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Constructivism and Technology

On the Road to Student-Centered Learning

TECHNOLOGY HAS REVOLUTIONIZED OUR SOCIETY. We now have immediate access to more information and to more avenues of information retrieval and use than was dreamed possible even a few years ago. Technology also makes possible opportunities for hands-on and real-world learning and communication with learners around the world. To fully capitalize upon the promise of technology for education, both teaching and learning are evolving to prepare students to acquire, analyze, and communicate information in the ways demanded by the world of their future.

While technology has the potential to transform classrooms, this change doesn't occur automatically. In some classrooms, computers sit idle, becoming expensive dust collectors. In others, computers are glorified—and costly—electronic workbooks, primarily used for drill and practice. But in many classrooms, students routinely use technology to collect, organize and analyze data; to enhance presentations; to conduct simulations and to solve complex problems. In these classrooms, the technology seems almost invisible; it is the learning that is apparent.

Research[1] suggests that educational technology is most effective when used to enhance constructivist or student-centered instructional strategies. But how does one get started on this path?

Constructivism...what's that?

There seems to be a great deal of talk about "constructivism" these days. You've probably already heard about it in a workshop or read about it in an article or book. Nevertheless, it's not always clear what constructivism is and how to apply its concepts to the classroom.

Constructivism is both a philosophy and a theory of learning. The key concept of constructivism is that learning is an active process of creating, rather than acquiring, knowledge. The following principles provide a general framework of constructivism and its relevance for instruction.

- Learners bring unique prior knowledge and beliefs to a learning situation.
- Knowledge is constructed uniquely and individually, in multiple ways, through a variety of tools, resources, and contexts.
- Learning is both an active and reflective process.
- Learning is developmental. We make sense of our world by assimilating, accommodating, or rejecting new information.
- Social interaction introduces multiple perspectives on learning.
- Learning is internally controlled and mediated by the learner.

Why change what I'm already doing in my classroom?

Constructivist approaches emphasize both the process and the product of learning.

We tend to teach the way we were taught. But things today are not the same as they were when we were in school. New research about the way humans learn, the changes in the student populations in schools today and the shift to more information-based jobs demand that we rethink what we do in our classrooms.

Constructivism is all about inquiry, exploration, autonomy, and personal expressions of knowledge and creativity. As a result, constructivist approaches to learning and teaching are becoming more widely accepted in school settings because they shift instruction from passive to active learning and to authentic tasks. Computers are good tools for such expressions since they allow for exploration and highly creative and individualized self-expression. If technology is used effectively as a tool for creative work, students can be more autonomous, collaborative, and reflective than in classrooms where the technology is not present.

Constructivist approaches match the way we learn.

According to research in education and psychology, constructivism mirrors the way humans learn.[2] We learn by doing, by interacting with others and through authentic (real-world) tools and experiences. Let's think back to our own student days. We probably don't recollect a great workbook exercise, but we probably remember an engaging field trip, an interesting class project, or a dynamic, creative teacher. Let's think about the workshops we experience as teachers. Would we rather sit passively and listen to someone lecture to us about new technologies or practices, or learn the same information through hands-on activities? And because they allow for exploration and highly creative and individualized self-expression, computers are perfect tools for hands-on learning.

Constructivist approaches accommodate individual differences.

As individuals, we are all obviously unique and different—with different experiences and understandings of our world. Yet, to what extent are these differences reflected in instruction or the curriculum? Perhaps so many kids "tune out" of school because teaching and learning do not fall into their range of life experiences. Learning is different for each individual. Teaching practices based on constructivism are flexible and varied and therefore accommodate different learning needs. Computers, for their part, offer students individualized learning, allowing them to progress at their own pace.

Constructivist approaches prepare learners for the workplace of their future

The shift in the workplace to information jobs that demand skills in analysis and synthesis of information requires changes in both how and what our future workers learn. To be prepared to enter our globally competitive market, students must go beyond memorization of facts to knowing how and why. Constructivist approaches emphasize both the process and the product of learning. The minimum set of vocational skills in this Information Age includes literacy, numeracy, and computation skills. Learning how to operate and manipulate hardware and software imparts a very important set of vocational skills.

Classroom Resources

In each issue, we'll provide examples of ways teachers have integrated technology in their classrooms to create more constructivist learning environments. This issue focuses on simulation software and the ways in which it creates learning opportunities that might be otherwise unavailable to students.

Urban Planning with SimTown

"Our town is burning!" The group of 10 year old boys was panic-stricken as flames began to engulf the stores and small homes of their street.

