Types of educational software

As you read the following descriptions, think about whether the different types of software would be used as tutors, mindtools, or supports for conversation.

_Tutorials_ are designed to teach new content in a step-by-step manner. You may be familiar with the tutorials that come with software packages. Some schools rely on instructional learning systems (ILS) that not only provide tutorials on a range of standards-based topics but interface with student management systems to help monitor and report student achievement. Tutorials typically provide a complete lesson on a specific topic including 1) presenting new information, 2) providing practice, and 3) evaluating student learning. Students should be able to work at their own pace and review material when needed. Tutorial programs are designed to provide additional instruction to students who need extra help or enrichment to students who want to explore a topic that is different from that of the rest of the class.

_Drill-and-practice_ software is designed to help students practice facts and remember processes or procedures they have encountered previously. Basic literacy and numeracy skills, such as letter and sound identification and mathematical operations, as well as other skills that need to become automatic, are well suited for drill and practice. Typically, students are presented with a task to which they respond, which is followed by feedback on the adequacy of their responses. Some programs allow students to adjust the rate at which the problems are presented; others automatically adjust the rate of display based on students’ responses. Some drill-and-practice software incorporates competition in a game-like format. It’s important to remember that drill-and-practice software is designed to provide practice in areas in which students have already received instructions. Drill-and-practice software is an effective means of reinforcing knowledge to the extent that it can be recalled quickly and automatically.

_Games_ are characterized by rules, have entertainment value, and typically involve competition. Students can compete against time constraints, for points, or with other students. Many games are available online. Some games allow students to complete drill-and-practice exercises, often within the context of earning a score. These games support low-level cognitive activities and skill acquisition and many emphasize performance goals over learning goals, but the performance goals can be directed at competition with one’s self rather than with others. Others can require sophisticated skill and knowledge development such as when games incorporate aspects of simulations. Consider simulations used by the military, such as
flight simulator software that is also readily available in several versions for many gaming systems. The equipment used by the military is often large and expensive, and incorrect use can be not just costly, but deadly. The stakes in that type of learning situation are extremely high.

Games can also take the form of board games, word games, adventure games, role-playing games, or logic games. Educational games may require students to explore and develop an understanding of complex concepts and manipulate a variety of variables in order to complete the games successfully. Games can address such complex systems as commerce, economics, diplomacy, and politics. Just as in real life situations, games often do not have one correct answer or solution and can draw upon multiple higher-order thinking skills and strategies. This characteristic, of course, makes student performance difficult to score.

Many games have the capacity to connect multiple players, sometimes at different locations, via the Internet. This type of interactivity ratchets up the social aspects and open-ended nature of games as students become engaged with other students. The unfortunate truth is that while many entertainment-based games include engaging graphics and animation and support multiple players, the market for educational games is not very lucrative (Kelly, 2005). While the games on your Xbox might illustrate amazing feats of technological development, it will take some time before educational games reach this same level of sophistication on a widespread level.

Simulations allow students to experience events that are too dangerous, expensive, or difficult to experience in reality. Variables can be manipulated and processes sped up or slowed down, such as the growth of a plant or the rise and fall of a civilization, to demonstrate the effects of such manipulations. Simulations can be used to provide practice in the operation of tools and equipment prior to using the actual device. Typically, simulations are not used to introduce new content, but to provide an opportunity to illustrate ideas in action and apply skills in a safe environment. Before using a simulation, students may need instruction in both the content of the simulation and the correct operation of the tools embedded within the simulation.

There are many different types of simulations as well as applications to support them. Simulations are available for almost any grade level. They are found in elementary and secondary classrooms as well as in military settings and are even used for licensure exams in fields such as medicine. There are stand-alone
simulations, such as the Concord Consortium’s GenScope™ and BioLogica™, which use minimal computing power and simple graphics to allow students to investigate complex problems related to genetics through an easy-to-use graphical interface. There are simulations that are strictly online, such as the Whole Frog Project, where students can “dissect” the parts of a frog without ever having to worry about using a scalpel or having to smell formaldehyde. Another online simulation involves the spy-based character, Guy Simplant, whose clumsy antics allow middle school students to learn about biomaterial implants in humans. There are simulations available from government organizations, such as NASA and long-standing educational resource providers, such as PBS and Discovery Education, which capitalize on budgets not usually available to educators. Hybrid forms of simulations have also been developed that span both stand-alone and web-based delivery, such as the popular Sim series of gaming software that include several versions of SimCity™ with added functionality and supports online.

Given the power of commonly available technologies to present high-quality graphics, audio, and video, simulations offer a highly engaging tool for many students. Simulations can provide a safe environment for students to explore new concepts and practice new skills. An explosion in a virtual lab is much less of a disaster than shutting down the science wing in your school. Simulations allow students to explore multiple paths to a conclusion and often allow novices quick entry into a complex setting or domain that would be difficult otherwise. However, this same aspect can lead to superficial learning, or even no learning, when students do not possess the foundational skills to truly capitalize on the power of the simulation.

