Instead, creativity is deeply social; the most important creative insights typically emerge from collaborative teams and creative circles (Farrell, 2001; John-Steiner, 2000; Sawyer, 2003a). Companies bring together collaboratively created ideas from many teams and coordinate the integration of multiple ideas into a single product; and companies interact with customers and suppliers as they innovate (Sawyer, in preparation). Empirical studies show that even single firms rarely innovate alone (OECD, 2000).

The most pressing problems that face our world are large in scale and complex in nature, far out of the realm of any one person to resolve—poverty, pollution, hunger, disease, armed conflict. The creativity that matters in today's world is the creativity of teams and organizations with the capabilities to make a difference. A chemist may have a brilliant insight, but the diseases that threaten our planet can only be cured if a large company is capable of implementing that insight, successively testing and refining the idea, and manufacturing and disseminating the drug on a large scale.

Today's most innovative companies are the ones that have successfully tapped in to team collaboration throughout their organization, in what I refer to as the *improvisational approach*. The improvisational approach is found in companies ranging from the Silicon Valley design firm IDEO to the manufacturing company W.L. Gore Inc., tucked away in the countryside along the Delaware–Maryland border.

IDEO is an award-winning design firm that brought the world the Apple mouse, the Palm handheld, the stand-up toothpaste tube, and hundreds of other products. They do it by tapping into the power of group improvisation, creating hot teams and then setting them loose in an intense version of brainstorming called “the Deep Dive” (Kelley, 2001). IDEO does not just apply the improvisationality of brainstorming at the front end of projects; it is an ingrained way of doing business throughout the project cycle.

IDEO uses rapid prototyping to tap into the innovation process, blending innovation and execution throughout the project cycle, and creating multiple teams to work on the same project independently so that emergent insights can cross-fertilize and blend together. They create inefficient redundancies and expect frequent failure. Employees are not assigned to teams; each team forms spontaneously and then splits up when its task is done. General manager Tom Kelley wrote that at IDEO, work feels like child's play (Kelley, 2001, p. 17)—and in my own studies of nursery schools, I have discovered that child's play is fundamentally improvisational (Sawyer, 1997).

In December 2004, *Fast Company* magazine went searching for the most innovative company in America—and they found W.L. Gore Inc., maker of the famous Gore-Tex waterproof material (Deutschman, 2004). Most people do not know that Gore has created over a thousand products—from Elixir, the top-selling acoustic guitar string, to Glide dental floss, to medical products such as heart patches and synthetic blood vessels.

Gore has consistently innovated by following the improvisational approach. Founder Bill Gore created a company with hardly any hierarchy and few ranks and titles. He organized the company as if it was a bunch of small task forces, constantly self-organizing and regrouping to respond to changing needs. These teams do not have bosses and they do not have clear-cut roles and responsibilities; instead, the teams are self-managed. As one employee said, “your team

is your boss, because you do not want to let them down. Everyone's your boss, and no one's your boss" (Deutschman, 2004, p. 59). Each new employee gets to choose which teams to join, and every employee is supposed to be like an amoeba, taking on a unique shape. Teams form improvisationally, teams manage themselves improvisationally, and employees define their own roles in the company improvisationally.

In addition to their team memberships, every employee is told to reserve 10% of their time to pursue speculative new ideas. In some cases, ad hoc teams form around these off-the-record ideas and continue for years before a new product is revealed to top management. The Elixir guitar strings started with a group of three employees who realized that the technology used in Gore's brand of Ride-On bike cables could be transferred to guitar strings. The idea was that by coating the metal strings with a fine film of plastic, natural oils from the fingers would not be able to corrode the strings and dull the sound. Strings would last longer and would always have the bright new sound that musicians wanted. These three gradually persuaded six other colleagues to help out with various expertise; everyone did this in their spare time. After 3 years of working without any permission or oversight, the team sought out the official support of the company. Soon after its release, Elixir became the top-selling acoustic guitar string.

Gore succeeds by following the improvisational approach. Of course, there is some structure to the company: four divisions, company-wide support functions like human resources and information technology, and specific businesses and cells. But management is always focused on leaving as much freedom for improvisation as possible, because they know that improvisation is the source of innovation.

When researchers and historians study the origins of the important innovations that change our world, they discover that they are never the isolated insight of a solitary individual; they always involve collaborative teams and complex organizations (Sawyer, *in press-b*). This is true of old inventions like the telegraph (not invented by Samuel Morse) and the light bulb (not invented by Thomas Edison); it is even more true of complex modern technologies like the windows-and-mouse use interface technology (not invented by Bill Gates). Schools should not try to identify and nurture a few special geniuses; instead, they should prepare all students to participate in complex creative systems, in which they will need to work collaboratively, at multiple levels of organization, to build knowledge together.