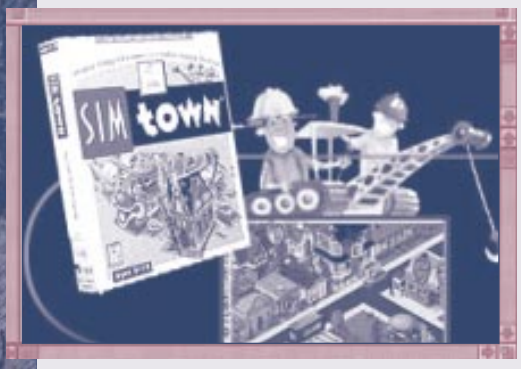
"Call the fire department!" said one.

"We can't! We don't **have** a fire department" another said in exasperation.

Helpless, with no fire station or assistance available, the boys could do nothing but watch as their town burned to the ground.

Fortunately the above scenario, while realistic, did not actually result in the loss of homes and lives. Rather, it occurred in a classroom using SimTown, a scaled-down version of SimCity, a popular urban planning simulation program. Geared toward 8 to 12 year olds (though popular with older kids), SimTown allows users to build a small town, and grapple with such issues as protecting natural resources, designing the urban layout, and providing infrastructure and services. The program includes a newspaper tool that provides feedback on the town's progress. In addition, a board of experts helps young urban planners negotiate between the often competing agendas of environmental and business interests. While the design of buildings is cartoonish and bears little resemblance to "real" structures, this seems to be part of its appeal to kids.

In this particular classroom, 10 to 13 year old students in a Texas-Mexico border settlement conducted a physical survey of their town's two main streets. They recorded the number of residences and businesses and noted areas of trash dumping, poor road quality, and vegetation. Students then used SimTown to construct a model of the two most densely populated streets of their community and documented some of their community's problems using the newspaper tool. These student planners discovered that their town was at great risk for fire and presented this information, along with fire mitigation suggestions, to the City Council. The result was an animated discussion between councilors and students about the need for a community fire-safety awareness program. Many of the students volunteered to help in this campaign.



Urban Planning with SimTown

SimTown costs $14.95 and comes in versions for either a Macintosh or PC. Even when begun in one platform it can be transferred to another. Because of the detail of its graphic drawings, its high degree of interactivity, and the multitude of possible activities, SimTown system requirements are:

- Windows 3.1 or higher with a 386 or above processor
- SVGA display
- 8MB memory
- standard CD-ROM
- mouse

or

- Macintosh system 6.0.7 or higher with a 68030 or above processor
- 256-color display
- 4MB memory
- standard CD-ROM
- mouse

or

- Windows 95 with a 386 or above processor
- SVGA display
- 8MB memory
- standard CD-Rom
- mouse

For more information on SimTown, call 800-245-4525 or visit

http://www.maxis.com/games/simtown/

Let's examine the ways in which this exercise was a technology-rich constructivist activity:

Using their prior knowledge.

Based on their knowledge of their homes and community, students came up with reasons for why their town would be at risk for fire—the preponderance of wooden houses, the hot, arid climate of South Texas, the large percentage of people who smoke at home, storage of such flammable materials as paint and cleaners in houses, and, most important, the absence of a fire station in their community. Though students could not change either the climate or the lack of emergency services, they proposed fire awareness campaigns that focused on removing combustible materials from homes and that advertised the dangers of smoking in the house.

Constructing knowledge uniquely and in multiple ways.

While all groups discovered that fire posed a grave threat to their community, each group discovered distinctive problems facing their community—illegal trash dumping, a dearth of organized activities—and proposed their own set of solutions to combat this problem.

Learning through action and reflection.

Students recreated their physical landscape using real-world data and made observations from which they could draw their own conclusions. They learned about urban planning by doing it—surveying, examining, and entering data—and by reflecting on it—discussing findings, presenting this information to the community, and sharing ideas with City Council members.

Learning is developmental.

The simulation software made it possible for students to re-create their community and test hypotheses by changing variables and viewing the results. The newspaper tool provided feedback on how students were progressing. SimTown provided immediate response and engaging pictures of their predictions, which would have been difficult to produce through paper-and-pencil plans.

Introducing multiple perspectives through social interaction.

Students offered their opinions and offered solutions on what they considered to be the most serious problems faced by the community. In turn, City Councilors shared with students some of the legal and financial constraints that might make certain solutions difficult. Together, the two groups brainstormed ways to initiate low-cost fire awareness programs. Such an exchange exposed each group to the concerns of the other and laid the foundation of a working relationship in creating a fire awareness prevention program.

Internally controlling learning.