On the higher end of the simulation continuum are virtual reality (VR) environments that may require different computer interfaces than a mouse and keyboard and that allow the user to feel physically "immersed" in the computer-generated environment. Some of these interfaces include headsets that allow the user to experience sounds and 3-D images; gloves or other sensors that help the user to interact with objects and other users; and haptic, or touch-sensitive, devices that provide feedback such as resistance or reaction to objects, weight, or gravity. Browser-based plug-ins are also available that allow the manipulation of 3-D elements.

Virtual reality environments can allow students to walk on the floor of the ocean, visit distant or imaginary planets, or go back and forth in time. Several VR projects have been developed that support...
model-based instruction—that is, they help learners form mental models of concepts and phenomena (Dede, Salzman, Loftin, & Sprague, 1999). In one virtual world developed by these education technology researchers, NewtonWorld, students can investigate the kinematics (the motion of a body without reference to force and mass) and dynamics of one-dimensional motion—essentially by launching and catching balls of various masses. These environments may have attributes of known environments and phenomena or may represent fanciful learning environments limited only by imagination—and enough computing power. Due to the costs of developing and delivering virtual environments, these applications currently suffer from limited educational use, but researchers and educators are working to make the power of VR affordable for use in schools.

An outgrowth from this work is the creation of “augmented reality” learning environments. Developed by the Massachusetts Institute of Technology’s (MIT) teacher education program in conjunction with the Education Arcade, augmented reality simulations require learners to visit real places, such as a museum, where they collect data from handheld devices to solve complex problems. The data can be in a variety of formats including GPS (global positioning) data and environmental data, as well as data sets downloaded from a computer or other workstation in the setting. The intention is to develop an authoring tool that would allow teachers to create their own augmented reality simulations.

Problem solving software, whether on the high-tech VR side of things or as more commonly available software, requires the use of higher-order thinking skills in order to achieve a solution to the problem presented. Problem solving software can present a realistic problem for the students to solve or can be game-like, sometimes both at the same time. Typically, students develop, test, and refine hypotheses as they synthesize information to solve the problem. Problem solving software can focus on a specific subject area or require the application of knowledge across several curricular areas. It can be open-ended in nature or model specific problem-solving strategies.

One of the early problem solving technology-based tools is The Jasper Project developed and researched by the Cognition and Technology Group at Vanderbilt University (CTGV; 1997) It originally consisted of complex problems embedded in video-based learning activities. The problems often addressed core content areas, such as math and science, but were contextualized in entertaining videos that—like real-life problems—often contained confounding information. The developers observed that teachers and
students in some classes spent much longer than anticipated on solving the problem and so developed software to support both modeling of problem-solving strategies as well as guidance for teachers. The new teacher software included a computer-based rubric to facilitate assessment of student-generated blueprints designed to address the features of the problems. The rubric helped teachers to focus on salient features of the student blueprints, provide appropriate feedback, and reduce the amount of assessment time. New modeling software provided a workspace for students to keep track of steps and calculations related to their solution attempts. It also incorporated a simulation component that allowed students to test developing theories and strategies, and coaching prompts to help students optimize their plans. This early experiment helped subsequent education software developers to create problem solving software that capitalized on a variety of media formats, such as the popular Science Sleuths series now provided by Discovery Education and Minds on Science, the result of a joint effort between the Smithsonian Institution and Tom Snyder Productions.

A prototype environment called MUVES (multi-user virtual environment simulators) represents an open-ended problem-solving environment that was designed to address the concept of experimental design, one that middle school science teachers identified as difficult for many students to understand (Dede, Ketelhut, & Ruess, 2004). While focusing on experimental design, the environment also addresses complex social and historical problems, such as the effects of pollution and disease in an area that becomes more urban. The MUVES environment enables multiple participants to interact in a virtual world called River City. The virtual environment contains digitized artifacts from the Smithsonian Museum, audio and video clips, and simulated data collection stations that provide data from environmental samples. River City’s inhabitants and the visiting students are represented by avatars, computer-based characters, and visits span two time period: at the turn of the last century when River City was in its prime, as well as the present day, when the water supply is ruined and citizens display signs of disease. In River City, students act as scientists. They gather data to explore complex questions, such as "Why are more poor people getting sick than rich people?" They work in teams to develop and test hypotheses to solve problems. They answer questions in a Lab Notebook, which can then be used for assessment by the teacher. There are several problems embedded in the environment and some real “solutions” to the problems, but the routes students take, the emphases teachers place on different content areas, and the strategies students use can vary.
Innovative problem solving experiments like River City have led to the creation of more feasible projects in the classroom, such as the “augmented reality” simulations described earlier.

References