2. Improvisational creativity

In today's economy, innovations emerge from improvisational teams. In my research I study innovative teams by focusing on the most improvisational ensembles: jazz and improvisational theater groups. In both a jazz group and a successful work team, the members play off of one another, with each person's contributions inspiring the others to raise the bar and think of new ideas. Together, the improvisational team creates a novel emergent product, one that is more responsive to the changing environment and better than what any one team member could have developed alone.

Although the examples above are taken from the world of business, they show educators what is special about the arts: the arts provide one of the best ways for students to experience improvisational collaboration. Creative performance genres such as music, theater, and dance provide opportunities for students to work collectively to create a shared, improvised creative product. These group creative activities are particularly valuable for younger students, because they can be structured so that they require no special training or expertise—thus allowing students to move directly into collaborative creative activities. For example, improvisational musical interaction has been used in therapy with people who have no musical training (Aldridge, 1996; Ansdell, 1995), and new musical technologies enable untrained young children to collaborate musically at a surprisingly sophisticated level (Sawyer, *in press-c*).

To better understand group creativity, I spent several years analyzing the staged performances of professional improvisational theater groups in Chicago (Sawyer, 2003b). Improvisational theater represents an extremely small segment of the U.S. theater business. But in Chicago, there has been a thriving community of improv actors since the genre originated there in the 1950s and 1960s. Most of my research was conducted in alternative groups that were attended by members of the theater community, rather than the tourists who sought out the more famous Second City Theater. These groups were devoted to a pure form of improvisation where they started with absolutely no predetermined structure; many of them improvised a 1 h play without stopping.

Improvisation actors are trained to follow a few basic rules that help to make collective creation work. The most important is known as the "Yes, and . . ." rule: in every conversational turn, an actor should do two things: metaphorically say *yes*, by accepting the offer proposed in the prior turn, *and* add something new to the dramatic frame. A turn that accepts the prior offer without adding anything new does not move the drama forward, and it is better to keep the scene moving by introducing something new to the dramatic frame with every turn.

Example 1. 1:50 min into a 60 min long form improvisation. By this time we have learned that Ronald and the Girl have each brought the Student some papers, and seem to be helping him study. We do not yet know the names of the Student and the Girl. A fourth actor enters (all examples are from Sawyer, 2003b).

1	Actor 4	I brought you those files,	Walks on, delivers line to Student with a teary voice, and walks off stage immediately.
2	Student	I think Ray's more nervous about it than I am.	To Ronald; names Actor 4's new character.
3	Ronald	He's the most nervous of all of us!	Blurted out, he seems a little upset.
4	Girl	Tell him, Ronald.	Touches his arm, walks offstage.
5	Ronald	Ray's the most nervous. There. It's out.	Quieter.
6	Student	I made him nervous. I'm surprised you're all not more nervous.	

Most of these turns follow the ‘Yes, and . . .’ rule, particularly turns 2, 3, and 6. Such turns are known as *complementary offers*, because they accept the prior offer and then elaborate on it in a way that develops and builds on the original offer. Turn 2 accepts Ray’s offer in 1 that he is nervous, implicitly communicated by his teary tone of voice, and then elaborates by proposing that Ray is “more nervous about it than I am,” suggesting that the Student is also nervous. In turn 3, Ronald further elaborates that Ray is the “most nervous of all of us”. Turn 6 elaborates further by suggesting “I made him nervous”.

The ‘Yes, and . . .’ rule can be productively used by teachers in classroom discussion. In fact, many teachers instinctively follow this rule, even when engaged in the traditional discursive pattern of IRE; the teacher’s evaluation is often a *revoicing* (O’Connor & Michaels, 1996) of the student’s prior response. An effective revoicing first accepts the student’s response as valid and appropriate, and then elaborates it by revoicing it in a way that scaffolds the student’s understanding, by connecting the response to other relevant material, or by reformulating the response in more scientific or technical language.

3. Making teaching improvisational

The innovation economy requires that schools emphasize learning for deeper understanding, rather than mastery of lower-order facts and skills (Bereiter, 2002; Bransford, Brown, & Cocking, 2000). Which classroom activities lead to the creative, deep understanding required in today’s innovation economy—to students who are not just individually creative, but are able to participate in complex collaborative organizations? Decades of educational research have demonstrated that unstructured group discussion has the potential to teach students the sort of group creativity that the new economy demands (Sawyer & Berson, 2004). Many students initially have difficulty engaging in productive collaborative work; they need to be taught and scaffolded to participate in effective learning discussions (Azmitia, 1996; Crook, 1994). Research in the learning sciences (Sawyer, *in press-a*) is showing that when the proper scaffolding is provided, the most effective classroom discussion has the free-flowing collaborativeness of an improvisational theater performance. This sort of discussion is most effective for learning because it taps into several key mechanisms of learning:

- * It allows students to collectively build knowledge together—in the same way that professional communities like science labs and business teams collaboratively innovate (Scardamalia & Bereiter, *in press*).
- * It allows students to engage in the inquiry process—identifying a driving question to guide their classroom activities, and then proposing hypotheses, and marshalling evidence in support of and against competing hypotheses (Krajcik & Blumenfeld, *in press*).
- * It allows students to engage in productive argumentation—and research is showing the many ways that argumentation contributes to learning (Andriessen, *in press*).
- * It allows students to externalize their own developing knowledge, supporting them in a metacognitive process of reflection (Bransford et al., 2000).