Students entered this activity with their own perceptions and values regarding their community. Consequently, the simulation problem held different significance for each student based on these values, and these differences were reflected in the variety of proposed student strategies for combating their town's problems.

What is Simulation Software?

Simulation programs create a model of real or imagined events and allow the software user to interact in that model. Long regarded as an effective learning tool, simulation software allows classroom students to experience physical situations in which they could never participate because of expense, logistics, or danger. Pilots and astronauts, for example, use flight simulators as part of their training[3].

Simulations are excellent learning tools, since users can negotiate environmental constraints, solve problems like those in real-world settings, and witness the effects of changes they make in variables[4].

Although we have noted one type of commercially available and educationally useful simulation software, there are a number of free educationally valuable simulation sites on the World Wide Web:

Interactive Frog Dissection is designed for high school biology classrooms and is a wonderful preparation (or substitute, in some cases where a shortage of lab supplies precludes such activities) for actual frog dissection. Through text, photos, audio and video, students can virtually dissect their own frog at their own pace and study the frog's internal organs. You'll need Internet Explorer or Netscape 2.0 or higher to run this program.

URL: http://curry.edschool.Virginia.edu/go/frog/home.html

The Stock Market Game 2000 (SMG) is designed for students in Grades 4 to 12. Teams of 3 to 5 students, monitored by their SMG-trained teacher, invest an imaginary $100,000 in the American Stock Exchange, New York Stock Exchange, or NASDAQ. Teams build their portfolio of common stock, calculate Price-to-Earning ratios and fees and track their gains and losses. Winning teams receive recognition at the end of the semester. This site is affiliated with the Securities Industry Foundation for Economic Education and the National Council on Economic Education. As of August 1998, there was a $14.00 fee for each participating team. SMG provides local training to teachers wishing to participate in this project.

URL: http://www.smg2000.org

Constructivism

On-Line Resources:

For more information about the topics in this newsletter, check out these resources by pointing your browser to these URLs:

1. **Computers and Constructivist Inquiry** provides information on teaching with technology.
   URL: http://www.ilt.columbia.edu/k12/livetext/readings/techped.html#construct
   Source: The Institute for Learning Technologies at Teachers College, Columbia University, New York.

2. **WWW Constructivist Project Design Guide** is another Columbia University site that provides articles and links to instructional resources on the Internet. The site also furnishes tips on student Internet surfing, and discusses multimedia resources as part of portfolio and program assessment.
   URL: http://www.ilt.columbia.edu/k12/livetext/curricula/general/webcurr.html

3. **Constructivism and the Five E's** is an instructional model for constructivism based upon the five E's of Engage, Explore, Explain, Elaborate and Evaluate.
   URL: http://www.miamisci.org/ph/lpintro5e.html
   Source: Created by the Biological Science Curriculum Study (BSCS), a nonprofit, research and development curriculum study group concerned with improving science education.

4. **Applying Technology to Restructuring and Learning** aims to assist schools in creating technology-integrated constructivist learning environments. This project of the Technology Assistance Program (TAP) of the Southwest Educational Development Laboratory is working with teachers in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas at the project's six partner schools. This site provides on-line subject area resources as well as general information on technology-integrated constructivist classrooms.
   URL: http://www.sedl.org/sedl/tap.html
   Source: Southwest Educational Development Laboratory

References:

[1] Association for Educational Communication and Technology. (1992). *Using Technology to Support Education Reform,* p. 10. Washington, D.C.: U.S. Department of Education Office of Educational Research and Improvement.

[2] See the works of Jean Piaget and Lev Vygotsky. See also *Creating Constructivism* by Catherine Fosnot.

[3] Maddux, C.D., Johnson, D.L., & Willis, J.W. (1997) *Educational Computing: Learning with Tomorrowís Technology,* p. 216. Boston: Allyn & Bacon.

[4] Ibid., p. 29.

What do constructivist practices look like in the classroom?

There is no blueprint for a constructivist classroom, and teaching practices based on constructivism are varied and flexible. However, you are likely to see lots of commonality across constructivist classrooms: students who are engaged, active, and responsible for their own learning. They work collaboratively to solve authentic problems that have real meaning for them. Students reflect on their ideas through peer and teacher questioning, discussion, or journals. They use technology and other tools for inquiry, exploration, research, expression, and assessment. In short, in a constructivist classroom, learning is something a student *does*—not something *that is done to* the student. The teacher moves around the room, coaching students, providing feedback on their ideas, and managing the structure of the class. Most important, the teacher is a learner too!

How can I do this in my classroom?