Teaching for the innovation economy must be improvisational, because if the classroom is scripted and overly directed by the teacher, students cannot co-construct their own knowledge. Educational research on collaborating

groups has begun to emphasize the features that they have in common with improvising groups: their interactional dynamics, their give-and-take, and the fact that properties of the group emerge from individual actions and interactions.

Example 2, from an introductory fifth-grade lesson on functions (Lampert, Rittenhouse, & Crumbaugh, 1996), is an example of creative teaching. The whole-class discussion in **Example 2** occurred after small-group work. Several of the small groups had found the following problem particularly hard: given four sets of number pairs, what is the rule to get from the first number to the second? The number pairs were 8–4, 4–2, 2–1, and 0–0.

Example 2. Whole-class discussion. Ellie is the first student to speak after the teacher opens discussion.

1	Ellie	Um, well, there were a whole bunch of—a whole bunch of rules you could use, use, um, divided by two—And you could do, um, minus one-half.
2	Lampert	And eight minus a half is?
3	Ellie	Four (In response to this answer, audible gasps can be heard from the class, and several other students tried to enter the conversation.)
4	Lampert	You think that would be four. What does somebody else think? I, I started raising a question because a number of people have a different idea about that. So let's hear what your different ideas are and see if you can take Ellie's position into consideration and try to let her know what your position is. Enoyat?
5	Enoyat	Well, see, I agree with Ellie because you can have eight minus one half and that's the same as eight divided by two or eight minus four.
6	Lampert	Eight divided by two is four, eight minus four is four? Okay, so Enoyat thinks he can do all of those things to eight and get four. Okay? Charlotte?
7	Charlotte	Um, I think eight minus one half is seven and a half because—
8	Lampert	Why?
9	Charlotte	Um, one half's a fraction and it's a half of one whole and so when you subtract you aren't even subtracting one whole number so you can't get even a smaller number that's more than one whole. But I see what Ellie's doing, she's taking half the number she started with and getting the answer.
10	Lampert	So, you would say one half of eight? Is that what you mean? (Lampert and Charlotte alternate for three turns; then, Lampert checks in with Ellie, who again repeats her original answer; then Lampert calls on Shakroukh.)
11	Shakroukh	I would agree with Ellie if she had added something else to her explanation, if she had said one-half of the amount that you have to divide by two.
12	Lampert	Okay. You guys are on to something really important about fractions, which is that a fraction is a fraction of something. And we have to have some kind of agreement here if it's a fraction of eight or if it's a fraction of a whole.

The students propose different answers throughout the discussion; the teacher does not evaluate any given answer, but instead facilitates a collaborative improvisation among the students, with the goal of guiding them toward the social construction of their own knowledge. In fact, she has guided them toward learning that was not in her lesson plan, which was simply to ask them to come with the “divide by two” rule—in addition, the students have begun to learn about variables, and have learned a fundamental insight about fractions that will help them when they begin to multiply by fractions.

Experienced teachers like Lampert are effective improvisers (Borko & Livingston, 1989; Nilssen, Gudmundsdottir, & Wangsmo-Cappelen, 1995; Sassi, Morse, & Goldsmith, 1997). These teachers lead their students in *disciplined improvisation*: collaborative discussion in which students build knowledge together. Creative teaching is *disciplined improvisation* because it always occurs within broad structures and frameworks. The most effective classroom interaction balances structure and script with flexibility and improvisation, as teachers improvisationally invoke and apply routines and activity structures (Sawyer, 2004a).

4. Implications

If the core of the knowledge society is innovation, then key questions for educators become: how can schooling contribute to the knowledge society? How should schools be redesigned to reflect our shift from an industrial to a knowledge society? How should we prepare teachers to teach creatively? What classroom environments lead to creative learning? What sorts of assessment tools do we need to evaluate the creativity of students? How should we design textbooks and curricula?