Just as there's no one template for a constructivist classroom, there's no one path to transforming your practice. Starting with your prior knowledge and building from there will make the transition easier. Since most teachers have experience with lesson and unit design, let's begin the journey toward constructivism there.

Begin with a problem or issue that your students find relevant and meaningful and that will encourage their autonomy and initiative.

Students love to debate issues, particularly when the issues affect their own well-being and sense of justice. If your curriculum includes the Constitution, for example, you might choose the First Amendment and have students investigate their community's policy of teenage curfews. The idea of constitutional rights can then go beyond a legal abstraction to a vehicle to guarantee student rights. Students can research news articles and court cases about freedom of assembly, write and perform a skit for language arts, create and conduct a trial about such a case for government studies, e-mail attorneys, or investigate the process and accuracy of analysis of physical evidence in a science class. Better yet, a group of teachers could work collaboratively on an interdisciplinary project that would include all of these ideas and more.

Provide students the opportunity for interdisciplinary exploration

Language provides a great window on a culture. Rather than studying disparate subjects, find connections between subject areas. The study of "French" could encompass not just learning the language, but also French geography, history, cuisine, literature, use of the metric system, scientific discoveries, film and music. Such connections between disciplines make learning experiences more authentic and powerful.

Develop tasks that require higher-order thinking

For example, while reading a story to students, stop periodically and ask them to predict what will happen next, or by the end of the story, and to furnish rationales for their predictions. Note these ideas on a chart tablet or chalkboard. Finish the story and then discuss the similarities and differences between their predictions and the story's ending. In this way, through prediction, interpretation, and analysis, students can practice essential reading skills while creating new understandings of the story and the writing process.

Use raw data and real-world data from primary sources.

For example, instead of only lectures, videos, or readings, a unit on African-American history could include raw data downloaded from the U.S. Census site on

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Second grade students are investigating the flexibility of different materials. They have been asked to examine, predict, test, and record their findings to determine which, and how, different materials bend. Once they have completed this investigation, they are asked to find, analyze, and test materials that stretch and tear and materials that do not.

Middle school students are analyzing the pH of several water samples taken from a local river over a period of time. They use pH test kits and then plot and label data in a bar graph. After they have analyzed the data to find trends and patterns, they will predict what effects these changes have on plants and animals in the ecosystem. Also, they will predict and discuss how these changes impact the area's agricultural economy.

In the first classroom, students gather, manipulate and analyze data based on their own observations.

In the second classroom, students create data from which they make predictions and apply such conclusions to their community.

How can I do this in my classroom?

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the Internet <http://www.census.gov>. Students could examine the political, social, and economic status of African-Americans since the 1960s Civil Rights Movement by looking at such census categories as employment status, educational attainment, household income, home value, and poverty rates by race. Students could then produce their own charts, graphs and reports to examine socio-economic changes within the African-American community. In this way, students generate and author their own knowledge about a particular concept rather than passively receiving it from a secondary source.

How do I get started with technology in my classroom?

Just as the journey to a more constructivist classroom starts with small steps, so too does the shift from a non-technological to a technology-enriched classroom.

Start small.

Start with a small task such as supplementing research with some Internet resources or having students word process (vs. hand write) a report. As you feel more comfortable you can increase your repertoire of computer-based classroom activities.

Don't expect change overnight.

Technology is not a panacea for all that ails a classroom and may take years to become integrated into a school. (However, don't use this as a reason not to start right away!)

Remember that the computer is a tool, not the curriculum.

The computer should supplement the curriculum, not vice versa. If the computer can help teachers or students do something that would otherwise be impossible, or if it helps us to something better, then we should use it. If not, we shouldn't.

Ask for help.

For those of us who came of age and started our professional lives before the Information Age, getting used to computers and the different types of software seems difficult. Learning technology, however, is easier than it appears. It just takes time. We shouldn't let not knowing or having difficulties with software get us down or deter us from the true potential of the technology. There are lots of experienced educators around. Ask for their help!

Learn from and with your students.

Many of our students have grown up around and feel comfortable with technology. We should not feel ashamed that they may know more about technology than we do. As educators we should welcome opportunities to learn from and with our students.

To contact the Technology Assistance Program, please call us at 1-800-476-6861 or write to us at Technology Assistance Program, SEDL, 211 East Seventh Street, Austin, TX 78701. You may also send us e-mail by writing to Vicki Dimock, Program Manager (vdimock@sedl.org).

TAP into Learning is a collaborative effort by the staff of the Technology Assistance Program. This issue was written by Mary Burns, Marilyn Heath, and Vicki Dimock.

Mary Burns, Editor.

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