Because innovation is a group phenomenon, understanding the connection between education and the knowledge society requires analysis at not only the psychological level, but also at a social group and institutional level. The key challenge is for schools to connect individual learning for creativity to social and organizational creativity and learning. To do this, schools have to provide students with opportunities for collaborative knowledge building, for group creation in improvisational teams. Toward this end, they should:

- * bring groups of students together to collaboratively work on tasks;
- * the tasks should be focused on questions that are motivating for students (Krajcik & Blumenfeld, *in press*);
- * students should be provided with extensive scaffolding in answering these questions, but ultimately granted the freedom and responsibility to find their own collective way to the solution;
- * accumulate knowledge across the school year and across grades, rather than break knowledge into 2- or 6-week units that are not thematically connected (Lehrer & Schauble, *in press*).

Of course, students are not adult professionals. They need support and structure as they engage in these collective knowledge building activities. Learning environments should be designed to scaffold this collaborative improvisational creativity so that it becomes a pedagogically effective disciplined improvisation. Some of the most exciting uses of educational technology are designed to provide scaffolds that will guide students' collaborative discussions, so that their natural improvisational abilities are channeled to most effectively result in constructivist learning (Sawyer, *in press-a*).

Some of the most significant implications for education are in lesson structure, curriculum design, and teacher preparation.

4.1. Lesson structure

Improvisational and collaborative teaching methods must be incorporated into schools if they are to contribute to the knowledge society. Research into individual and group creativity suggests that disciplined improvisation leads to constructivist learning for deep understanding, rather than rote memorization as assessed through standardized tests (Bransford et al., 2000; Sawyer, *in press-a*). If schools impose rigid scripted curricula—as has been happening in some urban U.S. school districts (Sawyer, 2004a)—the creative economy could grind to a halt.

4.2. Curriculum design

Curricula should be designed to provide scaffolds for creative group activities, and they should have substantial flexibility built in, allowing students and teachers to jointly improvise their own collective path as they build their own knowledge. The most effective teachers are those that can effectively use a wide range of degrees of structure, shifting between scaffolds and activity formats as the material and the students seem to require. These shifts in themselves are improvisational responses to the unique needs of the class.

Disciplined improvisation balances structure and script with flexibility and improvisation. Experienced teachers develop a repertoire of useful routines, and they have the professional skill required to instantly assess the flow of the classroom improvisation and interject exactly the right routine to advance their pedagogical goals, while allowing the improvisational discussion to continue.

Curricula that provide scaffolds for collective classroom improvisations include inquiry based designs, project based designs, and many software systems developed by learning sciences researchers (Sawyer, *in press-a*).

4.3. Teacher preparation

To build a creative classroom, the teacher has to relinquish control and allow the class to improvise as a group. This unpredictability is naturally stressful for many teachers; giving up control can be frightening, particularly for novice teachers. One of the most difficult skills for teachers to acquire is how to break out of structured routines and lead open discussion, where the students partially guide the direction of the class.

Improvisation is a conversational skill (Sawyer, 2001), and like other social and interactional skills, it can be taught. For example, teacher preparation could include training in improvisational theater techniques (Sawyer, 2004b). These

techniques can help to show teachers how to skillfully facilitate disciplined improvisations, free-flowing discussions that contribute to creative learning. Several professional development programs in the United States have begun to use improvisational exercises with teachers (Sawyer, 2004b).

5. Summary

In today's knowledge societies, one of the key missions of the schools is to educate for creativity. The knowledge economy is, at root, driven by the creation of new knowledge—prototypically, technological innovation, but also the creation of new procedures and new organizational forms (e.g., distribution of goods, market segmentation and targeted advertising, new financial instruments for funding research investment or international trade). Business theorists are essentially rediscovering Piaget's original insight that learning and creating are fundamentally the same process (Sawyer et al., 2003); it is a commonplace today among business scholars that a creative organization must also be a learning organization (Senge, 1990). To educate for the innovation economy, schools must provide students with opportunities to engage in collaborative knowledge building activities, through disciplined improvisations.

As Example 2 makes clear, any subject could be taught by using disciplined improvisation. But researchers have also found that children need to be taught how to engage in effective collaborative discussion. Here is a place where arts education can contribute—because arts educators have long emphasized the importance of collaboration and creativity. The performing arts are fundamentally ensemble art forms. Music educators are increasingly realizing the importance of using musical collaboration in their classes (Sawyer, 1999, *in press-c*). And as Example 1 shows, theater improvisations can provide a uniquely valuable opportunity for students to learn how to participate in collaborative knowledge building teams.

Many schools have already transformed their curricula to emphasize creative teaching. But these transformations have been occurring in the wealthiest countries and the wealthiest school districts, leading to a knowledge society that is generally run by children of privilege. In many large U.S. urban school districts, schools have taken an opposite tack—toward scripted curricula that are teacher-proofed, removing all possibility for improvisational action. Imagine the immense benefits if we unlocked the creative potential of the world's population by systematically implementing creative teaching throughout schools.

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